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IMPLICATIONS OF EXTENDING CROP INSURANCE TO LIVESTOCK

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Congress extended the crop insurance program to livestock with the Agricultural Risk Protection Act (ARPA) of 2000. Two livestock insurance products, Livestock Risk Protection (LRP) and Livestock Gross Margin (LGM), were subsequently approved by FCIC for sale beginning in the summer of 2002. Originally, LRP offered insurance against unexpected declines in the market price of hogs in Iowa. In 2003, LRP coverage was expanded to include fed cattle and feeder cattle in 10 states and swine in Indiana, Illinois, and Nebraska. LGM offers insurance against unexpected declines in hog margins in Iowa. The margin in LGM is defined as the market price of a hog less the cost of feed, which is calculated using corn and soy meal prices.

Until the creation of LGM and LRP, U.S. livestock producers received little direct-risk federal support. Traditional federal farm programs have historically bypassed livestock producers. And before ARPA, crop insurance legislation explicitly denied coverage to livestock producers. Thus ARPA represents a milestone in federal involvement in livestock production.

Both LGM and LRP have run into problems in their initial pilot phases. LGM sales to new customers were suspended for the sales period beginning January 15. LRP sales to fed cattle and feeder cattle producers were halted on December 24 when BSE was discovered in Washington State. Given that both LGM and LRP are pilot programs, it is instructive to review the implications of extending the crop insurance program to livestock producers and the problems associated with trying to design an insurance product that delivers price-only protection. The intrinsic difficulties of offering price insurance are caused by the perceived need to fix the insurance guarantee for a period of time before sales are closed. This creates the opportunity for customers to observe price changes during the sales period and then base their purchase at least in part on whether futures prices have moved to make the insurance underpriced. This problem underlies the suspension of LGM and LRP sales. To illustrate, consider what happened in July 2003 with LGM.

The projected gross margin for hogs to be marketed in October 2003 under LGM was $75.71/hog. The premium was fixed at $5.50/hog. Producers had until July 31 to buy LGM. By that time, the projected margin had fallen to $63.60/hog. Producers could have insured hogs at $75.71 when their market value was $63.60. This created a large incentive to buy LGM. The fair value of a $75.71 guarantee with a market value of $63.60 is $13/hog.

The objective of this paper is to review two sources of demand for LGM and LRP. The first source is the role that LRP and LGM play in terms of risk management. Simple illustrations are used to show that their risk-reducing property is why they were approved as risk management products. The second source of demand is speculative demand, whereby producers will be interested in buying LRP and LGM when they are underpriced. The extent to which this speculative demand could threaten the financial integrity of the program is measured by estimating expected loss ratios for the products. Results indicate that speculative demand could increase loss ratios to between 1.15 and 1.25 when premium rates do not consider the value of being able to observe changes in market prices before making the purchase decision.

The paper is organized as follows. First the amount of price risk that typical Iowa hog producers face is examined. The impacts of LGM and LRP on this risk are then illustrated by showing the effects of insurance on the distribution of prices received with and without insurance. The potential speculative demand for LRP and LGM is then examined by first considering what happens if buyers only purchase the products when prices move in their favor. It is shown that this is a reasonable assumption for LRP because each day there is a 50% chance that prices will move in the buyers' favor. Thus it always pays producers to wait for a price decrease. The last two section of the paper examine the justification for the two livestock insurance programs and whether the programs will do harm to the livestock or related industries.

A note of disclosure is appropriate before I begin with this review. Two of my colleagues at Iowa State University and I are partially responsible for the design of LGM and fully responsible for LGM premium rates. Although we receive no direct financial benefits from sales of LGM, we do receive compensation for our time spent maintaining the product.

Review of Risk Situation of U.S Livestock Producers

Most farmers face price risk and yield risk. Livestock farmers also face significant feed cost risk. Livestock farmers put a great deal of effort into managing production risks. Control of disease, proper feeding and watering, adequate ventilation, and careful monitoring of weight gain and overall health throughout the life of animal are critical to obtaining desired production levels. The two major production risks facing hog operations are catastrophic losses from disease and fire. Most hog producers carry named-peril insurance against losses from fire. To reduce the losses from disease, managers invest significant resources in designing production systems and feed additives that minimize disease risk.

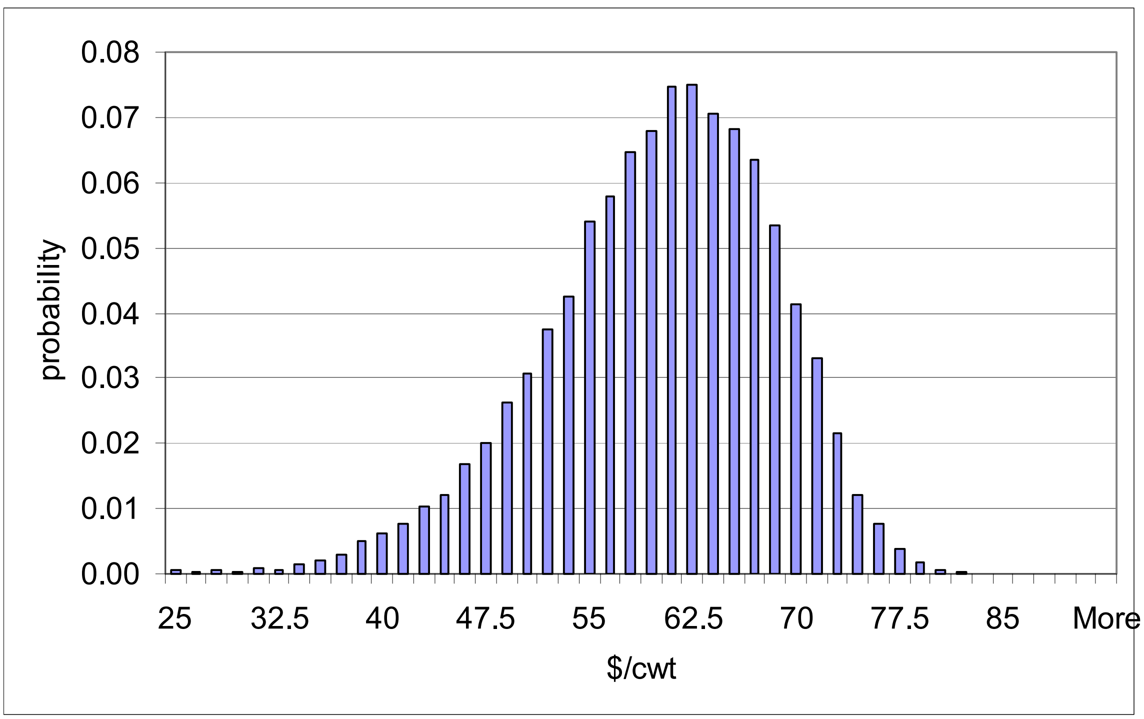
Management practices play a much more important role in determining production levels on a livestock farm than they do on a farm with dry-land field crops. For many field crops, including corn, soybeans, wheat, and grain sorghum, good pre-plant management practices and some post-emergent insect and weed control are all the care that a farmer can provide. The rest depends on unpredictable weather. This unpredictability is what makes crop yields somewhat of an insurable risk.

Many livestock producers face significant price risk. The segment of producers who do not face price risk are those contract producers who never take ownership of the animals they raise. The amount of price risk that producers face varies across species and time periods. Figures 1 and 2 illustrate the amount of output price risk that a hog producer faced on January 15, 2003, for delivery of hogs in April and in July. The distributions are based on those used to rate LGM and then modified by adding an expected basis of $-3.00 and $-1.50 and basis standard deviations of $1.00 and $2.50 for April and July respectively (Lawrence http://www.econ.iastate.edu/faculty/lawrence/HOGS_files/Car-Hog%2003%20FINAL.pdf). A comparison of Figures 1 and 2 shows that the July price distribution is much wider than the April distribution. This increased risk simply reflects the fundamental fact that the amount of uncertainty increases with time. These pictures can be used to measure the likelihood that prices will be below some break-even price level, say $55/cwt.

The first decision that had to be made in coming up with a design for a new livestock insurance product was to determine what perils would be covered. Insurance against losses due to fire and other named perils already exist. If insurance against production losses (lack of weight gain) were offered, then this could induce producers to substitute insurance coverage for proper management because management is the primary determinant of weight gain. This leaves insurance against price risk, which is both significant and cannot be influenced by producer decisions. Thus, it is not surprising that the first two livestock insurance products offer coverage against price risk.

But what price risks should be covered? As shown in Figures 1 and 2, hog producers face significant risk that the price of their hogs will be less than projected. LRP is designed to insure against this output price risk. But livestock producers also face feed-cost risk. LGM is designed to cover against declines in the margin between output price and feed costs. Figure 3 shows the distribution of market revenue (measured on a carcass basis) less the cost of corn and soy meal required to raise a hog to market weight (10.41 bushels of corn and 150 pounds of soy meal). The standard deviation of the margin shown in Figure 3 is actually less ($11.64) than the standard deviation of price only ($12.09).

