Risk Reduction of LGM-Dairy and its Potential Impact on Production

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Abstract

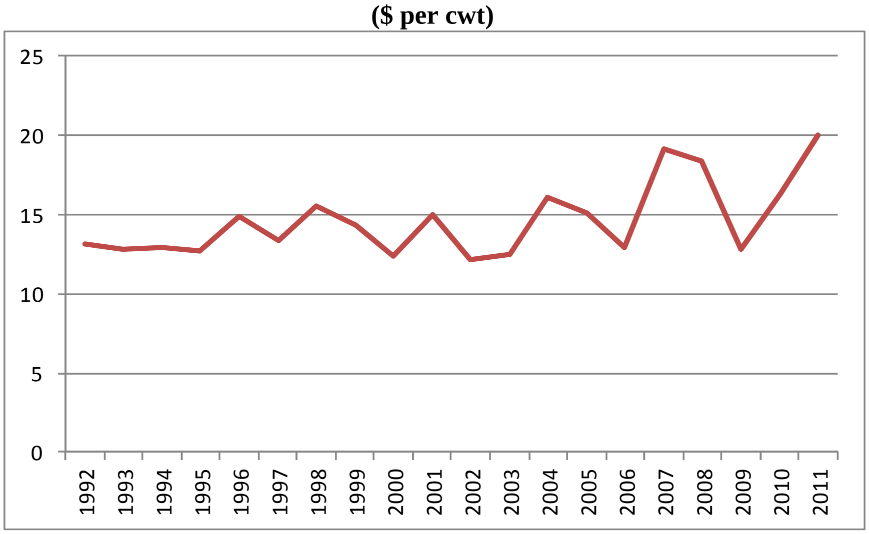
Both input and output price volatility have become major challenges for dairy producers. USDA's LGM-Dairy has been a well received risk management tool that has been utilized by many. This paper analyzes the effectiveness of LGM-Dairy as a risk management tool and discusses its potential impact on supply. Results suggest that risk levels, specifically root mean squared downside deviations from the median gross margin, were reduced in each milk marketing order by a range of 28-39% for zero deductible coverage levels. The potential impacts on supply from this risk reduction are likely limited due to lack of consistent availability of LGM-Dairy, relatively low participation level among dairy producers, and risk inelasticity of supply.

Introduction and Background

Price volatility has become a major risk for producers in all aspects of production agriculture. Dairy producers have been no exception to this as they have dealt with rapidly changing input and output prices and their associated impacts on profitability levels. Regarding output prices, Figure 1 depicts the average annual U.S. All Milk price from 1992 to 2011. Even casual observation reveals that price fluctuations appear to have increased in recent years. Explanations for the increased price volatility include greater dependence on export markets, weather challenges in the U.S. and Oceania, changes in production and stocks levels, and other factors. Simultaneously, U.S. dairy producers have faced input price volatility, especially in prices of feed, fuel, and fertilizer. The resulting unpredictable pattern of profit levels presents multiple challenges for dairy producers as they consider operation of, and investment in, their dairy operations.

Traditional price risk management tools present both opportunities and challenges to manage these risks. Challenges have outweighed the opportunities: forward pricing opportunities are not available in many markets, producers generally have struggled to become comfortable with futures and options trading, and even in cases where these tools are understood, scale issues often prevent smaller dairy operations from utilizing them to their full potential. Livestock Gross Margin Insurance for Dairy (LGM-Dairy) was initially developed as a response to many of these challenges.

Figure 1: Average US All Milk Price 1990-2011
($ per cwt)



Data Source: Understanding Dairy Markets, UW Madison

LGM-Dairy is a public risk management policy program overseen by the Risk Management Agency (RMA) of USDA designed to reduce the damaging effects of milk and feed price volatility on U.S. dairy farms (USDA Risk Management Agency, 2010a) that has several strengths. First, insurance of a gross margin (milk output price less the corresponding input costs of corn and soybean meal) puts the focus on profitability, the true variable of interest for producers. Second, producers can insure any output level, unlike futures and options contracts that are for large and discrete output values. Third, insurance indemnities are based only on CMEGroup futures prices, eliminating the problem of moral hazard. Fourth, a transparent method exists for setting insurance premiums. Fifth, producers can participate without committing large sums to margin deposits and without investing scarce time in learning to hedge directly in futures or options markets.

