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Title: Potential Effects of Subsidized Livestock Insurance on Livestock Production

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Abstract:

Recent legislation has cleared the way for subsidized livestock price insurance. Such programs could increase production. Expected feeder cattle prices with and without subsidized insurance will be analyzed using E-V and Stochastic Dominance. Results will highlight the potential effects of the program on marketing risk and production decisions.

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Introduction

Over the past few years, there has been a noticeable change in agricultural policy that has involved expanding the role of risk management and insurance. Subsidized crop insurance that insures either crop yields or revenues has been the focus of much legislation and debate. In general, crop insurance programs involve government subsidies to producers to cover a portion of insurance premiums along with reinsurance (and, in some cases, direct subsidies) to private firms that provide the insurance. While these programs offer farmers a means of risk management, they have often been costly and have drawn criticism for the incentives that they create (Skees 1999b, Turvey). Recent legislation has now cleared the way to introduce similar insurance programs for livestock. Like crop insurance programs, these programs have the potential to establish risk sharing markets that will allow producers to manage net income risk associated with livestock production and, if subsidized by the government, also have the potential to introduce perverse incentives to livestock producers. With this in mind, it is worthwhile to carefully evaluate the situation of livestock producers and the potential effects of subsidized livestock insurance. This paper will do just that by comparing the risk faced by livestock producers with no insurance, fairly priced insurance, and subsidized insurance.

Livestock producers, like all farmers, must make decisions in a risky environment and will make decisions based upon the level of risk present and their individual attitude toward risk (Anderson, Dillon, and Hardaker, Boisvert and McCarl; Hardaker, Huirne, and Anderson; Robison and Barry). Given the lack of vertical integration or cooperation in the beef industry, beef producers generally have limited opportunity to share the risk of their respective operations and are left to design individual risk management strategies. One type of risk that greatly influences profitability is marketing or price risk. Futures market hedging and cash forward

contracting provide opportunities to manage price risk. However, these alternatives come at a cost. For example, futures options offer a mechanism to establish a price floor for some premium. If futures markets function efficiently, this premium reflects the true value of the option. Producers realize that they will not always exercise these options and therefore in some years will actually forgo income in exchange for being insured against possible loss. Thus, the option premium (and therefore the risk it is priced to manage) is internalized into their decision-making process. In general, the premiums a producer will expect to pay are at least as much as the payments they realize, over the long run. The same can be said for actuarially fair price insurance, which functions much like a European option and can only be exercised when it expires. As long as these instruments are fairly priced, decision makers will choose to utilize them or not based upon their individual risk preference. Specifically, more risk averse producers will forgo a larger proportion of expected income to realize a given decrease in the variability of that income.

If the same risk management instruments are offered with subsidized premiums, the true risk is not internalized into the decision-making process and as a result, producers will be inclined to take on more risk than they would with fairly priced insurance (Skees 1999a). In the case of beef production, this can mean producing more beef and/or producing beef under riskier conditions. As producers realize that the true value of the insurance is greater than the amount they must pay, they are likely to expand their operations to levels that result in their being exposed to the same level of risk as they were prior to the subsidy. This behavior has been shown in some studies regarding subsidized crop insurance and crop production (Skees 1999a and 1999b, Turvey).

The general goal of this study is to highlight the effects of government subsidized insurance on the actual risk faced by livestock producers. Specifically, this paper will simulate three possible marketing alternatives that a livestock producers might face: (1) selling feeder cattle with no means of price protection, (2) purchasing actuarially fair European put options, and (3) purchasing insurance in the form of European put options with a portion of the premium subsidized by the government. Each alternative will then be ranked according to its risk efficiency for a variety of risk attitudes ranging from risk preferring to risk neutral to risk averse. This ranking will be done using Expected Value Variance (E-V) Analysis and Stochastic Dominance Criteria. Results from both dominance analyses will be of interest to policy makers wishing to implement programs that allow livestock producers to manage marketing risk while introducing appropriate incentives to these producers. Results from the E-V analysis will help to approximate how much producers of different risk attitudes will value a government subsidy on the insurance premium.