Figure 1. Distribution of April Cash Hog Prices as of January 15, 2003



Effect of Livestock Insurance on Risk

In contrast to the large premium subsidies that exist for crop farmers, premium subsidies are small or nonexistent for LRP and LGM. LGM places a 3 percent reserve load on its rates. LRP places a 10% reserve load that is offset by a 13% premium subsidy, for a net subsidy of 4.3%. Thus, in principle, farmers are paying near-actuarially fair premiums for the two products. This means that the only effects on producer risk from the two products are due to a change in revenue variability rather than a change in the expected level of revenue.

Figure 2. Distribution of July Cash Hog Prices as of January 15, 2003

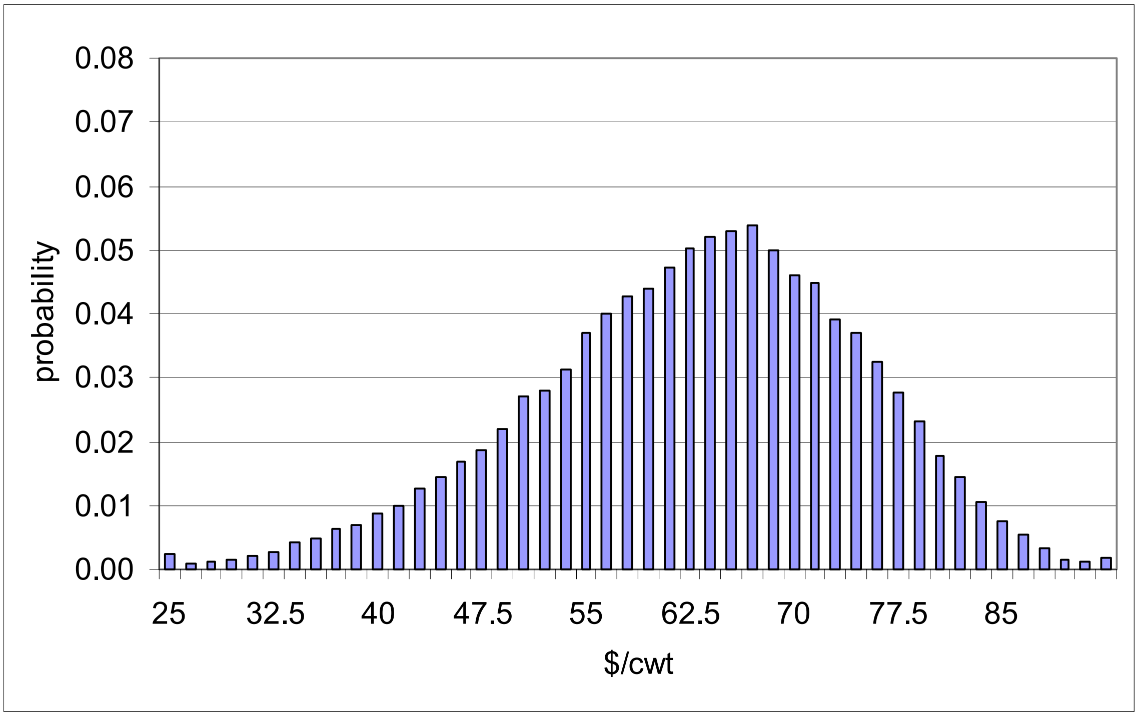
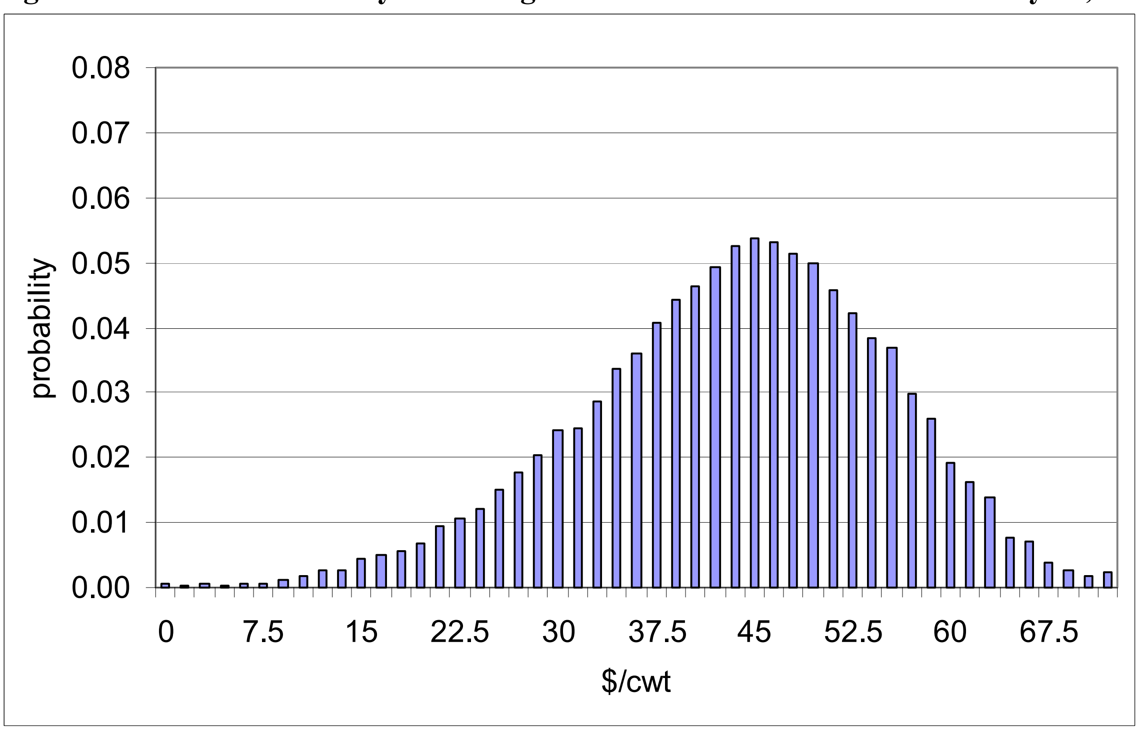
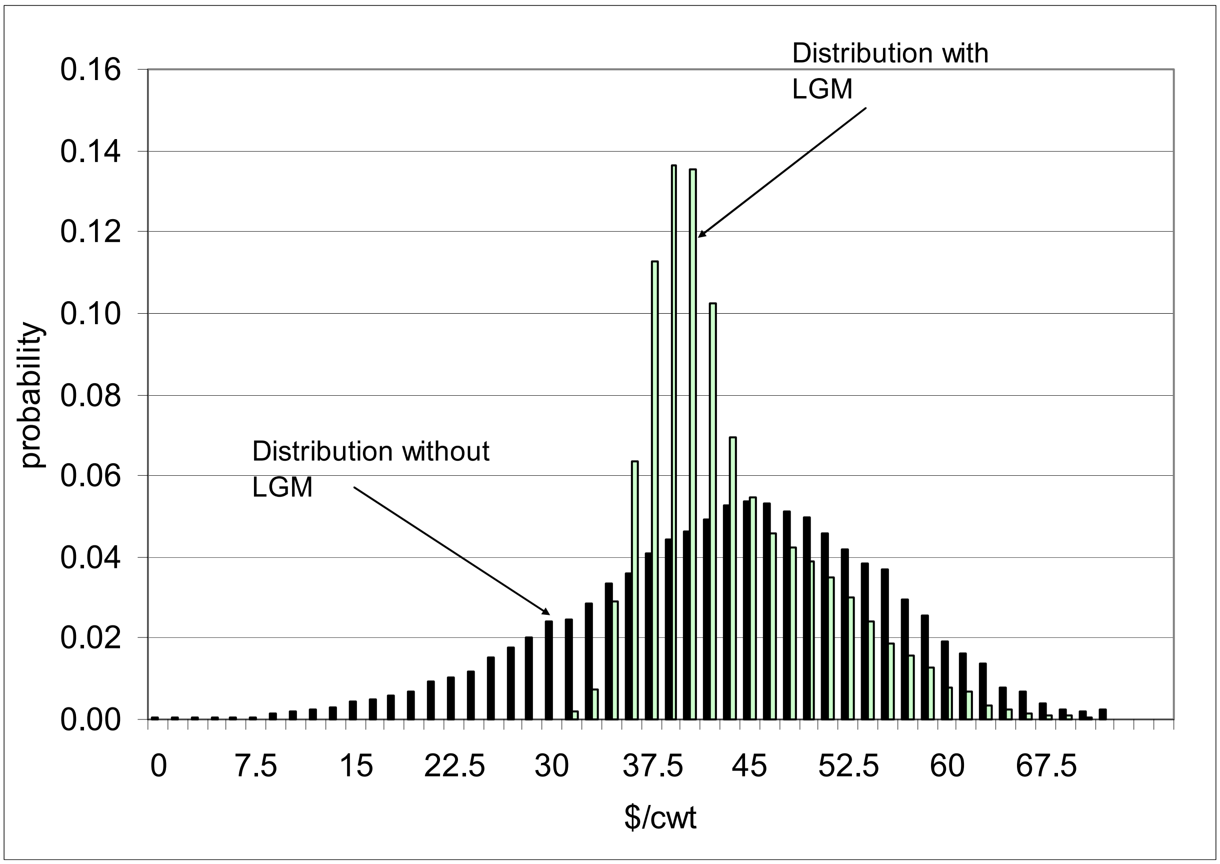


Figure 3. Distribution of July Lean Hog Prices Less Feed Costs as of January 15, 2003



The effect of purchasing LGM on the hog producer's risk is shown in Figure 4, under the assumption that the producer buys 100% coverage. The situation modeled assumes that the producer buys insurance only for hogs to be delivered in July of 2003. As shown, the risk of having an outcome of market revenue less feed cost below $36/cwt is nearly eliminated by LGM. At first glance, it would seem that many livestock producers would prefer the risk profile shown in Figure 4 over the Figure 3 profile. After all, without LGM, the producer could have outcomes below $25/cwt. But closer examination shows that the farmer ranking of profiles may not be that clear-cut.