This study primarily addresses the effectiveness of LGM-Dairy as a risk management tool. Aggregate demand for farm-level milk is price-inelastic, implying that farm revenues fall when the supply curve shifts out (to the right). By comparing historical gross margins over several years with the corresponding outcomes had LGM-Dairy been in place, the degree of risk reduction can be estimated. Using supply impact parameters from previous literature, the supply impact corresponding to the risk reduction level under LGM-Dairy is estimated.

Background and Literature Review

Milk price risk management has traditionally not been a major element of dairy producers' decision processes. In part, that situation stems from the public dairy policy regime in the United States that has evolved along with the dairy industry since the 1930s. Programs and policies implemented at that time and modified to the current period reduced the effects of milk price declines.

The Dairy Price Support (DPS) program, now known as the Dairy Product Price Support (DPPS) program, was established to support milk prices at or above a specified level. This price support was achieved by the Federal government removing “surplus” products from the domestic market if they were offered to it at announced purchase prices. The program did not necessarily prevent the milk price from falling below the support price but it actively discouraged such low prices from persisting. The DPS truncated the price distribution until the 1990s when ongoing decreases in the announced support price level led to wider fluctuations in the milk price, and attendant price declines rarely reached support levels (i.e., there was almost no downside risk protection).

More recently, agricultural policy prescriptions gravitated away from direct payments and price supports toward more market based price risk management tools. Futures and options strategies are commonly used in many agricultural sectors, but both futures and options markets are generally thin for dairy products. In 1999, a Dairy Options Pilot Program (DOPP) was launched in hopes of increasing use of options among dairy producers, thereby increasing their effectiveness. Evidence suggested that the DOPP did increase volume of options traded, but also increased the price of those options (Bushena and McNew, 2005).

Further study suggested that hedging effectiveness could be achieved through the use of dairy futures and options, but also found some considerable hurdles. First, hedging effectiveness was highest in areas where Class III utilization was greatest.

Second, hedge ratios and CME© contract sizes made hedging most practical for very large operations. And third, existing milk price policy limited the perceived need for price risk management (Maynard, Wolf, and Gearhardt, 2004). Another challenge was assessing and improving the level of understanding on the part of the dairy producers, a challenge for the introduction of any new marketing tool. Previous research suggests that comprehensive training on put options increased the comfort level of producers, but many still felt more experience was needed. Further, many still saw using futures and options as a gamble not a price risk management tool (Ibendahl, Maynard, and Branstetter, 2002).

LGM-Dairy is a more recent introduction to the array of price risk management tools available for agricultural producers. It offers multiple advantages over previous insurance and price risk management tools. First, LGM-Dairy is a type of index insurance, which reduces the common insurance problems of moral hazard and adverse selection (Barnett, 2004). In the case of LGM-Dairy, indemnities are based on an index of futures prices for Class III milk, corn, and soybean meal rather than actual prices received for milk and paid for feed inputs.

Second, unlike futures and options on milk prices alone, LGM-Dairy offers dairy producers the opportunity to insure a margin, rather than milk price alone. The milk price is only one piece of the profit equation. While basis risk certainly remains, the mechanics of LGM-Dairy provide protection for both decreasing milk price and increasing feed costs. This effectively amounts to single insurance policy for a profitability index.

Third, LGM-Dairy is available through insurance agents, rather than commodity futures brokers, and is offered in scales appropriate for small and medium sized dairies. Finally, its introduction coincided with increased market volatility, making it a popular risk management tool. By December, 2011, for example, the Federal Crop Insurance Corporation funds initially allocated to LGM-Dairy for the 2012 crop year were already exhausted, with sales not expected to resume until October, 2012 (USDA Risk Management Agency, 2011). Limited funding has prevented producers from using LGM-Dairy insurance as a year-round risk management strategy (Wright, 2012).

LGM-Dairy is similar to a “bundled option strategy” – purchasing a put option on Class III milk futures, as well as call options on corn and soybean meal futures. For a short window of time each month, from the last business Friday of each month until the next evening, producers can purchase the insurance for a ten-month period beginning with the second month after the offering month. For example, on the last business Friday of March, coverage can be purchased for milk produced the following May through February.

