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Evidence and Implications for Managing Margin Risk by
U.S. Dairy Producers

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ABSTRACT

With increased volatility of feed prices dairy farm managers are no longer concerned with managing just milk price volatility but are considering the adoption of risk management programs that address income over feed cost (IOFC) margin risk. Successful margin risk management should be founded on understanding of the behavior of IOFC margins. To that end, we construct forward IOFC margins using Class III milk, corn and soybean meal futures prices. We focus on the characteristics of the term structure of forward IOFC margins, i.e. the sequence of forward margins for consecutive calendar months, all observed on the same trading day. What is apparent from shapes of these term structures is that both in times when margins were exceptionally high and when they were disastrously low, market participants expected that a reversal back to average margin levels would not come quickly, but would rather take up to 9 months. Slopes of the forward margin term structure prior to and after most of the major swings in IOFC indicate these shocks were mostly unanticipated, while time needed for recovery to normal margin levels was successfully predicted. This suggests that IOFC margins may exhibit slow mean-reverting, rather than predictable cyclical behavior, as is often suggested in the popular press. This finding can be exploited to design a successful catastrophic risk management program by initiating protection at 9 to 12 months prior to futures contract maturity. As a case study, we analyze risk management strategies for managing IOFC margins that utilize Livestock Gross Margin for Dairy Cattle (LGM-Dairy) insurance contracts. We created two farm profiles where the first one represents dairy farms that grow most of their feed. The second profile is designed to capture the risk exposure of a dairy farm that purchases all their dairy herd, dry cow, and heifer feed. Our case study of this program encompasses the 2009 period which was characterized by exceptionally poor IOFC margin conditions. We analyzed the dynamics of realized IOFC margins in 2009 under four different risk management strategies, and found that optimal strategies that are founded on principles delineated above succeeded in reducing the decline IOFC margins in 2009 by 93% for home-feed and 47% for market-feed profile, and performed substantially better than alternative strategies suggested by earlier literature.

Keywords: risk management, income over feed cost margin, Livestock Gross Margin for Dairy Cattle program

Introduction

On a typical dairy farm, the cost of feed can range from fifty to seventy percent of total operating cost to produce a kilogram of milk. Increase in feed exports, U.S. gasoline policies mandating minimum percentage corn based ethanol blends, and general macroeconomic instability have all contributed to both increased levels and volatility of corn and soybean prices. With these feeds being the foundation of most dairy rations, dairy farm managers are no longer concerned with managing just revenue volatility but are considering the adoption of risk management programs that address income over feed cost (IOFC) margin risk.[1]

Successful margin risk management must be founded on understanding the behavior of IOFC margins. Three issues stand out as particularly important. First, what is the magnitude of IOFC margin volatility? Second, when IOFC margin declines, how long does it take the margin to recover to an average level? And finally, are oscillations in IOFC margins predictable? Nicholson and Stephenson (2010) decomposed All-milk prices over 1988-2010 period to cycles of different length and claimed that predictable cycles explain much of the variability in milk prices. They found the 36-month cycle to have become the largest component of cyclical variation, and state the length is consistent with biologic constraints on the time needed to expand a dairy herd. The dynamic model of the U.S. dairy sector used by these authors also produces substantial cyclical component in All-milk price dynamics. In this article we examine if expectations regarding future IOFC margins, as embedded in the futures prices, are consistent with predictable multi-year oscillations around average margin levels. Answers to the stated questions inform design of risk management strategies presented in the second part of the article.

Analysis of IOFC Margin Behavior

In order to answer the questions regarding magnitude and predictability of oscillations in IOFC margins, we construct forward IOFC margins using futures prices for Class III milk $\left(f_{t,i}^{M} \right)$, corn $\left(f_{t,i}^{C} \right)$, and soybean meal $\left(f_{t,i}^{SBM} \right)$. The subscript i denotes a particular month for which forward margin will be calculated. This is the same set of prices currently used in the Livestock Gross Margin for Dairy Cattle (LGM-Dairy) program that is being promoted as a tool to protect minimum IOFC margins (Valvekar, Cabrera and Gould, 2010). While there is no ambiguity about the level of futures prices, there is no single approach to constructing forward IOFC margins given that dairy rations and feed price risk exposure vary across farms. For a producer that grows most of the feed required for milk production, a forward IOFC margin would reflect

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[1]Over the past twenty years, the private sector has been actively developing risk management tools for managing milk price volatility. Since 1993, nearly a dozen dairy-based futures and options contracts have been listed on commodity exchanges. Five dairy commodities are actively traded today at the Chicago Mercantile Exchange, with Class III milk futures and options the most liquid and widely used contract.

lower feed market price risk compared with a dairy operation that purchases a majority of its feed, and is therefore vulnerable to adverse feed price shocks.

To facilitate our discussion, we take as a starting point the IOFC margin first suggested by the National Milk Producers Federation (2010) and adopted in modified form in the 112th Congress U.S. House of Representatives bill H.R. 6038 referred to as Federal Agriculture Reform and Risk Management Act of 2012 (Farm bill). IOFC margin, as proposed in the 2012 Farm bill, is defined as farm-level value of a hundredweight of milk minus the specific feed ration composed, by weight, of 58.8% of corn, 14.4% of soybean meal and 26.8% of alfalfa hay with a total ration weight of 46.34 kg. The ration cost is calculated as the sum of 1.0728 times the U.S average price of corn ($/bu), 0.00735 times the U.S. average price of soybean meal ($/ton), and 0.0137 times the average price of alfalfa hay ($/ton). To be able to calculate forward IOFC margins, we must use prices of commodities actively traded on futures markets. Farm bill stipulates U.S. All-Milk price be used to value milk production. Although there is no futures contract written on the reported U.S. All-Milk price, we can exploit the fact that announced Class III milk price and reported monthly all-milk prices have been extremely highly correlated over the period 2000-2012, with correlation coefficient 0.966. We proceed by using basis-adjusted Class III futures prices, where for tractability we add to each futures price $1.40, i.e. the average difference between the U.S. All-milk and announced Class III prices observed over the 2000-2012 period.

In addition, unlike corn and soybean meal, alfalfa hay does not trade on organized futures markets. In order to obtain a measure of expected future alfalfa hay costs, we regressed monthly alfalfa hay price received by U.S. farmers on monthly prices received for corn and soybean meal. The estimation period used is January 2005-June 2012. Regression results are given in Table 1.

[INSERT TABLE 1 HERE]

Based on regression results, a ton of alfalfa hay is converted to 25.96 bushels of corn and -0.135 tons of soybean meal. Given the proposed utilization of alfalfa hay listed above, after conversion has been performed, the final corn and soybean meal equivalents per hundredweight of milk are 1.4248 bushels of corn and 0.005503 tons of soybean meal per hundredweight of milk produced. The intercept from the regression of hay on corn and soybean meal prices, multiplied by the utilization of alfalfa hay per hundredweight of milk subtracts $0.995 from the basis. Given these specifications, time-t expected per cwt. income over feed cost margin $E_t(\text{IOFC}_i)$ for month i is given by

$$E_t\left(\text{IOFC}_i\right) = \$0.305 + f_{t,i}^M - 1.4248 f_{t,i}^C - 0.005503 f_{t,i}^{SBM} \tag{1}$$

Figure 1 is used to illustrate the behavior of forward margins over the 1998-2011 period. The thin solid line plots realized margins, i.e. margins calculated using terminal futures prices for milk and feed contracts for the period 1998 through 2011. For example, corn and soybean meal futures contracts for December 2008 last traded on December 14, 2008, for $3.60/bu and

$258.50/ton. On that day, December 2008 Class III milk futures traded for $15.11/cwt. Inserting these prices in equation (1) yields IOFC margin level of $8.86/bu or $195.4/Mg. Inspection of Figure 1 reveals a well-known pattern in the IOFC margin with an apparent 3 year cycle: peaks in 2001, 2004 and 2007, and dips in 2000, 2003, 2006 along with a major trough in 2009. The range of realized margins reveals immense margin volatility faced by dairy farmers. The difference between the maximum and the minimum realized IOFC margin is higher than $300/Mg ($13/cwt), and the coefficient of variation is 0.33.