Figure 4. Effect of Purchase of LGM on Distribution of Net Revenue

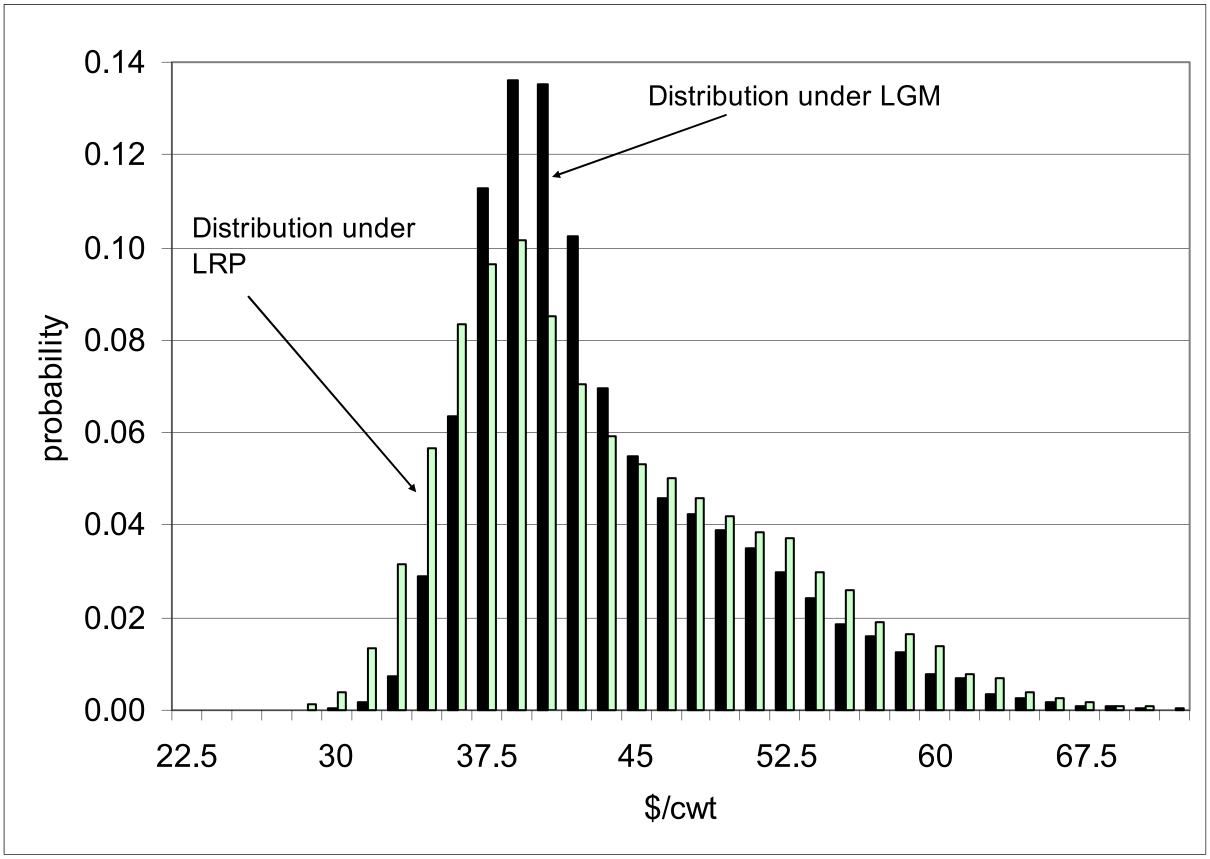


LGM decreases the probability of every outcome above $45/cwt. This decrease is shown by a decrease in the height of the bars with LGM. The reason for this decrease is that the producer pays the full cost of LGM, which amounts to $4.75/cwt. So when LGM does not pay out, the farmer is worse off. The gross margin guarantee under LGM is $43/cwt. The reason why revenue can still be below $43 is due to an average basis of -$1.50, the LGM premium of $4.75, and basis risk, which is not covered by LGM.

Economic theory tells us that all producers who are averse to risk will prefer the risk profile under LGM to the risk profile without LGM. The strength of the preference will depend on how averse to risk the producer is. Under the assumption that LGM rates are actuarially fair, then except for the 3 percent reserve load on LGM, expected revenue with LGM is the same as expected revenue without LGM. That is, LGM does not change the mean outcome—it just creates a more stable distribution of outcomes. To put this another way, if this farmer paid the premium each year for a large number of years, then the sum of the insurance payout over this time would equal the sum of the premiums paid. Thus, the producer's mean income is constant. This also means that the loss ratio for LGM (indemnities paid divided by premium collected) should be 1.00 over time (0.97 if accounting for the 3 percent reserve load).

A comparison of risk profiles under LGM and LRP (shown in Figure 5) reveals that both products offer quite similar coverage. Because LRP does not allow producers to purchase 100% coverage, revenue outcomes for LRP can be less than with LGM. The probability of high outcomes is greater under LRP because the premium is lower. And because LGM provides some protection against high feed costs, there is a higher probability of having outcomes close to the mean level of revenue.

Figure 5. A Comparison of the Effects of LGM and LRP



Speculative Demand from a Divergence between Insurance Prices and Market Prices

LGM sales to new customers were suspended for the sales period beginning January 15, 2004. The primary reason for this suspension was a realization that market prices can move significantly in the two weeks that elapse between the time that the LGM insurance guarantee is fixed and the sales closing date. The price movement that occurred in the July 2003 sales period brought this issue to the forefront. The first two rows of Table 1 show the divergence between the monthly projected gross margin for finishing hogs as determined by LGM on July 15, 2003, and the monthly projected gross margin calculated using market prices on July 31 at the end of the sales closing date. The large decline in hog prices that occurred between July 15 and July 31 greatly decreased projected gross margins for each month. The third row of Table 1 shows the impact on the implied coverage level. This is the ratio of the LGM guarantee at 100% coverage to the guarantee that would have been offered had the LGM guarantee been calculated at the July 31 settlement prices. Producers essentially were offered a very high level of coverage at a discount price.

The expected loss ratios for 2003 are given in the fourth row of Table 1. They are calculated for each month assuming a marketing plan that had hogs only in the indicated month. A ratio of 2.0 means that the actuarially fair value of the July 15 LGM guarantee on July 31 is double the actual premium charged. This would translate into an expected loss ratio of 2.0.

The fifth row shows the actual loss ratio for the same type of marketing plan. The actual loss ratios are lower than the projected loss ratios in the first three months because hog prices increased. They are worse than the projected ratios for the last three months because the short soybean crop caused feed costs to rise dramatically. It can be surmised that LGM sales were suspended to new customers because of a fear that this pattern would repeat itself.

Table 1. LGM Projected Gross Margins and Market Gross Margins in July 2003

	August	September	October	November	December	January
Projected Gross Margin - LGM	86.03	81.24	75.71	74.35	72.61	74.84
Projected Gross Margin - July 31 Market	70.83	66.72	63.6	63.91	62.99	66.85
Implied Coverage Level	121%	122%	119%	116%	115%	112%
Ratio of July 31 Value to Charged Premium	4.35	3.85	2.41	2.11	1.81	1.69
Actual Loss Ratio	2.95	2.26	1.42	2.48	2.79	2.69*

*Projected based on the February lean hogs futures price on January 16, 2004.

LRP sales were suspended on December 24 ostensibly because the BSE incident resulted in a disruption in the futures and options markets for fed cattle and feeder cattle. However, sales remained suspended even after the markets found a new equilibrium level. News reports indicate that concerns about LRP remain because producers have discovered that they can insure their cattle at a lower cost than market conditions would indicate on days in which prices drop.