When purchased, the producer specifies the amount of milk that he or she produces and plans to insure as well as expected levels of corn and soybean meal (SBM) to be fed to reach that level of milk production. There are default values for feed usage, as well as minimums and maximums that can be declared. The prices for milk, corn, and SBM used to determine the margin guarantee are based on a three day average of futures market closes for those three contracts during the offering month. Following the previous example, on the last business Friday in March, the margin guarantee for the months of May through February would be based on the respective futures closes for each of the ten contract months for those three commodities for the last business Wednesday of March through the last business Friday of March.

As opposed to the guaranteed gross margin, the actual gross margin is later determined by the three-day average price for Class III milk, corn, and SBM on the last three trading days of that month. For example, the actual gross margin for June is determined by the prices on the last three trading days of that month. The indemnity received is the difference in the guaranteed gross margin and the actual gross margin. Producers can chose to insure their gross margins for any time period within the available ten months. For example, a producer could insure over the entire ten available months or choose any number or combination of months to insure. Regardless, indemnities are paid at the end of the insured period whether it is the full ten-month period or a single month.

It is also important to note that indemnities are paid at the end of the period and on a gross basis. For example, a producer who insured each of the ten months separately might well receive an indemnity in two or three months out of the period and not receive an indemnity in the others. Conversely, the same producer who chooses to insure the gross margin for the entire ten months may not receive an indemnity at all as better months may offset the effect of the weaker months in aggregate (Gould and Cabrera, 2011).

Given the availability and popularity of LGM-Dairy, an analysis of the program's effectiveness as a risk reducing tool is well warranted. One of the primary objectives of this study is to assess, through historical actual and realized gross margins, what the impact of LGM-Dairy would have been on an individual dairy producer. Once the risk reduction impacts of LGM-Dairy have been evaluated, one can begin to consider the potential impacts that this risk reduction may have on supply. This question is one that has considerable implications for dairy policy.

It is logical that a reduction in perceived risk would lead to increased production levels, thereby depressing prices in the long term. Much of the literature on supply response to risk follows the approach taken by Chavas and Holt (1990), who modeled corn and soybean acreage decisions of potentially risk averse producers as a function of price variances and covariances. They found evidence of wealth effects implying decreasing absolute risk aversion, some price variance terms were significant, and nontrivial acreage responses were predicted for price support programs.

Bakhshi and Kerr (2009) modified the Chavas and Holt (1990) methodology to isolate insurance effects from market and wealth effects in an application to Canadian field crops. The insurance effects were statistically and economically significant, prompting the authors to conclude that decoupled government payments were production distorting, in conflict with their WTO Green Box status. Lin and Dismukes (2007) also found statistically and economically significant impacts of revenue risk on both soybean acreage and the share of crop acreage planted to soybeans. Not all studies produced evidence of supply response to risk. Luh and Stefanou (1989) found no evidence of risk aversion in 1977-84 Pennsylvania dairy farm data, and Liang et al. (2011) found revenue variance responses with small magnitudes. In the literature that follows Chavas and Holt (1990), risk is typically proxied by the variance of price or revenue, with no distinction between upside and downside risk.

Given the history of dairy policy and price risk management tools, this work addresses two primary questions. First, how effective is LGM-Dairy as a margin risk management tool? Second, assuming risk reduction is achieved, how much of an impact on production would be expected as a result given a range of risk elastacities? The approaches used to address these questions, and the data utilized to answer them, are discussed in the next section.

Data and Methodology

The central question of this research was to evaluate the potential risk reduction associated with participation in LGM-Dairy. The first step of the evaluation is for the researcher to choose the definition of risk. A common risk measure is variance, but supply is expected to respond negatively only to downside risk, so only downside deviations from a measure of central tendency were considered. The most common measure of central tendency is the mean, but the mean might not represent a "typical" outcome if the distribution of gross margins is heavily skewed, so instead deviations from the median gross margin are utilized.

A convention of measuring risk using root mean squared deviations that weight large deviations more heavily than small deviations is incorporated in the empirical approach. Finally, risk is measured over each 10-month LGM-Dairy contract period, and it is assumed that the producer purchases pooled insurance every month, with each contract representing 10 percent of production during the 10-month contract period. In this way, 100 percent of each month's production is insured over 10 successive, overlapping LGM-Dairy contract periods. To summarize, risk is defined as root mean squared downside deviations from the median gross margin over a 10-month contract period.

The gross margin was calculated with and without insurance, the measure of risk was calculated for both scenarios, and the percentage reduction in risk attributable to LGM-Dairy was calculated. Using risk response elasticities from prior studies, an associated percentage change in supply was attributed to LGM-Dairy's impact on margin risk levels.