To complete this analysis, it will be necessary to present a brief review of choice under uncertainty. This will be followed by an explanation of how the three previously mentioned marketing alternatives of a livestock producer are simulated. The three alternatives can then be ranked and the results of this ranking can be discussed and conclusions can be drawn.

Conceptual Framework

It is widely agreed upon in agricultural economic literature that agricultural production decisions are made in an uncertain environment and that depending upon an individual's aversion to risk, he or she will evaluate all available risky alternatives accordingly (Anderson, Dillon, and Hardaker; Boisvert and McCarl; Hardaker, Huirne, and Anderson; and Robison and

Barry). There has been much research concerning how to simulate this decision-making process to aid producers in choosing strategies that are optimal to them. The classic model for choice under uncertainty is the expected utility framework as proposed by Von Neuman and Morganstern. In this framework, an individual will maximize utility subject to the probabilities of the occurrence of “good” or “bad” events. While theoretically sound, this approach is very difficult to use in an applied sense, as it requires that the utility function of the decision maker be known and specified. Since it is neither practical or, in some cases, even possible to specify decision makers’ utility functions, many alternative procedures have been developed to rank risky alternatives. In general these approaches are designed to present a risk efficient set of choices, which is a subset of all available choices, and allow decision makers to choose from them. Any alternative not in the risk efficient set is said to be risk dominated and should not be considered by the decision maker. Two widely used techniques that follow this general framework are E-V analysis and stochastic dominance rules.

E-V analysis (Markowitz, Freund) is very widely published in agricultural economic literature as means for ranking risky decisions. However, there has been debate as to whether E-V analysis is a theoretically appropriate method to represent optimal decision making. It is generally agreed upon that expected utility theory (Von Neuman and Morganstern) provides the theoretical base for choice facing uncertainty. E-V analysis is consistent with expected utility theory in three cases: (1) the underlying income distribution is normal (Freund), (2) the distributions of the decision variable differ only by location and scale (Meyer 1987), and (3) the underlying utility function is quadratic (Markowitz, Tobin). If any of one of these conditions is present it is generally agreed upon that E-V analysis is indeed consistent with expected utility

theory. In addition to a presence of many economic studies, empirical evidence demonstrates the closeness of E-V analysis to the expected utility maximizing choices (Levy and Markowitz).

In this study it is necessary, as mentioned earlier, to simulate livestock prices. In general, prices are not expected to be normally distributed and therefore the returns associated with prices may or may not be normally distributed. Furthermore, comparing a case of no price protection with purchasing a put option, which effectively truncates a distribution at a certain price (strike price – premium), ensures that the two alternatives do not differ only by location and scale. Given these shortcomings, only under the assumption of a quadratic utility function can E-V be expected to be consistent with expected utility theory. This assumption is rather restrictive, given that it implies that absolute risk aversion increases as the level of payoff increases so that at some level marginal utility of wealth becomes negative (Robison and Barry; Hardaker, Huirne, and Anderson). Even though these assumptions are not met, E-V analysis is still a strong analytical tool. According to Robison and Barry its strengths beyond decision theory include relative ease in deriving optimal solutions and conducting equilibrium analysis and the natural relationship between the concepts of risk and variability and the statistical concept of variance. Given these characteristics and the fact that this study aims only to rank the marketing alternatives and approximate the value producers might place on the subsidy, E-V analysis is an appropriate tool for analyzing the three alternatives outlined earlier. If alternatives A and B are mutually exclusive and/or not correlated, they can be ranked by calculating the certainty equivalent (CE) or risk adjusted returns for each alternative using E-V analysis as follows:

$$(1) \quad CE_A = E(A) - \Phi(\text{Var}(A))$$

$$(2) \quad CE_B = E(B) - \Phi(\text{Var}(B))$$

where $E(A)$ and $E(B)$ are the expected values of A and B, respectively and $Var(A)$ and $Var(B)$ represent the variance of each. Φ is a risk aversion coefficient. If $CE_A > CE_B$ then A dominates B, if the two are equal then both A and B might be in the risk efficient set of choices. However, for two choices with equal expected returns, the one with the lower variance is preferred (i.e., the risk dominant choice).