To see how this works, suppose the fed cattle futures price settled yesterday at $80/cwt. LRP would offer a maximum insurance guarantee today at 95% of this level, or $76. Now suppose the futures price today drops by $2.00/cwt. Then the coverage guarantee of $76 is, in reality, a coverage level of 97.4% (0.974 = 76/78). With a log-normal distribution and a price volatility of 18%, the option premium for a $76 option when the market price is $80 would be approximately $3.79/cwt. However, a $76 option when the futures market is at $78 would be $4.55. That is, producers would be paying $3.79 for something that the market values at $4.55. This market value is taken to be the best indicator of actuarially fair value by the developers of both LGM and LRP. Thus, the implied loss ratio of LRP on this day would be 1.20.

An underpriced financial product undoubtedly increases demand. It is reasonable to expect that the more underpriced the product is, the greater will be the demand. This increase in demand can be called speculative demand or adverse selection. However it is described, the result is a reduction in the financial soundness of the product. That is, the premiums collected will tend to be less than the insurance indemnities paid.

The potentially detrimental effects on the soundness of LGM caused by a divergence between market prices and insurance prices were recognized by the developers of LGM and by the Federal Crop Insurance Corporation (FCIC). Changes to LGM that reduced the sales period from two weeks to two days were submitted to FCIC on April 1, 2003. The changes were approved by FCIC on July 31. But there still remains a two-day window during which producers can observe market price movements and make their LGM purchase decision. And there remains a one-day window for LRP. Furthermore, this potential problem of allowing producers to observe price changes before making their purchase decision is not unique to livestock insurance products. For example, Revenue Assurance, Crop Revenue Coverage, and Group Risk Income Protection all freeze their projected corn prices on the last day of February but allow farmers to delay their purchase decision until March 15.

An exploration of the impact of a divergence between the time guarantees are determined and the deadline for purchases should give insight into potential problems in the crop insurance program. The next section conducts such an analysis with a focus on LRP, with its one-day sales window, and LGM, with its two-day sales window. The commodity chosen for examination is hogs.

Setting Up the LRP Example

Suppose a producer wants to insure hogs for delivery in April and the LRP premiums and guarantees are based on market conditions that existed on January 2, 2004.[1] We need to answer the question of what would happen if we set the insurance guarantee based on the price on January 2, then a producer could observe prices on January 5, 2004 (the next trading day), before making the LRP purchase decision. What is the amount of error that we would introduce?

Of course, in reality, January 5, 2004, only occurs once (price went up by 1.02%). But insight can be gained into the potential impact only if we can determine what would happen by repeating this experiment many times. This can be done by essentially "drawing" January 5 prices and then calculating what LRP premiums would be if they were based on January 5 prices instead of January 2 prices. If the price increases, the guarantee at the lower price implies a decreased coverage level.[2]

Estimating the impacts on expected loss ratios of being able to observe prices before making the purchase decision requires calculation of the market value of LRP for each price draw. It is tedious to calculate this market value for a single price draw, let alone for 5,000 draws. A straightforward shortcut is to estimate market values for a small number of representative price draws and then use a fitted line to estimate the values for other price draws. Figure 6 shows how the calculated and interpolated values vary with the implied coverage level for alternative January 5 price levels. For example, 108% coverage corresponds to a market price on January 5 of $50.05 (1.08 = 56.9*.95/50.05).

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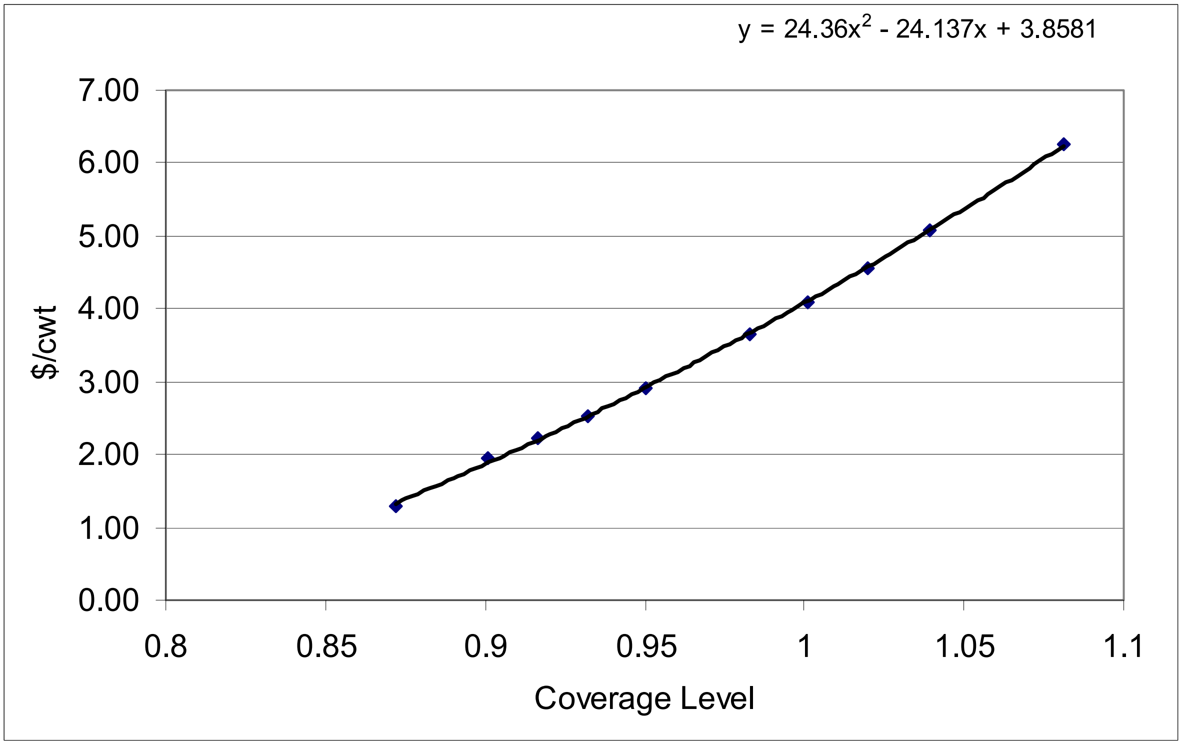
[1] The April lean hog futures prices on January 2 settled at 56.90. A 58.00 call option on the contract settled at 3.80. Expiration of the contract is in the middle of April or 0.29 years. This implies an annualized volatility of 34.95%. Translating this annualized volatility into a one-day volatility, multiply by the square root of (1/253) where 253 is the average number of trading days in a year. Thus, the daily volatility is 2.2%. The amount of volatility (deannualized) between January 2 and the close of the contract is 0.19.

[2] This is, in fact, what happened. Based on January 2 prices, 95% LRP coverage would give a guarantee of $54.06/cwt. But a $54.06 guarantee at the January 5 futures price of $58.05 is implicitly 93.12% coverage, which should cost significantly less than 95% coverage.

Figure 6. Effect of Implicit Coverage Level on Correct Put Option Premia on April Lean Hog Futures



To determine the impact of having the ability to wait and observe prices before choosing whether to purchase insurance can be simulated by generating daily price draws for the waiting period. For LRP, 5,000 price draws from a log-normal distribution with a mean of 56.90 and a volatility of 2.2% are used. For each of the 5,000 draws, we calculate the coverage level if insurance is purchased and the corresponding actuarially fair premium using Figure 6. For all draws for which insurance is purchased, we calculate the average of the correct premium and compare that to the premium that is actually charged. The ratio of the two gives the expected loss ratio.

Setting Up the LGM Example

For analysis of LGM, we use market conditions as they existed on January 8, assuming that a producer wants to insure July hogs.[3] If LGM had been offered for sale based on the January market conditions, it would have cost approximately $9.59 per hog to be marketed in July.