In addition to affecting risk, the LGM-Dairy program can also affect the mean level of gross margins, either because of loaded or subsidized premiums, or because the premiums are not actuarially fair. The percentage change in mean gross margins over each 10-month contract period was calculated and applied to price elasticity of supply estimates to predict the percentage change in supply due to the program-induced changes in margin levels.

Regardless of the outcome, participation in LGM-Dairy requires payment of insurance premiums. The premiums were calculated from the same simulation data used to construct the actual LGM-Dairy premiums. The data are posted at the "Understanding Dairy Markets" website (Gould, 2011) under the section "Underlying Data." The premium calculation methods follow the guidelines in place since December 17, 2010 (USDA Risk Management Agency, 2010b), and the scenario analyzed is based on assumed default feed ration values, selection of pooled coverage for 10-month contract periods, and a zero deductible. For each month in each contract period, 5,000 simulated prices of milk, corn, and soybean meal were provided, allowing the calculation of 5,000 simulated "actual" gross margin values. Comparing those calculations to the gross margin guarantee value for the corresponding contract period generates 5,000 simulated indemnities. The average of the simulated indemnities, plus a 3 percent load, represented the unsubsidized premium used in the analysis. For reference, premiums were also calculated that included an 18 percent subsidy, which as of this writing, applies to pooled coverage with a zero deductible (USDA Risk Management Agency, 2009).

After accounting for the premium that is paid with certainty, the remaining impact of LGM-Dairy participation is represented by indemnity payments that occur when the Actual Gross Margin falls below the Gross Margin Guarantee. Historical data from January, 2002 through April, 2011 were used to calculate outcomes if LGM-Dairy had been in place during the entire period. The calculations make use of the default feed coefficients and other contract specifications used in 2011, and do not use prior calculation methods, such as the basis adjustments for milk and corn that were used before July, 2009. A zero deductible was assumed so the maximum risk reduction could be evaluated. With no deductible, the Gross Margin Guarantee is equal to the Expected Gross Margin.

The Gross Margin Guarantee is the sum over each 10-month contract period of monthly gross margins calculated from appropriately deferred futures prices for Class III milk, corn, and soybean meal. The historical deferred futures prices are conveniently available online in the “Underlying Data” section of Gould (2011). Gross margin calculations were performed in an Excel spreadsheet using assumed parameters for the milk quantity insured (1 cwt), a zero deductible, default feed coefficients of 0.5 bu/cwt for corn and 0.002 ton/cwt for soybean meal, and lookup functions that attributed the correct deferred futures prices to each month.

The Actual Gross Margin was calculated using the same parameters and formulas, again using historical data provided online by Gould (2011). In this case, "actual" prices represent the average of the final three days of milk, corn, or soybean meal futures settlement prices before expiration. For months with no futures contract, a weighted average of surrounding months is used instead. At this point, indemnities were calculated.

The term "Actual Gross Margin", while necessary for the calculation of indemnities, is misleading in the sense that it does not describe the gross margin realized by an individual producer at a specific location. The effectiveness of LGM-Dairy for reducing gross margin risk might vary widely across space, especially in locations with low Class III utilization, or during periods when the Class IV milk price was the Class I mover. For clarity, we will identify a producer's local gross margin as "Realized Gross Margin." The most feasible way to approximate Realized Gross Margin is to use region-specific mailbox milk prices, available online from Gould (2011), and state-level monthly average corn prices where possible (USDA, National Agricultural Statistics Service, various years). National average soybean meal prices are used, as the 10 cash markets for which USDA's Agricultural Marketing Service collects soybean meal prices align poorly with the regions evaluated in the present analysis.

Just as producers who hedge in futures and options markets face basis risk, participants in LGM-Dairy face an analogous risk so that changes in realized gross margins may not be highly correlated with indemnity payments. There are two causes of potentially low correlation. The first is that national-level Class III milk and corn price changes are imperfectly correlated with state- and regional-level price variation. The second is that indemnities do not necessarily occur when absolute gross margin levels fall; indemnities occur when gross margins fall from higher expected levels during the life of an insurance contract. One can receive indemnities when gross margins are high but not as high as expected, and one can receive no indemnities when gross margins are very low. This is the nature of futures as a price risk management tool. It does not provide counter-cyclical risk protection, instead it allows producers the opportunity to capitalize on the expectations of prices in the future manifested within futures contracts.