Given that the assumptions required for E-V to be consistent with expected utility theory may not hold in this study, another test for dominance should be used to test the robustness of the E-v results. For this reason, the choices will be analyzed using stochastic dominance (SD) criteria as a means of ranking livestock marketing strategies. Three types of stochastic dominance are generally used to rank risky choices. These are first degree stochastic dominance (FSD), second degree stochastic dominance (SSD), and stochastic dominance with respect to a function (SDRF) or generalized stochastic dominance (Meyer 1977). SDRF is the most discriminatory and flexible test for risk dominance among the three SD criteria mentioned (Robison and Barry; Hardaker, Huirne, and Anderson). Also, FSD and SSD can be shown to be special cases of SDRF (see Meyer for explanation). These characteristics of SDRF make it the most robust and useful tool for this analysis. FSD and SSD will be referred to in parts of the analysis but the reliance upon ranking choices will be placed upon SDRF.

Unlike E-V analysis, which is based solely on the first two moments of a distribution, SD criteria consider the entire distribution and therefore can generally deal with non-normality of the distributions involved. This is because SD places fewer restrictions on the utility function of the decision maker and bases risk dominance on the entire cumulative distribution function (CDF) of each alternative.

SDRF, like E-V, introduces the advantages of knowing decisions makers preferences without actually eliciting utility functions. This is accomplished by relying on the specification of upper (Φ_U) and lower (Φ_L) bounds of the Pratt risk aversion coefficient, which is often easier to estimate than a utility function (Hardaker, Huirne, and Anderson). Assuming an individual has a utility function $U(y)$, then the Pratt coefficient is equal to

$$(3) \quad \frac{-U''(y)}{U'(y)}$$

Once L and U have been specified then a $U(y)$ that minimizes

$$(4) \quad \int_{\Phi_L}^{\Phi_U} [B(y) - A(y)] U'(y) dy$$

is found. If the expression is positive then A is preferred to B. If the expression is zero, SDRF cannot rank the two alternatives. If the expression is negative, B might be preferred to A. To verify this $A(y) - B(y)$ is substituted into the brackets and the expression is reevaluated. If the minimum of new expression is positive then B is definitely preferred to A. If the expression is again negative, SDRF cannot rank the alternatives.

Both E-V and SDRF require the estimation of risk aversion coefficients. McCarl and Bessler offer a method for calculating the Pratt risk aversion coefficient when the utility function is unknown. In their formulation the decision maker is said to maximize the lower limit of a confidence interval from a normally distributed set of returns. The formula is:

$$(5) \quad \Phi = \frac{2Z_a}{S_y}$$

where Φ = risk aversion parameter, Z_a = the standardized normal one-tailed Z value of an α level of significance, and S_y is the relevant standard deviation under risk neutral returns. This

method will be used to estimate risk aversion coefficients for both E-V and SDRF. S_y is represented by the standard deviation of the expected price assuming the producer does not attempt to manage price risk (this expected price will be defined in detail later in the paper) and Z_α will be specified from 5% to 95% in 2.5% increments. In this formulation, $Z_\alpha = 50\%$ is considered to be risk neutral while $Z_\alpha > 50\%$ is risk averse and $Z_\alpha < 50\%$ is risk preferring. Some of the extreme values of Z_α are not likely realistic levels of risk preference for agricultural producers but serve to illustrate how individuals of different levels of risk aversion respond to available choices.

The ranking of the three aforementioned beef cattle marketing strategies will be completed in the following sections of this paper. First, it will be necessary to specify the type of beef producer to be analyzed and make any necessary assumptions. Then the alternatives of no price protection, fairly priced European put options and subsidized price insurance can be ranked using E-V and SDRF. The results of all the analysis will then be reported and discussed with conclusions following this discussion.