[INSERT FIGURE 1 HERE]

For this analysis we focus not on realized IOFC margins, but on the characteristics of the term structure of forward IOFC margins. The term structure of futures prices is defined as the set of futures prices for different delivery months, observed at a single point in time. Likewise, the term structure of forward IOFC margins is the sequence of forward margins for consecutive calendar months, all observed on the same trading day. In Figure 1, the thick black solid and dashed lines illustrate eight different observations of the forward margin term structure. The dashed line represents forward margin term structure after four major shocks to the IOFC margin: July 2001, December 2004, July 2007 and May 2009. Each term structure is calculated based on futures prices for milk and feeds for up to at least 12 calendar months, at the middle of the months indicated above. For example, December 2003 forward margin term structure in calculated using daily settle futures prices on December 15, 2003. Futures prices for March, May, July, September and December 2004, as well as March 2005 were collected, margins for respective months calculates using equation (1), and the short dashed line starting in December 2003 connects the calculated forward margins. What is apparent from shapes of these term structures is that both in times when margins were exceptionally high, and when they were disastrously low, market participants expected that a reversal back to average margin levels would not come quickly, but would rather take up to 9 months.[2]

Forward margins can also be used to gain insight as to the existence, regularity and predictability of apparent multi-year cycles. If such cycles were indeed a stable characteristic of IOFC margins, then it would follow that high volatility in IOFC margins is not to be equated with high risk to dairy producers. That is, as long as average long-run margins provide adequate returns, stability of multi-year cycles means that oscillations around average would be mostly predictable. If futures markets are efficient, i.e. if futures prices fully account for predictable future supply and demand shifts, then term structure of forward IOFC margins would reflect predictable cyclical

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[2] It should be noted that while futures market prices are a good predictor of the time needed to return to average margins, they are in fact no better in timing the start of margin recovery than they are in predicting the occurrence of a major shock. For example, in January 2009, futures market pointed to milk price recovery starting in March 2009, while the extremely low milk prices persisted until July 2009.

declines in margin, making it impossible to use futures and options to protect against such parts of the cycle. The only effective cash flow smoothing approach would then be to use windfall profits from above-average margin periods to compensate for inevitable and predictable low-margin part of the cycle.

Do forward IOFC margins indicate that deviations from average margin level in the past decade were predictable? The thick solid line in Figure 1 represents forward margin term structure immediately preceding major shocks to dairy gross margins: December 2000, December 2003, December 2006 and December 2008. How well did the market anticipate margin shocks that followed? From Figure 1 it is apparent that the answer is not well at all. Rather than sloped to indicate predictable cycles, term structure curves of forward margins are mostly flat, accounting only for intra-year seasonality. If 3-year cycles do exist, futures markets did not seem to notice. Even if some commodity traders were betting on such outcome, that was clearly not the market consensus.

There are three principal implications of the above analysis for margin risk management. First, farmers may not want to time major operation expansions based on expectations of above-average milk prices that a predictable 3-year cycle would entail, for there may not be much predictability in oscillations of IOFC margins afterall.

Second, and more important - for risk management purposes, it is the futures-based forward margins that matter, as these are the prices one can utilize to protect future cash flows. It may appear counterintuitive at first, but the lack of ability of futures markets to anticipate major margin declines is in fact beneficial for risk management purposes. If futures markets were correctly anticipating the collapse of dairy margins in 2009, they would have been completely useless for hedging against that catastrophic event.

Finally, if expected duration of price recovery when margins are exceptionally low can take up to 9 months, then trying to insure nearby cash flow is similar to purchasing home insurance while smoke is already coming from the attic. Available margins one can lock in after a major adverse shock has already occurred will likely be inadequate to preserve short-term profitability. The flipside of this argument comes from realizing that forward margins available *before* major shocks are generally at the level matching long-run averages. This suggests that smart risk management program would include protecting *deferred* rather than nearby margins.

Figure 2 is used to show an evolution of forward margins from 17 months to maturity through expiration of each contract. Each line on the figure depicts the evolution of a particular forward IOFC margin for a single contract month. All contract months between September 1998 and December 2011 are included in the figure. Wide dispersion at the right end of the figure – margins varying from $45/Mg to $335/Mg of milk ($2.02 - $15.20/cwt) - is just a different way to illustrate volatility in realized margins. More importantly, from 1998 to 2011 there was not a single month where a producer was not able to establish at least $154/Mg ($7.00 per

hundredweight) IOFC at some point between nine and twelve months prior to contract maturity. There are indeed uninsurable catastrophic risks in animal agriculture. However, they reside primarily in production, not marketing side of the business. For example, as late as October 2008 Class III futures prices were trading at above $340/Mg ($15.50/cwt) for any contract month in 2009. While 2009 was indeed a catastrophic year for dairy producers, it may have been more so due to the underutilization of available risk management tools, rather than being presented with a market risk that could not hedged.

[INSERT FIGURE 2 HERE]

Analysis of Alternative Risk Management Strategies

Early analyses of dairy revenue risk management using dairy futures contracts include Fortenbery, Cropp and Zapata (1997), Fortenbery and Zapata (1997) and Thraen (1999). These papers sought to identify whether or not futures contracts introduced in 1990s provide sufficient linkage with cash milk prices to justify hedging at all. A second generation of papers focused on managing downside milk price risk. Maynard and Bamba (2004) focused on measures of tail risk, i.e. large adverse price changes, and found a seven month hedge horizon to be more effective than hedge placed four months to contract expiry. Maynard, Wolf and Gearhardt (2005) found that hedging using Class III milk futures with a four-month hedging interval would have eliminated between 24 and 58 percent of mailbox price semi-variance over the 2000-2003 period.[3] More recently, Valvekar, Cabrera and Gould (2010) analyzed risk management strategies for protecting IOFC margins using Livestock Gross Margin for Dairy Cattle (LGM-Dairy), and Valvekar et al. (2011) found that its use can increase expected utility for risk-averse dairy producers. Given recent experience of catastrophically low IOFC margins in 2009, there is a need to examine how effective different risk management strategies would have been in protecting dairy farm profits in case of such massive market turmoil.

As shown by the previous studies, under market conditions characterized by stable feed prices, volatility in dairy farm profits could be addressed by focusing on the volatility of mailbox milk prices. With recent increases in the level and volatility in feed grain prices the focus of attention turns from trying to manage milk price volatility to one of managing dairy IOFC volatility. A variety of risk management strategies can be utilized to that end. Perhaps the most intuitive strategy is to simply acquire or rent enough land to grow all, or most needed feedstuffs. If that option is not available, or deemed attractive, one alternative could be to forward contract expected feed purchases and use conventional futures or options-based strategies for managing milk price risk.

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[3] A variable's semi-variance is a measure of the dispersion of all observations that fall below the mean or target value of this variable. The semivariance is an average of the squared deviations of values that are less than the mean or target value.