Determining the impact of a two-day sales period follows the same general procedure as previously outlined for LRP, but implementation is a bit more complicated. For each commodity (hogs, corn, and soybean meal) a series of five daily prices is needed. The first three days are averaged to determine projected prices, and then the three projections are combined to determine the LGM guarantee. The fifth daily price is observed for each commodity and the day-five LGM guarantee is calculated. The implied coverage level is calculated by taking the ratio of the day-three guarantee to the day-five guarantee. If

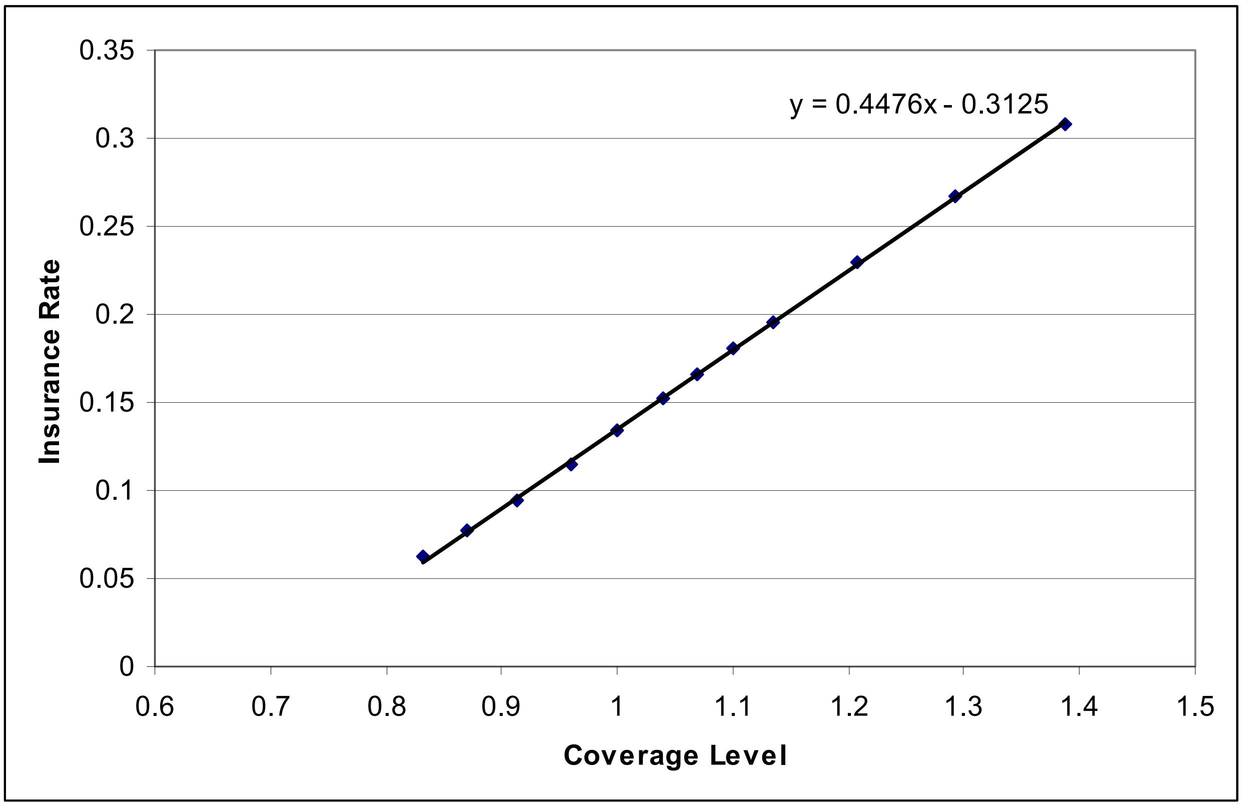
[3] On January 8, the settlement price for July hogs was $60.425/cwt. The settlement price for May corn was $2.55/bu. The settlement price for May soybean meal was $240.3/ton. The price of a $58 put option on July lean hogs was $3.65/cwt, which translates into an implied annualized volatility of 29.05%. A $2.50 put on May corn costs $0.104 per bushel, which implies a volatility of 22.07%. A $240 put on May meal costs $13.25/ton, which implies a volatility of 24.13%.

the day-five guarantee is lower (the margin shrinks in the two-day sales period), then the implied coverage level is greater than 100%. If the margin increases, then the implied coverage level is less than 100%. We do this procedure 5,000 times. All prices are assumed to be log-normally distributed.

The five daily price series follow a random walk process. For example, the first hog price draw (of 5,000) for day one is taken from a log-normal distribution with a mean equal to $60.425 and a price volatility of 1.83%. The first draw for the second day is taken from a log-normal distribution with a mean equal to the first draw for the first day and a volatility of 1.83%. The first draw for the third day has a mean equal to the day-two draw, and so on. In this way we repeat a series of five daily price movements 5,000 times.

To account for changes in the actual LGM guarantee, which will vary for each of the 5,000 draws, the LGM premium rate is calculated as a function of the implied coverage level at the end of the two-day sales period. Then this rate is multiplied by the day-five LGM guarantee to obtain the actual value of LGM at the end of the two-day sales period. Figure 7 shows the relationship that will be used for interpolation.

Figure 7. Effect of Implicit Coverage Level on Correct Rate per Hundred for LGM Liability



Results for LRP

The premium charged for 95% coverage for LRP (not accounting for load or subsidy) in this example is $2.93. If producers do not take into account price changes during the one-day sales period, then over time the expected loss ratio would be equal to 1.0 because the average payout under LRP would be $2.93.

However, adverse selection will arise if producers are more likely to purchase LRP when the market price declines than when the market price rises. One way of modeling this adverse selection is to treat the one-day sales period as an option on the insurance contract (an option on an option). That is, farmers have a one-day period in which to observe the departure of actual prices from the insurance guarantee price. If this departure works in their favor then they will purchase the insurance. If this departure does not work in their favor then they will not purchase the insurance.

First, suppose that the pool of farmers who potentially will purchase LRP will do so only when the coverage level rises above 95%. That is, there is only speculative demand. The average actuarially fair premium conditional on the coverage level being greater than 95% is $3.29 per cwt. This is 12.2% greater than the actuarially fair premium with no speculative demand. Thus, the ability to buy LRP when the price moves in the insured's favor should increase expected loss ratios by 12.2%.

There are two ways that these extra losses could be covered. The first way is to charge farmers an option premium for the right to purchase LRP knowing that they will be buying the product after they observe price movements. With pure speculative demand, the probability of purchase (which equals the probability that price moves down) is 0.51. The probability that there is no purchase is 0.49. The payout of the option conditional on the option being exercised is 12.2% of the fair premium. Thus the unconditional value of the option is obtained by multiplying 12.2% by 0.51 or 6.2% of the LRP premium. That is, to obtain the right to purchase LRP after prices are revealed, a farmer would have to pay 6.2% of the LRP premium before market prices are revealed in the second period. This would generate enough of a premium to cover the losses from speculative demand.

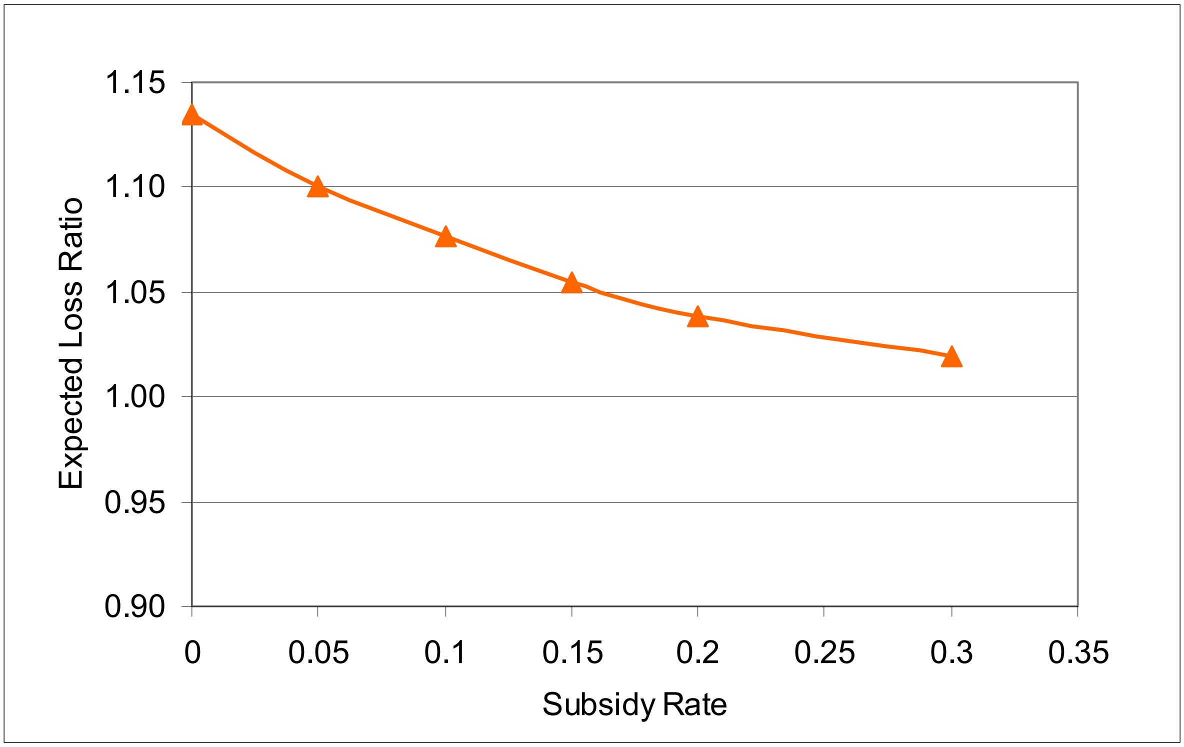
Of course, it may not be feasible to charge all farmers this option premium as a price of entry. An alternative is to charge all producers who buy LRP a surcharge of 12.2% would not solve the problem because speculators would simply wait until prices moved by a greater amount in their favor. Returning to the example, suppose now that there is no demand until the correct value of LRP exceeds $3.29. This corresponds to a coverage level of 96.8%. The expected option premium conditional on the premium (the value of the option) being greater than $3.29 is $3.58. Thus the expected loss ratio would be 1.09%. This is a lower loss ratio, but it is not 1.0 and the probability of participation would be 22% instead of 51%.