Historical monthly mailbox milk prices were gathered for the following available regions: the Northwest, California, New Mexico, Texas, Minnesota, Wisconsin, Illinois, Southern Missouri, Michigan, Ohio, Kentucky, Florida, and New England. State-level monthly average corn prices were available for a subset of these regions: Texas, Minnesota, Wisconsin, Illinois, Missouri, Michigan, Ohio, and Kentucky. Regional Realized Gross Margins were approximated using as much localized data as were available, and these represent outcomes without participation in LGM-Dairy. Indemnities were added to the Realized Gross Margins, and premiums were deducted, to calculate the net Realized Gross Margins with participation in LGM-Dairy.

Regional average Realized Gross Margins, with and without participation, were next calculated over the period January, 2002 to April, 2011 under two scenarios: no premium subsidy, and an 18 percent premium subsidy. These results are useful in estimating supply response to gross margin levels.

Similarly, the root mean squared deviations from median outcomes were calculated for each region, and each premium subsidy level, with and without participation in LGM-Dairy. These results are the core of the analysis and are useful in estimating supply response to gross margin risk and, in turn, analysis of both risk reduction and the impact of that reduction on milk supplies.

Results

Overall results suggest that LGM-Dairy was quite effective in reducing the risk levels of dairy producers. The root mean-squared deviation from the median was found to be considerably smaller when LGM-dairy was utilized than when not utilized. The results are quite robust as a considerable reduction in risk level was found for each of the regions analyzed. Estimated risk reduction levels ranged from 28% in Minnesota to 39% in Florida. Moderate risk reduction levels offer a logical explanation for the popularity of the program. Risk reduction levels are reported in Table 1 below for zero deductible scenarios.

Table 1. Risk Reduction Associated with LGM-Dairy (January 2001 – March 2010)

Region	Risk Level* Without LGM Dairy	Risk Level* with LGM-Dairy	% Reduction in Risk
Northwest	21.06	13.49	36%
California	20.76	13.23	36%
New Mexico	19.16	12.65	32%
Western Texas	19.59	12.65	35%
Minnesota	21.36	15.29	28%
Wisconsin	22.03	15.71	29%
Illinois	23.49	15.92	32%
Southern Missouri	21.56	14.50	33%
Michigan	23.61	15.18	36%
Ohio	22.75	15.23	33%
Appalachian	20.72	14.31	31%
Florida	21.92	13.45	39%
New England	25.35	17.58	31%

* Risk level is defined as the root mean squared downside deviations from the median gross margin

An interesting finding is that risk reduction was indeed achieved in each of the regions included in the analysis. This same general result was found in the analysis of the Dairy Options Pilot Program (Maynard, Wolf, and Gearhardt, 2004) but this study found considerably more advantage to LGM-Dairy in the lower Class III utilization areas than was associated with the Dairy Options Pilot Program. This result suggests that basis risk across regions is perhaps less of a concern than previously thought.

While consideration of risk reduction levels is certainly important, evaluation of realized margins, with and without LGM-Dairy, should also be discussed. Generally, a tradeoff is expected between risk and reward, so a decrease in average margin would not have been unexpected from utilizing LGM-Dairy. However, as can be seen in Table 2 below, the change in average margin ranged from -1% to 2%, with virtually no change when locations were pooled.

Table 2. Average Realized Margin by Order (January 2001 – March 2010)

Region	Average Margin Without LGM Dairy	Average Margin with LGM-Dairy	% Change in Margin
Northwest	$121.62	$124.27	2%
California	$115.69	$118.15	2%
New Mexico	$114.73	$117.03	2%
Western Texas	$122.59	$124.70	2%
Minnesota	$137.98	$137.95	0%
Wisconsin	$138.46	$136.77	-1%
Illinois	$138.07	$136.35	-1%
Southern Missouri	$136.15	$134.48	-1%
Michigan	$134.99	$133.31	-1%
Ohio	$140.99	$139.22	-1%
Appalachian	$147.21	$145.50	-1%
Florida	$168.01	$166.26	-1%
New England	$146.40	$144.24	-1%

Results reported in tables 1 and 2, both assume a zero deductable, which is associated with an 18% premium subsidy. Higher deductibles are generally associated with higher subsidy levels (on a percentage basis), so it is logical to also examine risk reduction and gross margin impacts for variable levels of deductible and premium subsidy. Table 3 below reports these results.