A more sophisticated, if likely more expensive strategy as well, would be to use a *milk-feed options bundle* (Gould and Cabrera, 2011). Under the options bundle strategy, purchasing Class III put options sufficient to cover monthly milk marketings establishes a Class III milk price (and revenue) floor. Given an estimate of the corn and soybean meal equivalents required to produce this milk, purchasing the necessary feed call options can be used to establish a ceiling on feed equivalent costs. With the establishment of a feed cost ceiling and a milk revenue floor, the IOFC margin floor has been established.

To understand the benefits and shortcomings of the milk-feed options bundle approach, a simplified illustration of bundled-option strategy is given in Figure 3. In this figure, the solid line presents the net payoff from a put option on milk futures (i.e. including cash revenue from milk sales at going market price), while net payoff from a call option on feed futures is given by the dotted line. The flat portion of the solid line depicts the strike price for the milk put option minus the option premium and associated brokerage fees. Similarly, the horizontal portion of the dotted line is found by adding the feed option premium to call option strike price. Should the realized milk price be higher than the put option strike price, the producer would let the milk option expire worthless, and benefit from the upside potential this strategy preserved. Likewise, if the feed price declines, the call option on feed futures would not be exercised, and feed would instead be purchased at the lower (than call) price. In the opposite situation, where either milk price declines, feed price increases, or both, the IOFC floor protection is activated (i.e., exercise the put and call options) and the producer's minimum IOFC margin will be guaranteed.

[INSERT FIGURE 3 HERE]

The usual complaints about the options bundle strategy include contract lumpiness, basis risk, inability to purchase the desired Class III options given the thinness in deferred Class III options markets and cost of undertaking such a strategy. One fundamental shortcoming that is rarely recognized though, is that this strategy *overinsures* the farm profits. In particular, using the options bundle approach protects more than just IOFC floor. To see why, consider a situation where both milk and feed prices increase such that the IOFC margin stays the same. Such a change in pricing environment would have no impact on profits of this dairy farmer, and yet, the options bundle strategy would produce a payoff on the feed call options side. The implication is that the options bundle approach is an imperfect method of protecting the IOFC margin floor. That is, a contract that would protect the IOFC margin floor, but would *not* trigger payouts for proportional changes in milk and feed prices that leave IOFC margin unchanged would be cheaper than the above stated bundled options package.

Because IOFC margins are farm specific, there exists no privately designed IOFC margin contract at Chicago Mercantile Exchange, or any other public exchange. Instead, such risk management strategies are made possible through government-sponsored Livestock Gross Margin for Dairy Cattle (LGM-Dairy) insurance. The LGM-Dairy program is administered by USDA's Risk Management Agency, and made available via authorized crop insurance agents to dairy farm operators in the lower 48 states. This program can be characterized as being quite

flexible and size neutral. It is size neutral in the sense there is no minimum contract size, and any amount of milk marketings up to 240,000 cwt can be insured at one time. In addition two farms with the same per cow productivity, declared feed use and insurance contract design will pay the same premium per insured hundredweight of milk regardless of farm size. The insurance design is very flexible given that the contract can account specifically to the market risk faced by a particular dairy operation as well as different degrees of desired coverage. Finally, the buyer of an LGM-Dairy contract can select the level of deductible, i.e. magnitude of revenue shortfall that has to be exceeded before any indemnities are due.

Under LGM-Dairy expected gross returns are based on Class III, corn and soybean meal futures prices at the time of insurance contract purchase and the amount of milk and feed desired to be insured. Class III milk futures are the most liquid dairy futures contract with actively trading options market, making that contract a natural choice for basket option-type product such as LGM-Dairy. However, as no other dairy futures and options are used, there could be a considerable basis risk for producers with high Class I or Class IV milk utilization (Newton and Thraen, 2012). Indemnities under LGM-Dairy are determined by the difference in expected and actual gross revenues, where the actual gross revenues are based on futures market milk and feed settle prices at futures contract expiration. For a more detailed discussion of the LGM-Dairy insurance program and evaluation of performance refer to Valvekar et al. (2010) and Gould and Cabrera (2011).

As the above analysis emphasizes, there are important reasons to focus on margin rather than milk price risk management, and there are potentially significant savings that can be achieved by using LGM-Dairy rather than separate financial instruments to protect cost and revenue streams. One further benefit is revealed upon realizing that the true risk to dairy producers comes not from a single month of negative cash flow, but from the possibility of prolonged periods of exceptionally low margins. Short-lived oscillations to cash flow can easily be smoothed out by cutting variable costs, drawing on cash reserves and operating lines of credit, or by taking loans against the farm equity. Such equity-based self-insurance is ill-suited, however, for riding through deep crisis such as 2009. Some estimates indicate that as much as 30% of dairy farm equity was lost that year, and very few farms could afford a self-insurance strategy as a risk management approach for the next crisis of similar magnitude (AgWeb, 2010). In other words, there is a need for *catastrophic risk management tool* that would insure *average IOFC margins*, rather than an IOFC margin for a single month. Just as the options bundle approach is revealed to be inferior to genuine margin-based insurance, so is insuring a single month inferior to protecting multiple months under the same contract. The probability that IOFC margins will decline is always higher than the probability that IOFC margins will decline and stay below average level for several consecutive months. Contracts that insure average IOFC margins over a longer period of time will thus be relatively cheaper than a sequence of comparable insurance contracts that protect IOFC margins one month at a time. LGM-Dairy can easily accommodate the need for catastrophic risk insurance, as up to 10 months can be insured on a single contract.

Valvekar, Cabrera and Gould (2010) proposed a cost-minimizing tool for the analysis of how LGM-Dairy can be used to obtain a pre-specified target net IOFC margin for all milk produced on the farm regardless of whether that milk is actually insured. Valvekar et al. (2011) used this tool to examine welfare effects of risk management. Figure 4 shows the characteristic pattern of monthly coverage in such cost-minimizing LGM-Dairy contracts found in these analyses. The pattern is one in which first several insurable months are covered at a rate of 100%, while for deferred months coverage generally declines as time to maturity increases. The intuition behind these patterns is that margin risk in deferred months is much higher, potential losses are larger, and consequently it is more expensive to set a floor on a margin for a period that is for example eight months away than it would be for nearby months.

[INSERT FIGURE 4 HERE]

The optimal percentage coverage strategies illustrated in Figure 4 are single contract focused and there are important hidden costs of these coverage strategies when one considers the short-run decision in the context of a long-run marketing plan. Buying LGM-Dairy insurance once a year, and obtaining insurance on target IOFC margin by frontloading coverage on nearby months exposes the producer to availability risk. That is, when the current insurance contract expires, and is time to buy coverage for the following year – good margins may not be available for purchase.

Results and Discussion

To further explore the above hypothesis we examine the potential efficacy of using LGM-Dairy to insure against 2009 declines in IOFC margins. We created two hedging profiles: *Home-Feed* and *Market-Feed*. The **Home-Feed** profile is used to represent dairy farms that grow most of their feed and may want to declare the minimum feed levels allowed within an LGM-Dairy contract.[4] The **Market-Feed** profile is used to represent the other end of the spectrum – dairy farms that buy all the feed for their dairy herd and would desire to declare the maximum allowable corn and soybean meal levels on the LGM-Dairy contract. For both of these profiles we examine four different contract designs where under each strategy the producer purchases an LGM-Dairy contract each month and insures:

(i.)   *Flat-10*: 1/10 of expected milk marketings for each of the ten insurable months (i.e. the maximum number of months that can be covered by a single LGM-Dairy contract).