An alternative method for controlling adverse selection is to subsidize the product. If the actual option premium were subsidized, then the futures price could actually increase by a certain amount before speculative demand ceased. Thus, a larger subsidy decreases the proportion of LRP purchased when the market price decreases. The subsidy would therefore increase participation and reduce adverse selection.

Figure 8 shows how the expected loss ratio (expected indemnities divided by the total (unsubsidized) premium would decrease as the subsidy rate increases for LRP. As shown, increasing the premium subsidy lowers the expected loss ratio by increasing participation. A 15% premium subsidy drops the loss ratio to about 1.05. Of course, this improved loss ratio does not account for the taxpayer costs of the subsidy, which amount to 15% of 2.93 or $0.44 per cwt.

Actual LRP loads its premium by 10% and subsidizes it by 13%, for a net subsidy of 4.3%. The 4.3% net subsidy lowers the expected loss ratio to 1.108. Thus, the 10% premium load reduces the expected loss ratio to 1.008%, which, at first glance, suggests that a combination of a load and a subsidy should generate a reasonable loss ratio in this case.

Figure 8. Expected Loss Ratios for LRP Assuming 100% Adverse Selection



This finding that LRP loss ratios will be close to 1.0 even with 100% speculative demand assumes that producers only have a one-time opportunity to buy LRP. However, producers have much more flexibility than this because LRP is sold every day. Flexibility gives producers the ability to wait for enough of a price drop to make the purchase worthwhile. The effect on loss ratios from this added flexibility is examined next.

The Effect of Waiting on Expected LRP Loss Ratios

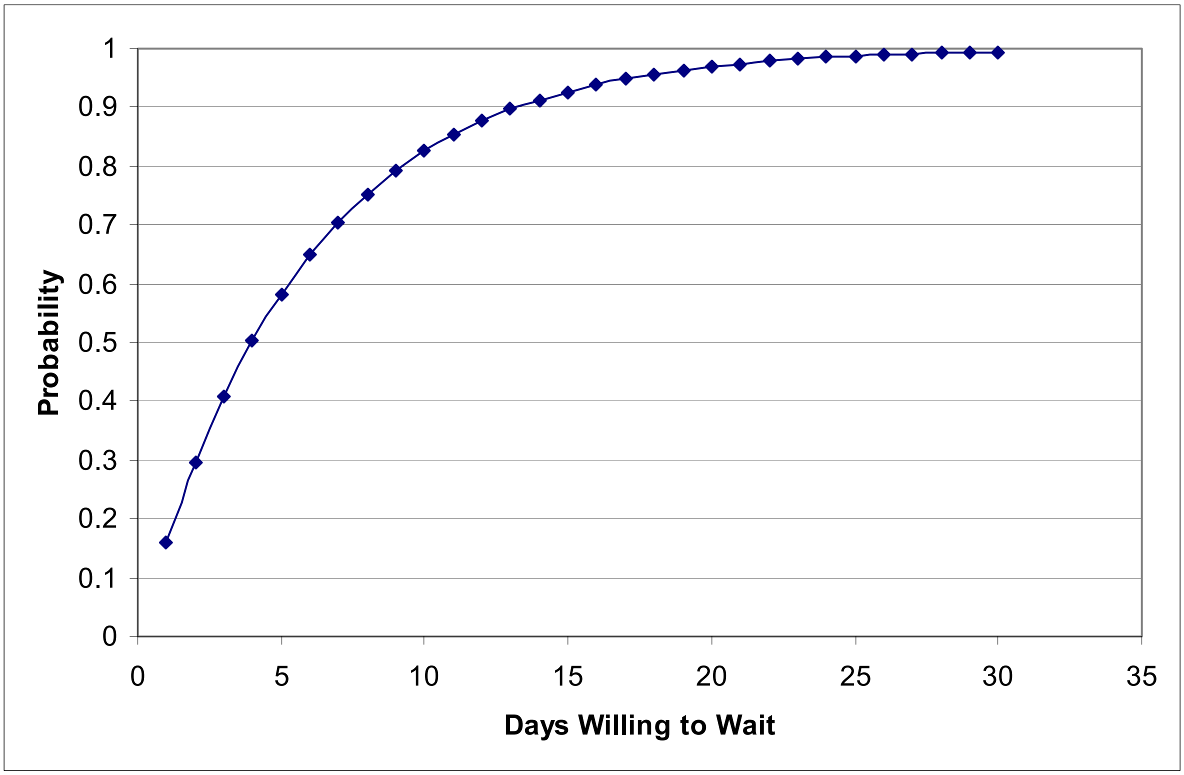
Again, LRP premiums are set based on January 2, 2004, prices. A farmer wants to insure some hogs that will be delivered in April. The farmer wants to lock a guarantee in sometime within the two weeks. What should this farmer do?

The first thing the farmer will realize is that there is value in waiting for a favorable downward price movement. Under reasonable assumptions, there is approximately a 50% probability each day that prices will decrease, thereby increasing the coverage level of LRP as discussed in the previous section. The magnitude of price movement is unknown, but a probability distribution of the price movement can be estimated.

Assuming that the ratio of tomorrow's futures price to today's futures price is log-normally distributed with a mean equal to 1.0 and standard deviation equal to the daily price volatility, which is 0.022 in this example. This completely defines the distribution of price moves. For example, there is a 2.1% chance that prices will drop by more than 4.4%. There is a 16% chance that prices will drop by 2.2%, and so on. However, there is a positive relationship between the chance that the price will drop by more than a certain percentage and the number of days that the producer will be willing to wait. For example, suppose the producer will buy LRP if the price moves by more than 2.2%. If the producer is willing to can wait only one day for the required price drop, then the probability of buying LRP is 16%. However, if the producer is willing to wait two days and will buy if the price moves 2.2% on any of the two days, then the probability of buying LRP rises to 29.44%. To see this, note that the only circumstance under which the producer will not buy LRP is when the price does not drop by at least 2.2% on either day. This occurs with a probability of 0.84 each day. Thus, the probability that the price does not drop by more 2.2% in either day equals 0.84 squared, or 0.7056. The probability that the producer buys LRP equals one minus the probability the producer does not buy LRP, which gives us the 29.44% chance.

For a given desired price drop, the longer the producer can wait, the higher will be the probability of purchase. The probability that a producer buys LRP is simply one minus the probability that the price does not move the required amount raised to the power equal to number of days the producer is willing to wait. Figure 9 shows the probability that prices will drop by at least 2.2% for a range of days.

Figure 9. Probability that Price Drops by at Least 2.2% in a Day for a Given Waiting Period

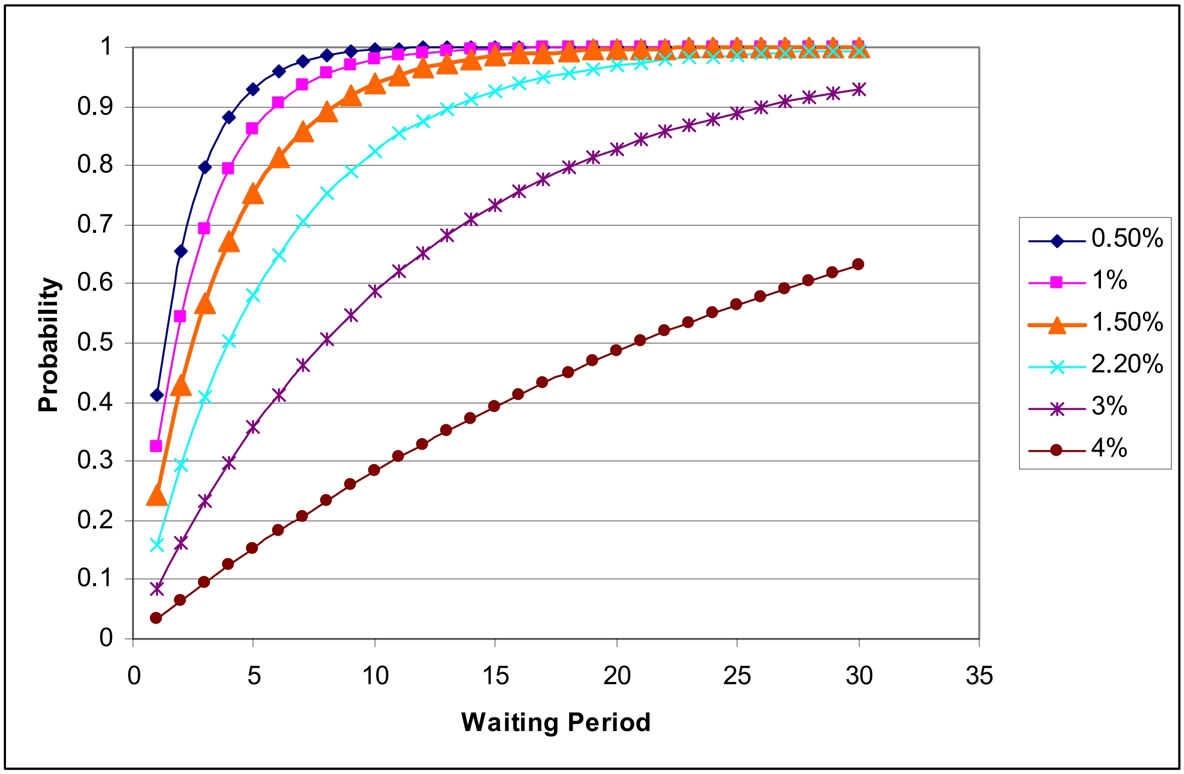


As shown, if the producer is willing to wait 10 days and requires a 2.2% price drop before purchasing LRP, then there is an 80% chance that the producer will purchase LRP. When the price does drop by at least 2.2%, the average price drop is 3.3%. This translates into an increase in the average coverage level from 95% to 98.2% and an expected loss ratio of 1.29%.