Table 3. Risk Reduction and Gross Margin Impacts of LGM-Dairy Participation Under Various Deductible Subsidy Combinations

Deductible ($/cwt)	Corresponding Premium Subsidy	Percent Risk Reduction	Percent Change in Average Gross Margin
$0.00	18%	33%	0%
$0.20	21%	31%	-1%
$0.40	25%	28%	-1%
$0.60	31%	25%	-1%
$0.80	38%	23%	-1%
$1.00	48%	20%	-1%
$1.50	50%	14%	-1%
$2.00	50%	9%	-2%

A second goal of this analysis was to estimate the likely production impacts associated with the achieved risk reduction levels. As discussed in the background section, results from previous research on the impact of risk reduction on product supplies has been mixed and most have focused on grain crops rather than livestock and milk production. Further, risk elasticities, when found to be significant, have also been quite variable. However, since there is logic in assuming a production impact, some discussion is warranted. Further, since risk elasticities have been highly variable, some sensitivity analysis would also seen worthwhile. Table 4 reports expected changes in production levels (on a percentage basis) given risk reduction by region at three different risk elasticity levels, -01, -0.05, and -0.025.

Table 4. Expected Supply Response Given Risk Reduction Level and Elasticities

Region	% Reduction in Risk	Supply Impact: E_{risk} = -0.10	Supply Impact: E_{risk} = -0.0.5	Supply Impact: E_{risk} = -0.025
Northwest	37%	3.66%	1.83%	0.91%
California	37%	3.72%	1.86%	0.93%
New Mexico	34%	3.36%	1.68%	0.84%
Western Texas	36%	3.59%	1.80%	0.90%
Minnesota	28%	2.84%	1.42%	0.71%
Wisconsin	29%	2.89%	1.44%	0.72%
Illinois	33%	3.29%	1.64%	0.82%
Southern Missouri	35%	3.52%	1.76%	0.88%
Michigan	36%	3.58%	1.79%	0.89%
Ohio	35%	3.46%	1.73%	0.87%
Appalachian	33%	3.27%	1.64%	0.82%
Florida	39%	3.86%	1.93%	0.96%
New England	31%	3.12%	1.56%	0.78%

Given the risk elasticity assumptions made in Table 4, and supported by the literature, milk production impacts are likely to be fairly small. Even at the highest risk elasticity levels, supply impacts never exceed 4%. However, a 3-4% increase in quantity supplied can be expected to have more than a 3-4% negative impact on price when price flexibilities are greater than -1.0. Of course, the participation level in LGM-dairy would also heavily impact any price effects. As one considers the positive impact of risk reduction it is worth noting the potential impact on supply as well. It is also worth noting that premium subsidies will increase the expected supply impacts.

Conclusions, Implications, and Areas for Further Research

This work contains implications for both dairy producers and policy makers. From the perspective of the dairy producer, LGM-Dairy appears to offer an opportunity for them to reduce their downside gross margin risk, defined as returns above feed (corn and soybean meal) costs. Evidence also suggests that LGM-Dairy may offer risk reduction exceeding that provided by use of dairy options, although an important caveat would be to note that overall risk levels were likely much higher during the time period of this study. The finding should also be encouraging for producers in higher class I utilization areas as risk reduction effects were similar across regions.

A clear advantage of LGM-Dairy is the ability to protect a margin rather than a single output price. Unlike purchasing Class III dairy options, which can only be triggered when milk prices fall, indemnities can be received on LGM-Dairy policies when milk prices fall, feed prices rise, or some combination of the two. An interesting extension of this work would involve analyzing the risk reduction effects of LGM-dairy in situations where corn and soybean meal are not the primary feeds being purchased. An additional "basis risk" would exist for producers who are primarily grass-based (grazing operations), or who purchase and feed large quantities of hay or other feeds.

While it would seem logical that reduced risk would have supply effects, the literature reviewed was not especially robust as to the magnitude of this effect. Further, the limited lack of funding available for LGM-Dairy, coupled with the fact that many producers do not participate regardless of availability suggest that production effects are likely to be quite small. An extension of this work involving milk supply modeling is currently ongoing with the USDA's Economic Research Service that should provide a better feel for risk elasticities specific to milk production. In terms of policy implications, the results of this work will be greatly enhanced by the results of this supply and risk modeling.

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