  (ii.)*Up Front*: 1/3 of expected milk marketings for the 1st, 2nd and 3rd insurable month.

(iii.)   *Middle of the Road*: 1/3 of expected milk marketings for the 4th, 5th and 6th insurable month.

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[4] A significant number of Wisconsin LGM-Dairy contracts have adopted this type of strategy (Hartzell, 2011). As specified in the LGM-Dairy contract there are maximum and minimum amount of feed that must be declared for corn and soybean meal equivalents. This range is 0.07 – 0.76 kg of corn per kg of milk (0.13-1.36 bu/cwt of milk) and 0.0161 – 0.26 kg of soybean meal per kg of milk (1.61-26.00 lbs/cwt).

(iv.)   ***Looking Ahead***:   1/3 of expected milk marketings for the 8th, 9th, and 10th insurable month.

Regardless of the strategy adopted, as long as it is persistently followed, eventually 100% of the expected milk marketings will be insured under an LGM-Dairy.

In Figures 5 and 6 we illustrate the implications of the use of these four strategies for *Home-Feed* and *Market-Feed* farm profiles in terms the level of IOFC margin net of premium costs under the four alternative strategies. Our analysis encompasses the November 2007 through December 2009 period. To make the evaluation of these insurance strategies more tractable, we introduced several simplifications. First, while the first period when LGM-Dairy was available for purchase was August 2008, for the purpose of this exercise we assume LGM-Dairy was available as early as November 2007. Second, we assume the operator chooses $24.25/Mg ($1.10/cwt) deductible level, and that 50% subsidy was available from contract inception. Finally, we assume that the insurance premium is always due at the end of the last covered month.[5]

[INSERT FIGURES 5 AND 6 HERE]

For each panel shown in Figure 5 we show the actual IOFC margin net of premium paid, the amount of premium paid when there are no indemnity payments and the net (of premium) indemnity received for months when indemnity was due. When there are indemnity payments the total level of IOFC margin equals the sum of the actual margin and the net indemnity. To place these margins in perspective it should be noted that over the 2000-2011 time period the average IOFC margin was $290.57/Mg (or $13.18/cwt) for the *Home-feed* farm type and $137.79/Mg (or $6.25/cwt) for the Market-Feed farm type. In Table 2 we summarize average per-tonne (per hundredweight) margins for both profiles and under each of the four strategies.

[INSERT TABLE 2 HERE]

Unprotected IOFC margins fell by 19.5% in 2009 compared to the 2000-2011 average for the *Home-feed*, and 63.7% for the *Market-feed* farm type, respectively. Reflecting on the analysis of the IOFC margin behavior undertaken in the first part of this article, it should come as no surprise that the *Up Front* strategy results in a very modest increase in IOFC margins for both farm types. Income is increased by $15.87/Mg ($0.72 per cwt) for the *Home-feed* producer compared to *No-LGM*, and by only $14.33/Mg ($0.65 per cwt) for the *Market-feed* producer. The other strategies all perform rather well for the *Home-feed* producer, with *Looking Ahead* superior with a full $88.85/Mg ($4.03 per cwt) increase in average margins in 2009 compared to the *No-LGM* scenario. Comparing the panels in Figure 5 we see that for the *Home-feed* farm type there would have been significantly larger indemnity payments using the *Middle of the Road* and *Looking Ahead* strategies than under either *Flat-10,* or *Up Front* strategy.

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[5] While panels in Figure 5 only show the impacts from October 2008, for two of the hedging strategies examined risk management program would have to be put in place as early as November 2007, when October 2008 was the 10th insurable month.

It is not surprising that in Figure 6 where the results for the *Market-feed* farm type are displayed we see much lower IOFC margins. In fact for July 2009 we actually would have observed negative IOFC margin even under the *Flat-10* strategy. As for *Home-Feed* profile, under the *Looking Ahead* strategy the average IOFC margins increased the most of the four strategies considered here. Under this strategy the negative IOFC for June 2009 was increased from -$14.16/Mg (-$0.64/cwt) to $56.80/Mg ($2.58/cwt). For the entire 2009 year, realized unprotected average margin was $50.10/Mg ($2.27/cwt), while average margin under *Looking Ahead* strategy was $83.23/Mg ($3.78/cwt). Using 2007-2011 average IOFC margins, we find that *Looking Ahead* strategy reduced 2009 shortfall in IOFC margin by 93% for *Home-Feed* and 47% for *Market-Feed* profile. For the purposes of this article we deliberately kept the risk management strategies as simple as possible, so as to illustrate the basic principles of effective IOFC margin smoothing. Higher protection for *Market-Feed* profile in 2009 could have been achieved under strategy that targets a particular level of IOFC margin, rather than always choosing a particular deductible level. In the extreme case of zero deductible, *Looking Ahead* strategy average 2009 gross margin level that could be insured is $110.89/Mg ($5.03/cwt), or 91% of average 2007-2011 IOFC margin.

It should be noted that this analysis, while useful in expositing basic fundamental principle of using distant-delivery contracts, is hypothetical in the sense that it assumes regular LGM-Dairy contract availability. In reality, between January 2011 and August 2012, LGM-Dairy has only been offered in only 5 sales events. The change in insurance rules and introduction of premium subsidy in December 2010 has created imbalance between demand for LGM-Dairy and available federal funds, rendering LGM-Dairy mostly unavailable for purchase. To illustrate the impact of this constraint, let us assume that farmers can buy LGM-Dairy only once a year, at the January sales event. If that were the case in 2009, then the highest margin *Home-feed* profile would be able to insure would have been $245.37/Mg ($11.13/cwt) and $57.98/Mg ($2.63) for the *Market-feed* . Those margins are only $11.02/Mg ($0.50/cwt) (*Home-feed)* and $7.96/Mg ($0.36/cwt) (*Market-feed)* higher than realized 2009 IOFC margins in a scenario without any kind of protection. In face of irregular LGM-Dairy availability farmers may consider an alternative strategy such as initiating a limit order to buy a distant-delivery milk-feed option bundle once IOFC margin exceeds a threshold they deem critical.

Another point worth emphasizing is that risk management should not be treated as a profit center in itself. LGM-Dairy premiums are designed to be actuarially fair, i.e. if used regularly, over the long run, indemnities paid on contracts purchased under a particular risk management strategy should be equal to premiums paid. To illustrate the effect of buying actuarially fair insurance, consider the impact of LGM-Dairy on IOFC margins in 2007, a year with above average IOFC margins. In Table 2 we see that smoothing effect is the strongest for *Looking Ahead* strategy, with IOFC margins decrease by more than twice the decrease under *Up Front* approach. Overall, however, cost of insurance seems rather reasonable, with average per hundredweight cost for

2007 IOFC margins at a very modest level of 16 cents ($3.53/Mg) for *Home-Feed and* 23 cents ($5.29/Mg) for *Market-Feed* profile.

CONCLUSIONS

As simulations undertaken in this article have shown, what may seem like an optimal strategy in short run may in fact bring a producer to a situation when no good alternatives are available for protection against imminent and precipitous decline in income over feed margins. Hedging using nearby futures may help lock-in above average margins when times are good, but historically, only consistent utilization of contracts with 9-12 months to maturity would have sufficed to protect against prolonged periods of very low margins. Considering forward IOFC margins based on 2012 Farm bill definition of dairy production margin, over 2000-2011 period, there was always an opportunity to lock in at least $154.32/kg ($7.00/cwt) if margin protection has been initiated early enough.