There are basic trade-offs between required price drops, willingness to wait, price volatility, and the probability of buying LRP. The smaller the required price drop, the more likely it is that LRP will be purchased for a given wait period, and the lower will be the loss ratio. The shorter the waiting period, the less likely it is that the price will drop by the desired amount. And the higher the price volatility, the more likely it is that a given price drop will occur.

Figure 10 shows the price triggers that will give a desired probability of purchasing LRP for a given waiting period. For example, suppose a producer can wait up to 10 days and wants a 90% chance of buying LRP. Waiting for a price drop a bit larger than 1.5% will meet these criteria. If the producer wants to buy LRP with 99% probability in a 10-day period, then a price drop of a bit less than 1% is the critical level.

Figure 10. Probability of Buying LRP Given a Waiting Period and a Required Price Drop with a Daily Price Volatility of 2.2%



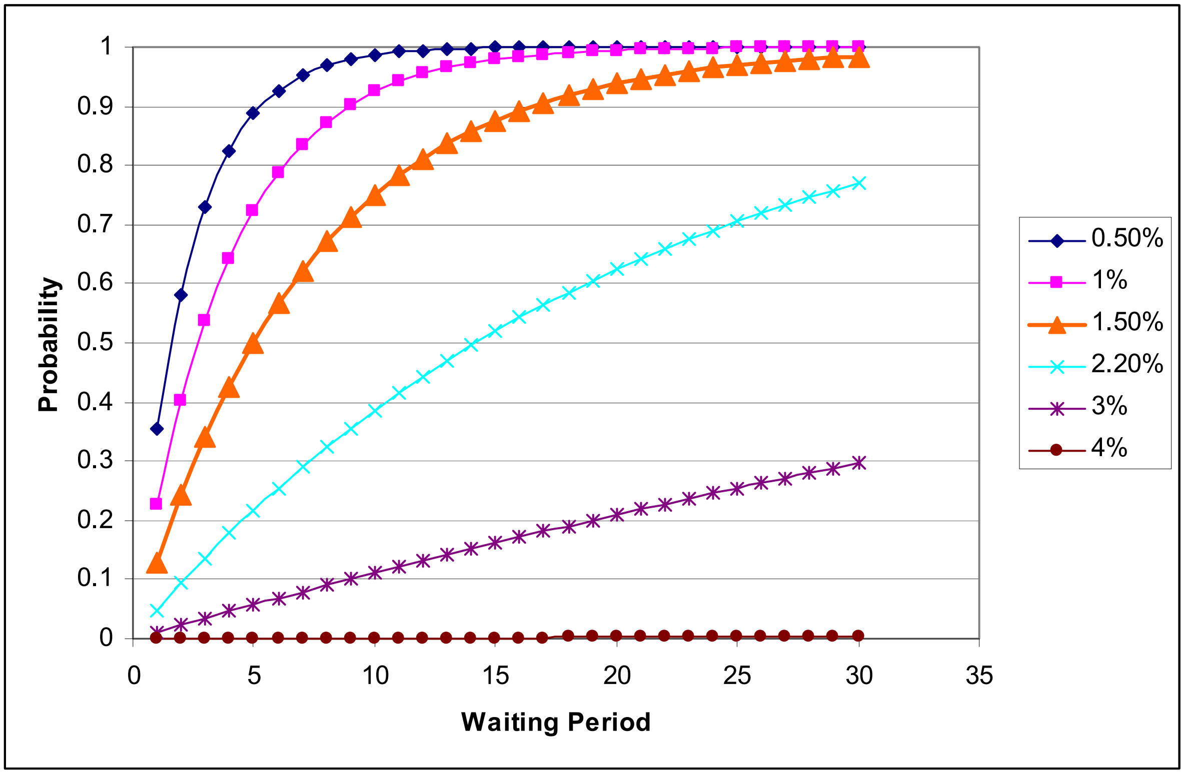
The price volatility used in this example is higher than the price volatility usually is on lean hogs contracts. For example, the implied volatility based on January 14 settlement prices on the July lean hogs futures prices was 21.16%, which translates into a daily price volatility of 1.33%. The futures price level is $60.825/cwt. Figure 11 duplicates the Figure 10 results for a price volatility of 1.33%. As shown, a lower price volatility decreases the probability that a given waiting period will result in a given price drop. For example, if the desired price drop is 1%, then there is a 90% chance that a 10-day waiting period will result in the producer buying LRP. Given that prices drop at least 1%, to some level below $60.22, the average price drop is 1.77% and the resulting expected loss ratio for those who purchase on that day is 1.22%. A lower price volatility does not eliminate the problem of an increase in the loss ratio. The reason for this is that both the premiums and indemnities drop, which makes the expected loss ratio relatively insensitive.

The potential buyers of LRP likely have different price drops that would trigger a purchase decision. In addition, there really is no reason for any producer to buy LRP on a day in which prices rise because there is about an even chance that prices will drop tomorrow. So even risk-averse producers would find it in their best interest to wait for a price drop.

Suppose that no producers buy LRP when there is a positive price movement, 100 producers buy LRP when the price drops by 0.5%, and 1,000 producers buy LRP when the price drops by 4%. Then fitting a curve between these points gives us a demand curve for LRP. With this responsiveness, the weighted average value of LRP when it is purchased is $3.56 per cwt compared to the actuarially fair premium of

$2.90, which gives an expected loss ratio of 1.23. The 10% reserve load drops this expected loss ratio to 1.12.

Figure 11. Probability of Buying LRP Given a Waiting Period and a Required Price Drop with a Daily Price Volatility of 1.33%



Results for LGM
It would seem that the results for LGM would be worse than would those for LRP because the two-day window for sales allows for larger price drops. In addition, the possibility that feed prices could rise at the same time that hog prices drop during this two-day window increases the potential that the implied coverage level of LGM could increase substantially. However, the potential for adverse selection because of a multiple sales period is substantially lower for LGM than for LRP because there are only 12 sales periods per year for LGM whereas each trading day creates a sales period for LRP. This means that there is likely to be less of a surge in demand when the projected gross margin shrinks during the sales period.

Under the assumption that purchases of LGM will occur only when the projected gross margin decreases during the sales period (the implied coverage level increases above 100%), then the average value of LGM is $10.94 per hog. The average premium charged is $9.70, which implies an expected loss cost ratio of 1.13.

It seems unrealistic to assume that no farmer would purchase the insurance unless it were underpriced (subsidized). A more realistic assumption would be that the demand for insurance would decrease as the product became overpriced and it would increase as LGM became underpriced. To simulate the effects of this type of demand response, assign a value of 100 to sales of LGM when the gross margin remains unchanged during the sales period. Assume that sales drop to zero if the ratio of the true value to the charged value drops to 0.60 and that sales increase to 500 if the ratio of true value to charged value increases to 2.0. With this type of demand response, the expected loss ratio is 1.16.

In summary, adverse selection is likely a problem for both LGM and LRP. While it is too early to estimate the responsiveness of producer demand for these products with respect to price changes during the sales period, the simulation results presented here indicate that adverse selection could increase loss ratios to between 1.15 and 1.25. Increasing the reserve load and then offsetting it with a producer premium subsidy will create loss ratios closer to 1.0 but at a higher taxpayer cost.

Why Do We Need LGM and LRP When We Have CME and CBOT?

Both LGM and LRP offer insurance protection against detrimental price changes. The insurance works just like a European option. A premium is paid up front and the payoff from the insurance is positive at the end of the insurance period if prices have moved enough to trigger the insurance guarantee. American options are available to cover these same price changes on the Chicago Mercantile Exchange (CME) and the Chicago Board of Trade (CBOT). Given that LRP for swine bases its coverage levels and premiums on the lean hog futures and options contracts, and LGM bases its coverage on the same CME lean hogs contracts and the CBOT corn and soy meal futures and options, what is the justification for supporting LGM and LRP? At first glance it seems that the public sector is duplicating services that could be provided by the private sector.