Analytical Procedure

Assumptions Regarding the Livestock Producer

To examine livestock production it is often necessary to limit the examination to a specific level of production. This is because different levels of livestock production may require very different management practices and decision-making procedures. For example, cow-calf producers must purchase breeding stock and expect to recover this investment over a period of a few years. Backgrounders, on the other hand, purchase weaned calves (approximately 500 pounds) and sell them to feedlots a few months later as feeder cattle (approximately 750 pounds).

They are more concerned about short run prices and conditions than cow-calf producers. For the purposes of this study, backgrounders will be used.

The assumption will be made that the backgrounder purchases weaned calves and will sell them in 150 days. Therefore, the producer is concerned with the expected price of feeder cattle 150 days from the date of purchase. One common method of estimating this expected price is the feeder cattle futures market contract. Specifically, the price of the feeder cattle contract that will expire in roughly 150 days will represent the expected price for a producer with no price protection. To accomplish the goals stated earlier, this study will approximate the risk associated with this expected price and offer two risk management strategies to determine producers' willingness to adopt fairly priced European put options versus their willingness to adopt subsidized price insurance that is structured as a European put option.

Simulation of Expected Prices

To represent the risk associated with this expected price, it is necessary to further specify the distribution of possible prices. Many investment consulting services report implied volatilities of futures market contracts. These are usually calculated using Black's formula for pricing futures options. A known premium and strike level are used to solve for the implied volatility. This measure of volatility represents the anticipated coefficient of variation of the distribution of possible prices for a contract. It is then a matter of simple arithmetic to derive the standard deviation and variance for the distribution. This study will use \$88.50 / cwt the expected price and 11.0% as the volatility measure (which was level and implied volatility for the September feeder cattle futures contract as reported by PM Publishing Options Analysis in mid April). This results in a standard deviation of \$9.74 / cwt and a variance of 94.77. As stated

earlier, normally distributed prices are not commonly observed. It is more likely that these prices will take on a distribution more similar to a gamma distribution. Based on the first two moments of the distribution (mean and variance), a cumulative function of the gamma distribution can be fully specified. This function can be inverted such that for a given probability, it returns a number that is expected to occur at that probability level in the gamma distribution. By selecting 1000 random probabilities, ranking them in ascending order, and inserting them into the gamma distribution one at a time, an accurate representation of the distribution around the expected price can be obtained. This distribution will represent the marketing alternative (M_0) of selling feeder cattle with no means of price protection.

Two risk management strategies will also be proposed. The first will be fairly priced European put options (RM1). These options can be purchased by producers to establish a price floor and can only be exercised at the time of maturity (i.e., approximately the sale date of the feeder cattle). This alternative is simulated based on the first alternative. A strike level and price are selected. This study will use a 95% strike level, which translates into a \$84.07 / cwt strike level or price floor. With the first distribution ranked in ascending order each observation n_i is evaluated. If it is less than \$84.07 / cwt then an indemnity payment (IP_i) is added to it so that it equals \$84.07 such that,

$$(6) \quad \begin{aligned} IP_i &= \$84.07 - n_i \quad \forall n_i < \$84.07 \text{ and} \\ IP_i &= 0 \quad \forall n_i \geq \$84.07. \end{aligned}$$

To avoid complicating the analysis, the option premium will be calculated based on these actual payments rather than on an option pricing formula. This premium (P) is calculated as:

$$(7) \quad P = \frac{1}{N} \sum_i IP_i .$$

In this formulation P is simply the average of all payments. N is the total number of simulated prices and all other variables maintain their previous definitions. This specification of P ensures that the total of all IP_i equals the total of all P , thus the options are actuarially fair. With the previously specified strike level, $P = \$2.02 / \text{cwt}$. At this point the price distribution for RM1 can be specified by the operation:

$$(8) \quad n_i + IP_i - P \quad \forall i.$$

The second risk management strategy (RM2) is government subsidized price insurance. This insurance will maintain the form of the European put option but producers will receive a subsidy (S) from the government that is a certain percentage of the premium. Thus the distribution for RM2 becomes