Buying a put option on average gross margin, which can be done using LGM-Dairy insurance, does not necessarily guarantee a protection against catastrophic risk. Frontloading the insurance policy to minimize costs of a target income over feed margin within a single insurance contract carries hidden costs that good margins will not be available for purchase when current insurance contract expires. Nevertheless, both producers that grow most of required feed and those that buy all of it can successfully protect themselves against catastrophic gross margin risk if they consistently pursue risk management strategies that protect margins in those periods sufficiently far into the future that current dynamics of supply and demand have little bearing on the purchase cost of the insurance contract and its availability.
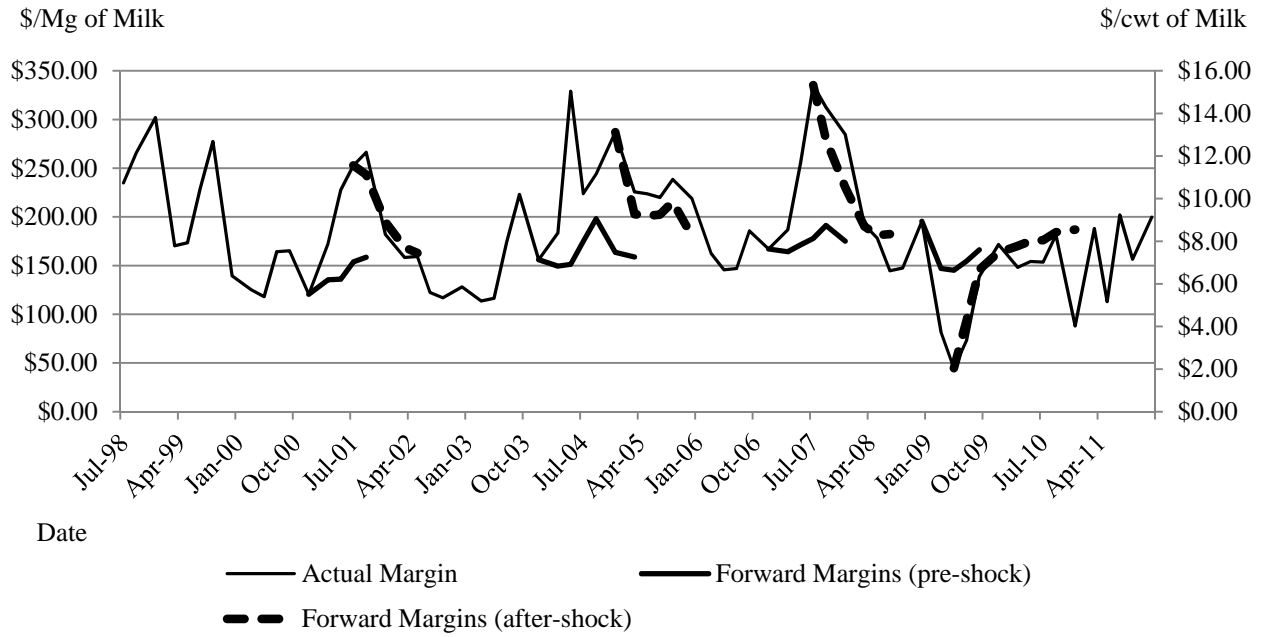
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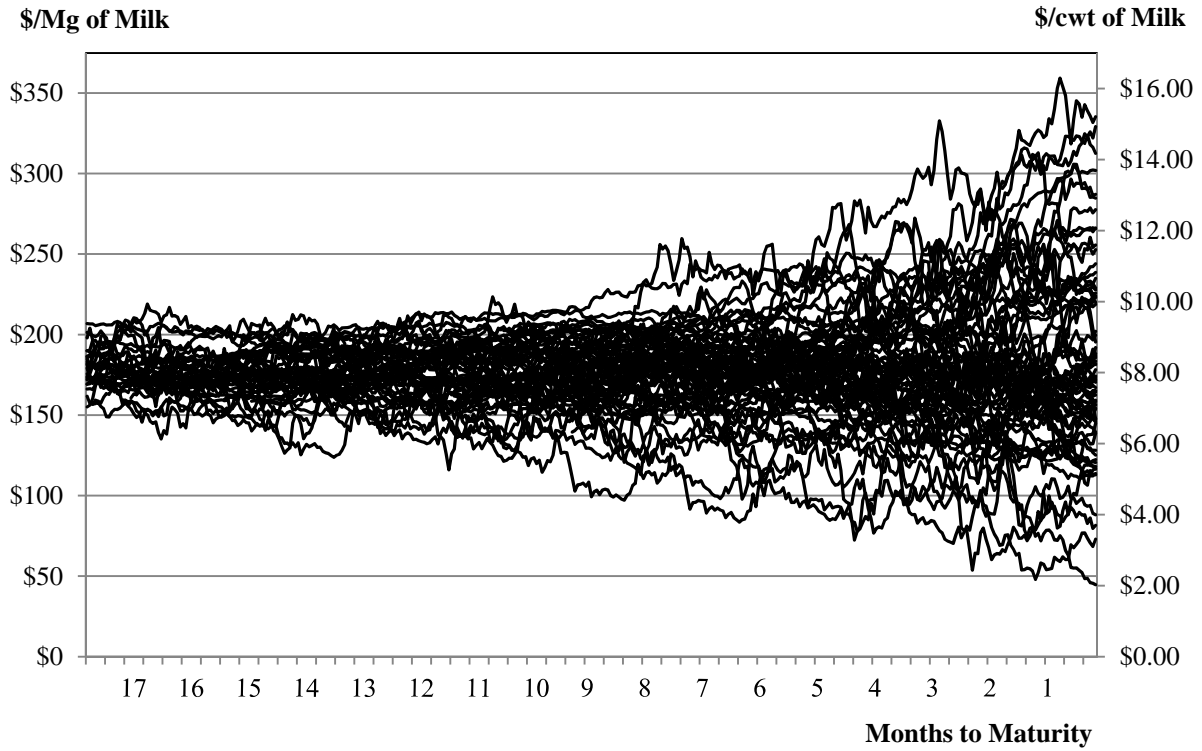
M. Valvekar, J. Chavas, B.W. Gould and V. Cabrera. 2011. Revenue Risk Management, Risk Aversion and the Use of Livestock Gross Margin for Dairy Cattle Insurance, Agr. Syst. 104:671-678

AgWeb. 2010. Dairy Producers Lost One Third of Their Equity in 2009. http://www.agweb.com/article/Dairy_Producers_Lost_One_Third_of_Their_Equity_in_2009_19 4692/ (Accessed 6/5/2012)