First consider LRP for swine. Suppose a swine producer wanted to insure the price of hogs to be delivered in June on December 15, 2003. The expected end price for these hogs using the LRP contract was $60.95/cwt, which was the settlement price on the June hog futures contract on December 14, 2003. Table 2 compares the option premium for CME options with LRP insurance premiums. LRP total premiums are the unsubsidized premium that includes a 10% reserve load. LRP premiums without the 10% reserve load are also shown. The last column shows producer-paid premiums that account for the 13% premium subsidy.

It is clear that LRP premiums without the reserve load are based on CME options premiums. The widest difference between the two is at the $56 insurance price, and they do not differ by more than 0.5 percent. In one sense, this coincidence of insurance and options premium is reassuring. If there was a big difference then one would think that something is amiss with the LRP rating methods. But, in another sense, this coincidence is troubling because it suggests that LRP provides equivalent coverage to CME options. If a producer can buy the equivalent coverage on the CME, then what justification is there for LRP?

Table 2. A Comparison of LRP Premiums and CME Option Premiums

	Option Premium	LRP Insurance Premiums ($/cwt)		
Insurance Price	CME ($/cwt)	Total Premium	No Reserve Load	Producer Paid
50	0.75	0.823	0.748	0.716
52	1	1.102	1.002	0.959
54	1.375	1.520	1.382	1.323
56	1.85	2.052	1.865	1.785
58	2.500		Not Available	
60	3.350		Not Available	

What about LGM? On January 15, 2003, a producer of finisher hogs could have purchased LGM that insured the value of hogs to be delivered in July less the cost of feeding those hogs. The value of the hog was set at $119.64, which equals the average settlement price on the CME July lean hogs contract over the previous three trading days, multiplied by 1.924 cwt, which is the assumed weight of a dressed market hog. The projected cost of feed under LGM is approximated by assuming that each market hog consumes 10.41 bu of corn and 0.075 tons of soy meal. The cost of corn and soy meal is approximated by the price of corn and soy meal in May. The average settlement price on the May futures contracts for corn and soy meal over the last three trading days prior to January 15 was $2.39/bu for corn and $164.47/ton for soy meal. Thus the projected price of feed was $37.17 per hog. Therefore, the maximum amount of insurance for a finished hog to be delivered in July is $119.64 - $37.17 = $82.47. The cost of insuring a hog is $8.88 or $4.62/cwt.

Equivalent coverage to LGM could have been purchased by buying put options on the July lean hog futures contract and call options on the May CBOT futures contracts for corn and soy meal. On January 14, the cost of a put option with a strike price of $60 on the July lean hog futures contract was $4.35/cwt or $8.35 per hog. The cost of a call option on the CBOT May corn futures contract at a strike price of $2.30 was $0.0975/bu. The cost of a call option on the CBOT May soy meal futures contract at a strike price of $160/ton was $0.065/ton. This translates to insurance against feed costs rising above $35.90, creating a guarantee that the margin per hog will not fall below $79.54. The cost of these options would be $9.85 per hog. How can this cost be more than the cost of LGM? The reason is that these options will pay off if hog prices fall, if corn prices rise, or if soy meal prices rise. LGM will only pay off if the margin per hog falls. Thus, with LGM, hog price increases may offset feed cost increases or feed cost decreases may offset hog price decreases. Because of these offsets, LGM will not pay out as often as the combination of separate options, so it costs less.

For LGM there are two possible justifications for federal involvement. The first is suggested by the preceding discussion, which demonstrated that LGM insures against declines in gross margin, whereas the combination of CME and CBOT options provides insurance against detrimental movements in any portion of gross margin. Thus, LGM is less expensive than the combination of options. In addition, because LGM allows producers to insure against declines in the average margin of hogs marketed anytime in a five-month period, the cost of insuring the average margin will be less than the cost of options that insure each month's margin alone. The averaging effect of coverage over months lowers the out-of-pocket expense because sometimes margin declines in a given month are countered by margin gains in other months. Thus LGM provides a more cost-effective means of insuring against declines in the gross margin of hogs.

The second justification that LGM shares with LRP is that both products are scalable to any number of hogs, whereas CME and CBOT options are "lumpy." An option on a CME futures contract covers about 210 market hogs (40,000 pounds of carcass weight). An option on a single CBOT corn futures contract covers 480 hogs. And an option on a single CBOT soy meal futures contract covers 1,440 hogs. To buy option contracts to approximately cover price risks associated with 1,400 hogs would require about three corn options, one soy meal option, and seven lean hog options. Farmers that had hogs that did not come in multiples of approximately 1,400 would have less precise coverage. Duplication of the coverage provide by LRP would be somewhat easier because precise coverage can be obtained with multiples of 210.

Another rationale for LRP is that producers seem reluctant to buy CME options to hedge their price risk. There are two possible explanations for this lack of participation in the options market. The first is that producers do not value the insurance that is available on the CME. Clearly, if this is the case, then LRP will not be attractive to producers unless they buy it for the subsidy or for speculative purposes

A last argument that has been provided for why federal provision of LGM and LRP is justified is that many farmers simply are not familiar with buying options and they are wary of dealing with commodity brokers. The argument goes that many of these same farmers are familiar with their crop insurance agents and are more comfortable talking with their agents about price insurance for hogs rather talking with brokers about options on futures contracts. Whether the payoff from added comfort for farmers generates sufficient benefits to compensate for the costs of administering LGM and LRP is doubtful.

Of course there is always speculative demand. But a federal crop insurance program cannot be justified because it allows producers an opportunity to purchase an underpriced financial product. Given that LRP provides equivalent coverage to CME options and that a producer can wait until the desired LRP option is underpriced, one would expect LRP to replace all demand for CME options.

Will Supply Increase (and Market Prices Fall) from Federal Livestock Insurance?

Before concluding, some discussion of the possible damage that livestock insurance could do to the livestock industry is warranted. One potential drawback of federal provision of risk management products is that a reduction in risk could cause an increase in production, which, in turn, could decrease market prices. There are two mechanisms by which a reduction in risk could induce a supply increase.

The first mechanism occurs when the reduction in risk causes an increase in the average price received by producers. The magnitude of the supply response to an increase in mean price is measured by the supply elasticity. For crops, the primary constraint on production is land. Thus if all crops received the same proportionate increase in mean price, then because the aggregate amount of land is largely fixed in the short run, the supply increase will be limited. In the longer run, such an increase in mean price should induce more land into production.

For livestock, there are two primary constraints on production. The first is the biological constraint of time needed to expand the breeding herd. Beef supplies are quite inelastic, even over a two- to three-year time horizon because of the long period needed to increase herds. Hogs have more elastic supply because of the shorter time needed to increase herd size. In the long run, the only significant constraints on production are environmental constraints. And perhaps given enough of a price increase, even these could be overcome. Thus, long-run supply elasticities of livestock are much larger than are those for crops.

But does the average price received increase with LGM and LRP? Without speculative demand, the answer is no for LGM because the farmer pays 103% of the actuarially fair premium. The answer is a small yes for LRP because a 13% premium subsidy more than offsets a 10% reserve load. These small changes in expected returns price should not significantly alter farmers' production decisions. Speculative demand could increase average returns to producers by less than $1.00 per cwt. This represents less than a 2% change in the price of hogs. With a supply elasticity of perhaps 0.5, this implies a change in hog production of less than 1%, and only this amount if every hog producer in the United States were eligible to take advantage of the program.

The second mechanism by which a supply increase could result is directly from the reduction in risk. The purchase of LGM or LRP can be thought of as a mean-preserving contraction in the distribution of prices received. If a mean-preserving spread in prices induces a supply decrease, would not a mean-preserving contraction induce a supply increase?

The likelihood of a significant change in supply because of the risk-reducing aspects of LGM and LRP is quite small. First of all, for such a contraction in price risk to have a supply-inducing effect would require that price risk be a significant constraint on production. Clearly, price risk is important in livestock production. But even before the introduction of LGM and LRP, livestock producers could hedge their price risk with futures and options. That most have chosen not to hedge their price risk suggests that price risk does not pose a significant constraint on livestock investment and operations. Thus we can conclude that introduction of LGM and LRP will not suddenly cause a significant expansion in livestock supplies.

This conclusion then leads naturally back to the question of why the federal government should even be involved with livestock insurance. The primary benefit of these pilot programs is a lowering of transaction costs of risk reduction by livestock producers. The lowered transactions costs may include the cost of learning about futures and options; the cost of forming option strategies and carrying out the required trades; the cost of worrying about when to exercise or sell options that are in the money; and the cost of trying to get around the lumpiness of options. Whether the benefits from these lowered transactions costs are sufficient to warrant public investments in livestock insurance product development and implementation should be something we learn over the next few years.