$$(9) \quad n_i + IP_i - P + S(P) \quad \forall i.$$

In this study $S = 50\%$ ($\$1.01 / \text{cwt}$) making the out-of-pocket expense for RM2 $\$1.01 / \text{cwt}$. It should be noted that this subsidy was chosen simply to represent the effects of a subsidy. Subsidies on crop insurance premiums are limited to 59% while the Dairy Options Pilot Program subsidizes 80% of dairy option premiums. Based on these programs, subsidies on livestock insurance premiums could fall anywhere in the 59% to 80% range. The descriptive statistics for all three alternatives are reported in Table 1 and the CDF of each is shown in Figure 1. With the three choices clearly laid out, it is now possible to simulate producers' acceptance of the alternatives by ranking the choices E-V and SD criteria.

Ranking the Risky Alternatives

The ranking of M_0 , RM1, and RM2 will be accomplished in a two-step process. First, only the choices of M_0 and RM1 will be available to producers. Under this scenario there are no

government incentives that subsidize risk management. A producer must choose to be fully to market risk or attempt to manage that risk at some cost determined by the futures market.

The second scenario will compare M_0 with RM2. With government subsidies in place, RM1 would still be a feasible alternative. However, no rational decision maker would choose RM1. This is because RM2 dominates RM1 under the E-V framework for all values of Φ , since the variance of prices under each alternative but the expected price of RM2 is greater. Furthermore, RM1 is dominated by RM2 in the sense of FSD. This makes it unnecessary to even evaluate the two using SSD or SDRF since the results will hold (Robison and Barry). In other words, for the second scenario anyone wishing to manage marketing risk would always choose RM2 over RM1 and anyone wishing to take on that risk would always choose M_0 , therefore RM1 is never in the risk efficient set. The results of this ranking are presented and discussed in the following section.

Results and Discussion

Scenarios 1 and 2 (M_0 vs. RM1 and M_0 vs. RM2, respectively) were analyzed using E-V and SDRF. Computer software developed by Goh et. al was used to rank choices by SDRF. (See Goh et. al for a complete description of the software.) In scenario 1 under both E-V and SDRF producers who are risk neutral or have any level of risk aversion will choose RM1. That is, producers who maximize utility based on the income that they will realize at least 50% choose RM1. The results of this comparison are reported in Table 2. Not all levels of Φ are reported in the table. For the omitted levels of risk aversion, the results were identical to the reported levels that would fall immediately before and after them. For example, results for all levels Φ from 5% to 30% are the same. It should be noted that FSD cannot discern between M_0 and RM1. This is

because the CDF's cross (see Figure 1). However in terms of SSD, RM1 is dominant since all risk averse producers prefer RM1.

In Scenario 1 the results of the two methods of ranking choices are the same. It has been shown that under normally distributed returns E-V and SSD (SDRF where $0 \leq \Phi \leq + 4$) are equivalent. In this application, even though the distributions of expected prices are non-normal, the two methods are still consistent with each other. On the other hand, the responses of the two methods to the introduction of a subsidy are noticeably different.

One interesting and expected effect of a subsidy on the purchase of insurance is that individuals who previously received no marginal benefit from the managing the risk of their respective operations now realize a benefit and therefore purchase insurance. Both methods of ranking the choices show this. The results of the comparison of Scenario 2 are reported in Table 2. However, SDRF indicates that a greater amount of producers who would not choose RM1 in scenario 1 choose RM2 in second scenario. This is because a greater range of risk attitudes now prefers subsidized insurance. This difference in the two techniques is shown in Table 3. These differences are due to the fact that SDRF bases decisions on the entire distribution of each alternative and E-V on the first two moments. SDRF recognizes, to some degree, that mainly downside risk is being foregone and therefore even individuals with only a slight aversion to risk would be better off utilizing RM1. E-V merely recognizes that the variance has decreased at the expense of a decreased expected price and judges the tradeoff accordingly with no regard to the type of risk that has been mitigated. It should be noted that both E-V and SDRF show that risk-preferring individuals would actually purchase the price insurance when it is subsidized. Under both techniques, these are individuals who prefer more risk to less because they are willing to weather the volatility of a marketing strategy due to the chance of large payoffs at times.