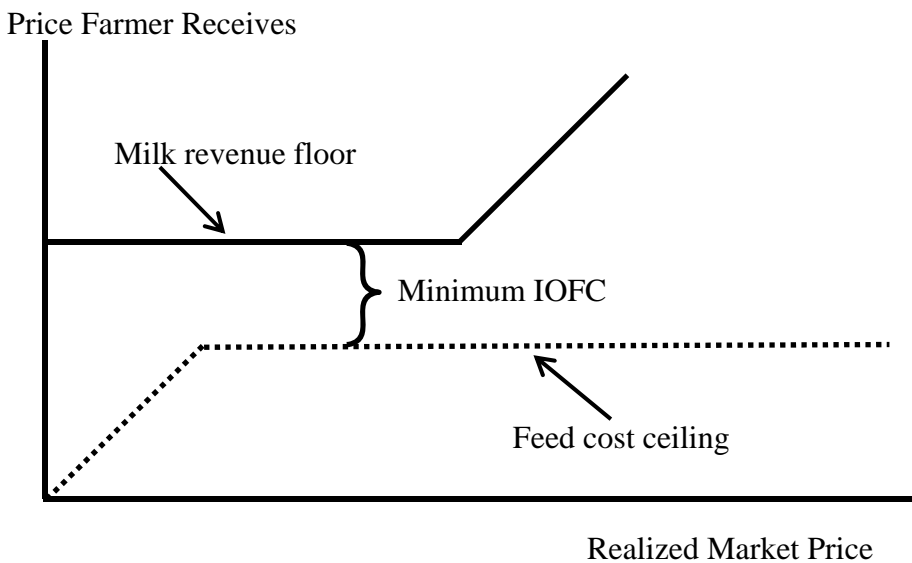**Figure 1. Unexpected Shocks and Expected Recovery in Dairy Gross Margins**

$/Mg of Milk

$/cwt of Milk

Date

— Actual Margin   — Forward Margins (pre-shock)

- - Forward Margins (after-shock)

Figure 2. Forward Dairy Margins, 1998-2011
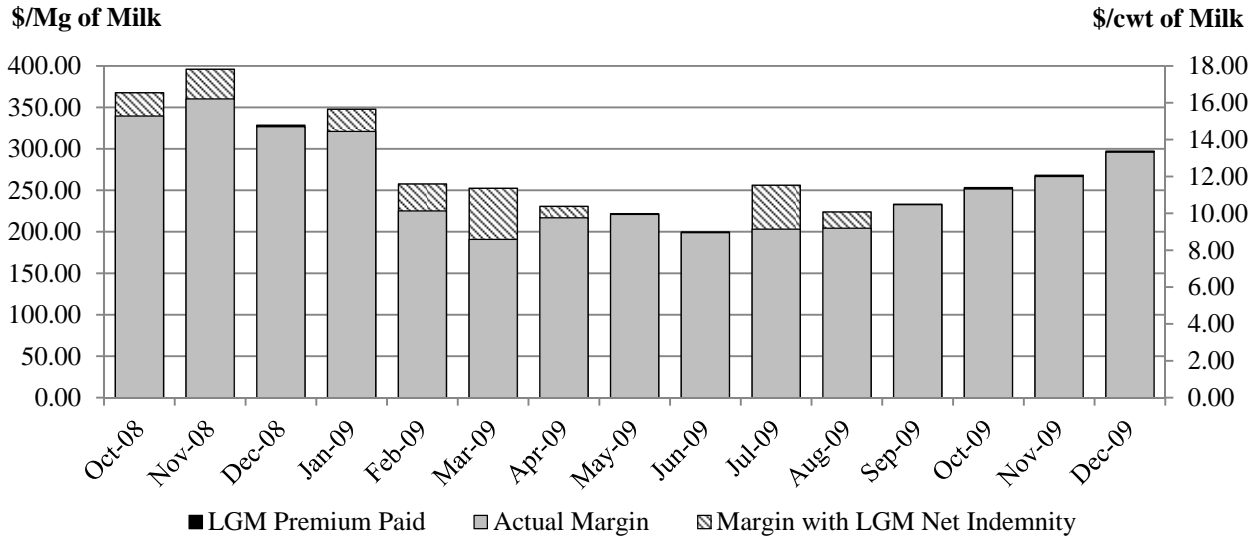

Figure 3. Use of Bundled Options Strategy to Establish an IOFC Floor

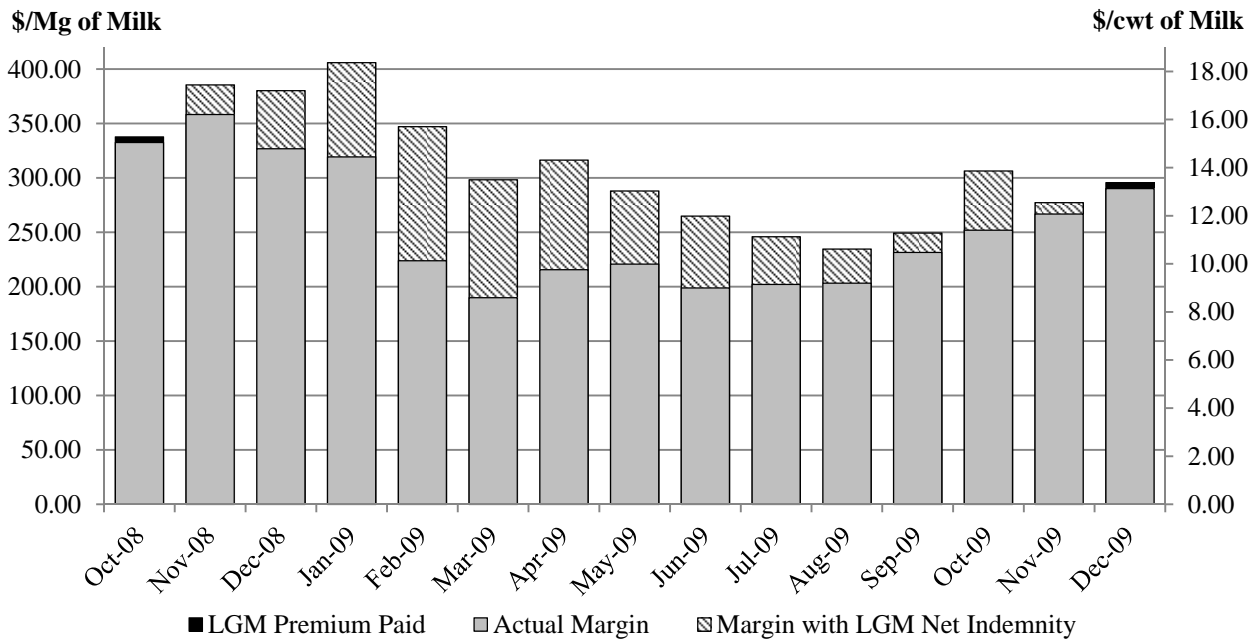**Figure 4. Patterns of Coverage for LGM Cost-Minimizing Strategies (Valvekar et al. 2009, 2011)**
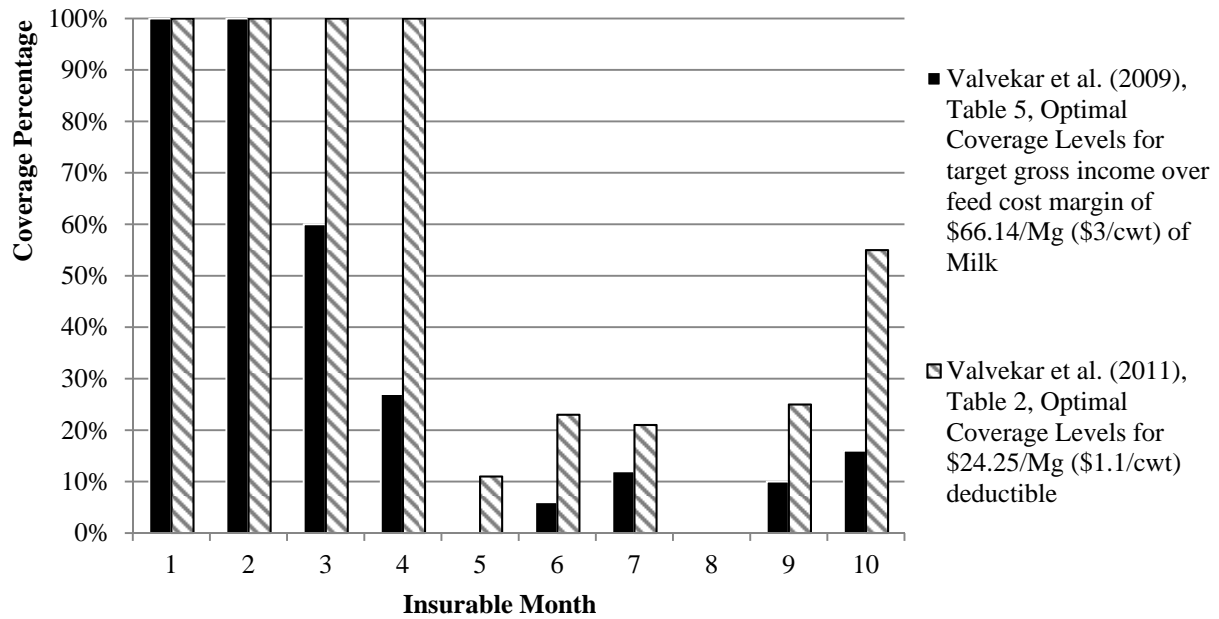
Figure 5. IOFC Margin Smoothing Under Different Risk Management Strategies:
   Home-Feed **Profile**