As mentioned earlier, the E-V approach calculates an individual's CE (or risk-adjusted returns) for a given situation. Given this CE it is possible to approximate the willingness to pay by producers of different risk attitudes for RM1 and RM2. As mentioned earlier, there are some theoretical concerns in using E-V as an empirical tool in this specific case, so these measurements should be considered approximations. It should also be noted that this willingness to pay assumes that RM1 and RM2 are the only marketing strategies available to livestock producers and that they are mutually exclusive. This does not drastically limit the discussion as this study looks to identify broad trends in the effects of subsidized livestock price insurance on risk faced by producers.

E-V analysis can be used to calculate the willingness to pay for both RM1 and RM2. Willingness to pay for RM1 and RM2 can be determined by comparing the CE of M_0 with that of RM1 and RM2, respectively, assuming that RM1 and RM2 were free. That is, equations 8 and 9 were modified to leave out the $(-P)$ term. The CE of M_0 was then subtracted from each. The result is the premium amount that a person of each risk attitude will forgo to utilize the risk management strategy. These measures of willingness to pay are shown in Table 4. As expected, the CE (and therefore willingness to pay) increases by the amount of the subsidy. This is because a producer can now realize the same expected price variance as with RM1 but now realize a higher expected price. This means that RM2 actually has a lower absolute volatility (C.V.) than RM1 (see Table 1). All individuals who did not wish to purchase RM1 and for whom this increase in CE results in a willingness to pay that is $> P$ will now purchase RM2. It is also true that any individual whose CE is $> P$ in scenario 1 would choose to purchase RM1. E-V analysis allows these changes in willingness to pay to be examined for all levels of risk aversion.

The case of the risk aversion level of 47.5% provides an interesting example of how the marginal benefit that comes from managing risk is affected by the subsidy. In scenario 1, an individual with risk preference level of 47.5% would be willing to pay only \$1.36 / cwt for RM1 and if forced to pay P for RM1 would realize a marginal benefit of $-\$0.66 / \text{cwt}$ (willingness to pay – P). Under Scenario 2 the same individual is willing to pay P for RM2 and receives a marginal benefit ($\$0.35 / \text{cwt}$) from doing so. The same procedure can be used for all levels of risk aversion to see this change in marginal benefit. The group of producers whose risk aversion level is greater than 50% were already receiving some marginal benefit from paying P to utilize RM1 as a marketing strategy. Their marginal benefits now increase by the full subsidy amount. Since the subsidy is based on the premium, this increase in marginal benefit is directly related to the amount of risk present. For example, this analysis assumed an 11.11% volatility of expected price, which is appropriate for a feeder cattle contract only 5 months out. If a producer were to insure a year in advance volatility around the expected price might be as high as 18%. This would result in a fair premium of \$4.30 and a subsidy of \$2.15. For the riskier situation, the subsidy is greater. This indicates that, as long as the subsidy is based on a percentage of the premium, producers in riskier situations will receive a greater benefit from the subsidy.

These results show, as anticipated, that offering a subsidized insurance product could very well effect the decision-making process of certain producers, depending upon their risk attitude. In general the subsidy obviously makes RM2 more attractive than RM1 to all producers. However, for many producers, the difference is enough to actually change their optimal risk management strategy from doing nothing to purchasing price insurance.

Summary and Conclusions

Livestock producers, like all agricultural decision makers, will choose production and marketing practices that maximize their individual utilities. The feasible production and marketing practices will, in general, have some level of uncertainty associated with them. How an individual evaluates these feasible alternatives to maximize utility is a function, in part, of his or her aversion to risk (Anderson, Dillon, and Hardaker, Boisvert and McCarl; and Hardaker, Huirne, and Anderson, Robison and Barry). This study focused on marketing risk and basically ignored production risk (and all other sources of risk) during the analysis. In the case of a backgrounder looking to sell feeder cattle in roughly 5 months, the marketing risk or uncertainty is the feeder cattle price fluctuation over that 5 months. In the real world, producers can purchase European options to establish a price floor thus mitigating the downside feeder cattle price fluctuations. This study introduced this marketing alternative (with options being priced based on the actual distribution of expected prices) along with the alternative of not managing price risk in Scenario 1. Next, in Scenario 2, subsidized insurance, in the form of subsidized European options was offered along with the do nothing strategy as alternatives. For both scenarios the optimal choice for a variety of risk aversion levels was chosen using E-V analysis and SDRF. The differences in the two scenarios were interesting and highlighted the effects of a subsidy on the risk faced by livestock producers.

In Scenario 2, a wider range risk attitudes, including risk preferring individuals, found price risk management appealing. This was true for both ranking techniques. It could also be shown with the E-V results that the marginal benefit that producers realize from managing price risk is increased by the subsidy amount. This is evident in the increased willingness to pay for subsidized insurance compared to fairly priced options (see Table 4). It is easy to see how these

two components could be of concern to policy makers. If individuals who have an inherent desire to seek risk (i.e., $\Phi < 0$) now realize a positive marginal benefit from purchasing insurance, it is conceivable that they will use this as means to finance the taking on of additional risk. This practice can result in producers bearing as much or more risk as they did before the subsidy was introduced. Furthermore, the very presence of this subsidy as rent to be collected by livestock producers can change the structure of livestock production. If rational decision makers realize that this rent is available to them only if they produce livestock, then livestock production may then become a desirable (possibly optimal) method of earning income. If producers are attracted only by this rent, they may or may not have the management skills to run a livestock operation. In these cases subsidies could go to fund livestock price risk management that is being used in lieu of sound management practices.

These are only some of the possible general effects of subsidized livestock insurance. It is beyond the scope of this study to attempt to quantify or even identify with certainty production responses to subsidized insurance. However, by using proven and accepted tools for evaluating risky decision making and by observing past instances in the crop sector, as this paper has done, it is possible to inform decision makers about what these general changes might be.

If the additional benefits realized due to the subsidy are used to invest in increasing feeder cattle production, there are likely to be noticeable changes in beef cattle production. For example, when market prices for beef are low enough, a decrease in the quantity of finished cattle (cattle ready for slaughter) occurs. This results in a decreased demand for feeder cattle by feedlots which translates into lower feeder cattle prices. In this case the backgrounders examined in this study would now be willing to pay less than before for weaned calves. As a response to this cow-calf producers are likely to liquidate herds to some degree and decrease calf

production. Unless there is a change in consumer demand for beef, this decrease in production by the entire sector is eventually realized at the slaughter level and prices begin to recover.

While this cycle is less defined in recent years it can still be observed in beef productions.

With subsidies on price insurance in place, backgrounders (and other levels of productions) would now be responding to signals that are based on receiving this subsidy, in addition to market signals. They might find that there is no reason to cut back production so quickly when prices are declining since they are guaranteed the subsidy in addition to a price floor. If feeder cattle production was kept at higher levels than the market would normally support there would be more finished cattle and, subsequently, more beef than the market demands. This excess supply could serve to keep beef prices and cattle prices at other levels of production low for prolonged periods of time. Simultaneously, production would be at abnormally high levels. Furthermore, individual livestock producers might utilize riskier management and/or production strategies given their expectations of receiving the subsidy. Taxpayer dollars in the form of subsidies would be financing livestock production that, otherwise, would not be taking place.

It is beyond the scope of this study to attempt to quantify these supply responses. However, the tools used to identify and explain the general trends in supply response are well established and accepted methods of analyzing risk. Therefore, the conclusions drawn here are based on sound economic analysis and should serve as a starting point for critically evaluating the effects of subsidizing livestock insurance.