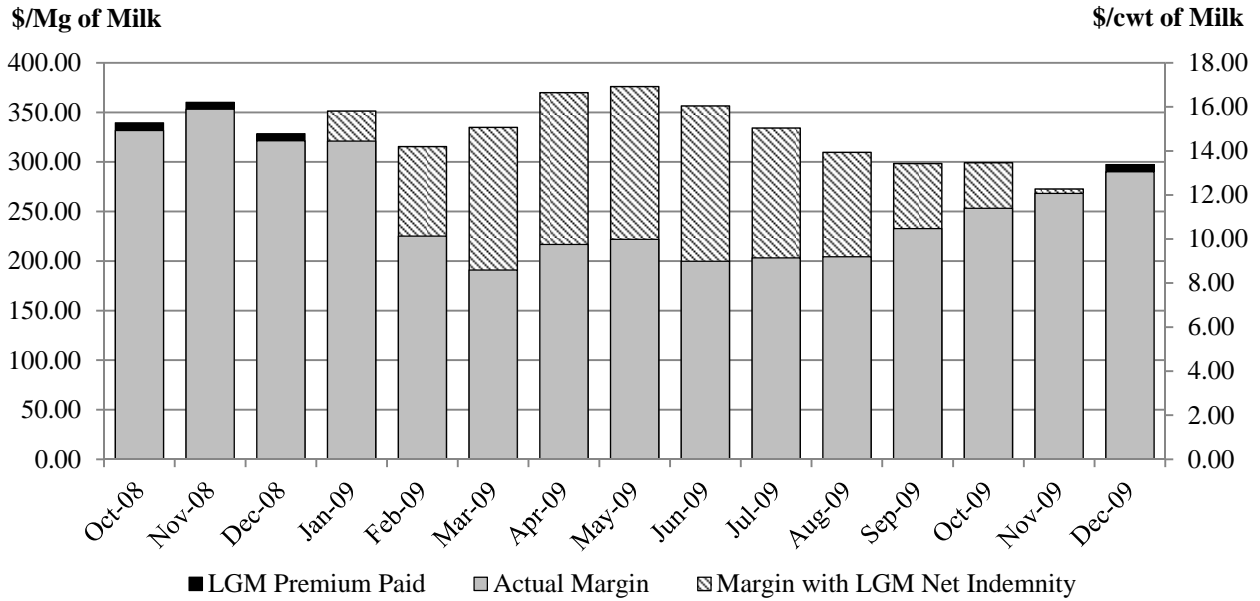*5.a. Up Front* Strategy: Insure the First Three Insurable Months

5.b. Middle of the Road Strategy: Covering 4th, 5th and 6th Insurable Month

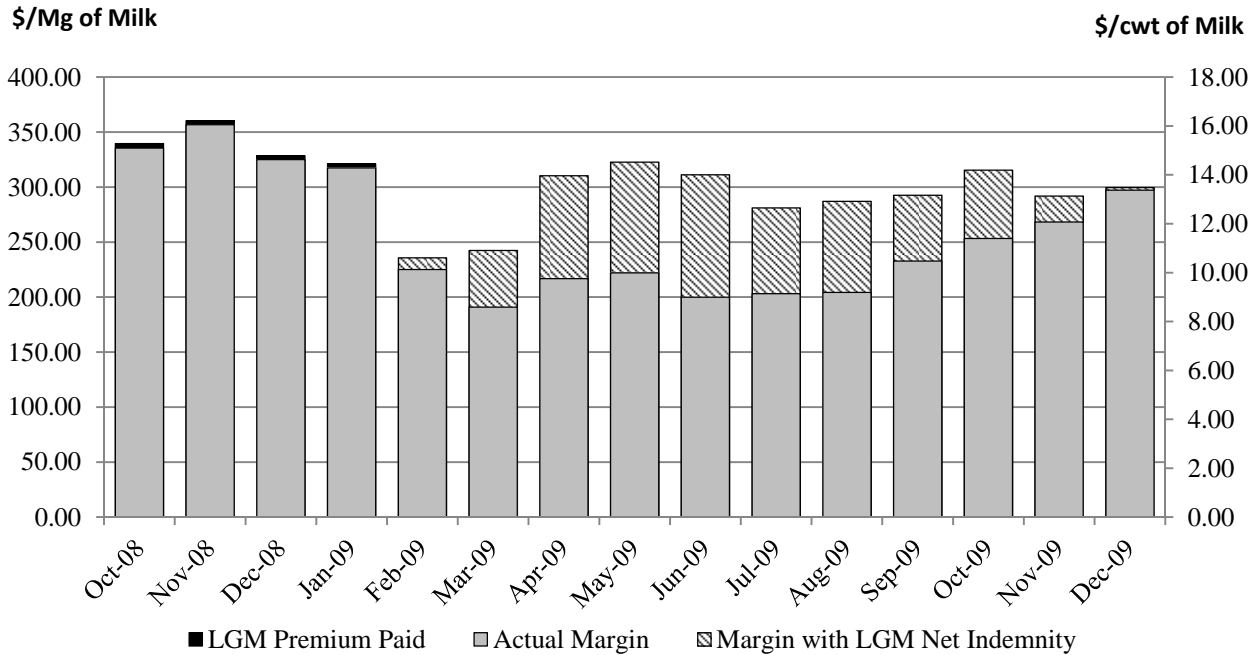
(continued)

Figure 5. IOFC Margin Smoothing Under Different Risk Management Strategies: *Home-Feed* **Farm Type (continued)**