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Table 1. Descriptive Statistics of Three Price Distributions of Feeder Cattle Marketing Alternatives

	Mean (\$ / cwt)	Standard Dev (\$ / cwt)	C.V. (%)
No Price Protection	88.50	9.834	11.11
Fairly Priced European Options	88.50	7.396	8.38
Government Subsidized Insurance	89.51	7.396	8.26

Table 2. Risk Efficient Marketing Alternatives for Livestock Producers of Varying Risk Attitudes

Risk Aversion Level	Risk Aversion Coefficient	Scenario 1		Scenario 2	
		<i>E-V</i>	<i>SDRF</i>	<i>E-V</i>	<i>SDRF</i>
5%	-0.33455	M ₀	M ₀	M ₀	M ₀
30%	-0.10657	M ₀	M ₀	M ₀	M ₀
40%	-0.05145	M ₀	M ₀	M ₀	RM2
42.5%	-0.03864	M ₀	M ₀	M ₀	RM2
45%	-0.02562	M ₀	M ₀	M ₀	RM2
47.5%	-0.01780	M ₀	M ₀	RM2	RM2
50%	0.0	RM1	RM1	RM2	RM2
52.5%	0.01780	RM1	RM1	RM2	RM2
55%	0.02562	RM1	RM1	RM2	RM2
57.5	0.03864	RM1	RM1	RM2	RM2
60%	0.05145	RM1	RM1	RM2	RM2
62.5%	0.06508	RM1	RM1	RM2	RM2
65%	0.07830	RM1	RM1	RM2	RM2
67.5	0.09231	RM1	RM1	RM2	RM2
70%	0.10657	RM1	RM1	RM2	RM2
72.5%	0.12202	RM1	RM1	RM2	RM2
75%	0.13728	RM1	RM1	RM2	RM2
77.5%	0.15361	RM1	RM1	RM2	RM2
87.5%	0.23388	RM1	RM1	RM2	RM2
95%	0.33455	RM1	RM1	RM2	RM2

Note: Scenario 1 M₀ indicates the marketing strategy of doing nothing to manage price risk, RM1 and RM2 indicate purchasing fairly priced European put options and subsidized insurance, respectively. In Scenario 1 only M₀ and RM1 are available. In Scenario 2 M₀ and RM2 are compared. E-V is Expected Value Variance analysis and SDRF is Stochastic Dominance with Respect to a Function.

Table 3. Risk Seekers for Which Subsidized Insurance is a Risk Efficient Choice While Fairly Priced European Options are Not

Risk Aversion Level	Risk Aversion Coefficient	E-V	SDRF
5%	-0.33455		
30%	-0.10657		
40%	-0.05145		X
42.5%	-0.03864		X
45%	-0.02562		X
47.5%	-0.01780	X	X

Note: E-V is Expected Value Variance analysis and SDRF is Stochastic Dominance with Respect to a Function. X denotes that no price risk management was preferred to fairly priced European options while subsidized insurance is preferred to no price risk management.

Table 4. Willingness to Pay for Fairly Priced European Put Options and Subsidized Price Insurance

Risk Aversion Level	Risk Aversion Coefficient	Fairly Priced European Put Options (\$ / cwt)	Subsidized Price Insurance (\$ / cwt)
5%	-0.33455	-11.30	-10.29
30%	-0.10657	-2.19	-1.18
40%	-0.05145	0.01	1.02
42.5%	-0.03864	0.52	1.53
45%	-0.02562	1.04	2.05
47.5%	-0.01780	1.36	2.37
50%	0.0	2.07	3.08
52.5%	0.01780	2.78	3.79
55%	0.02562	3.09	4.10
57.5	0.03864	3.61	4.62
60%	0.05145	4.12	5.13
62.5%	0.06508	4.67	5.68
65%	0.07830	5.20	6.21
67.5	0.09231	5.76	6.77
70%	0.10657	6.33	7.34
72.5%	0.12202	6.94	7.96
75%	0.13728	7.55	8.57
77.5%	0.15361	8.21	9.22
87.5%	0.23388	11.42	12.43
95%	0.33455	15.44	16.45

Figure 1. Cumulative Distribution Functions of Three Feeder Cattle Marketing Alternatives