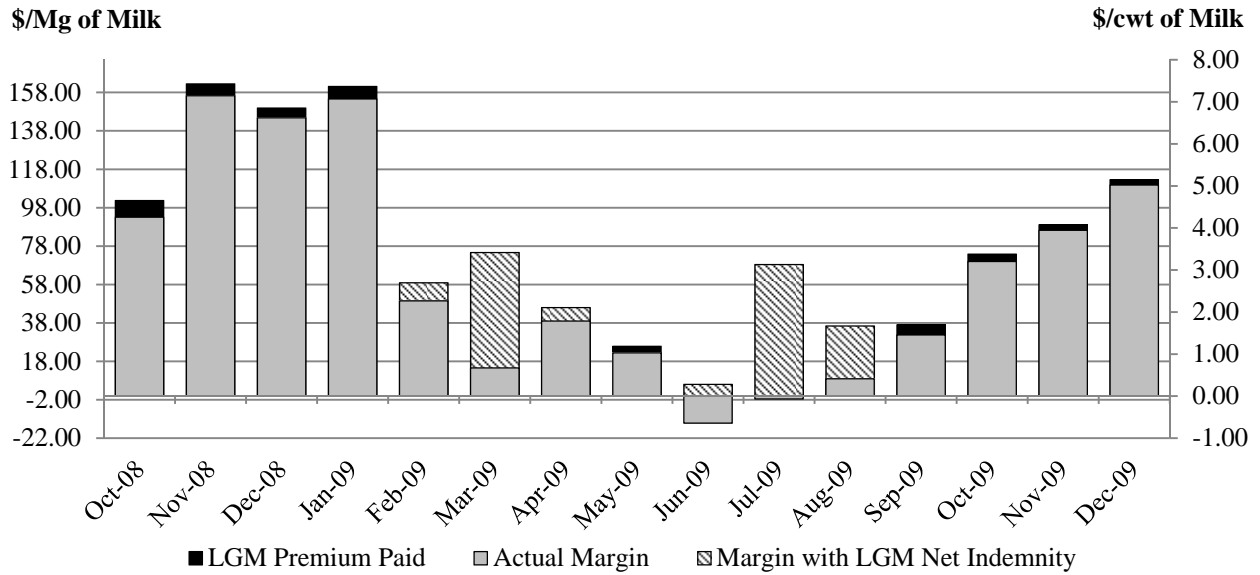*5.c. Looking-Ahead* Strategy: Covering 8th, 9th and 10th Insurable Month

5.d. Flat 10 Strategy: Covering all 10 Insurable Months via LGM-Dairy

Figure 6. IOFC Margin Smoothing Under Different Risk Management Strategies:

Market-Feed Farm Type

6.a. *Up Front* Strategy: Insure the First Three Insurable Months

$/Mg of Milk   **$/cwt of Milk**

■ LGM Premium Paid   ☐ Actual Margin   ▨ Margin with LGM Net Indemnity

6.b. *Middle of the Road* Strategy: Covering 4th, 5th and 6th Insurable Month

$/Mg of Milk   **$/cwt of Milk**

■ LGM Premium Paid   ☐ Actual Margin   ▨ Margin with LGM Net Indemnity

(continued)

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Figure 6. IOFC Margin Smoothing Under Different Risk Management Strategies: *Market-Feed* Farm Type (continued)

6.c. *Looking-Ahead* Strategy: Covering 8th, 9th and 10th Insurable Month

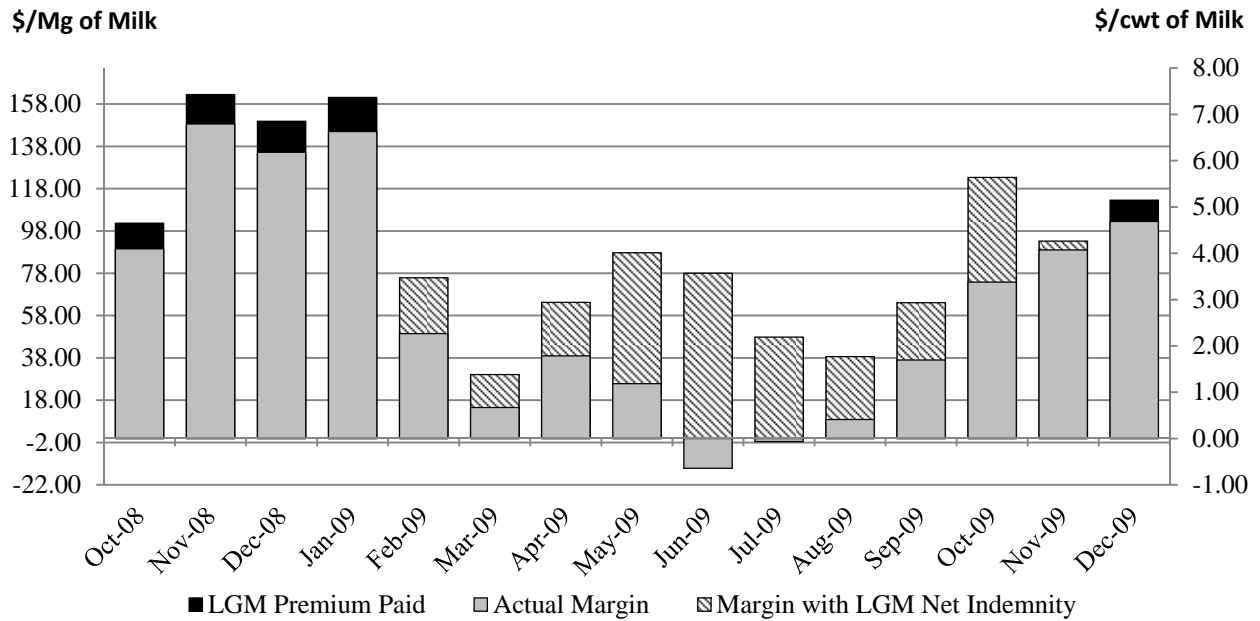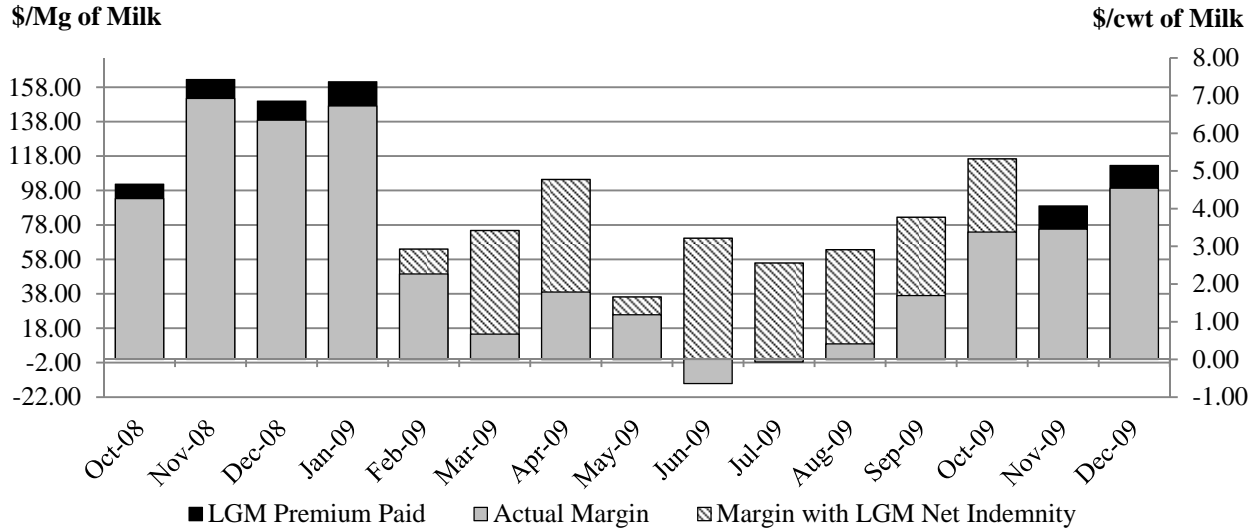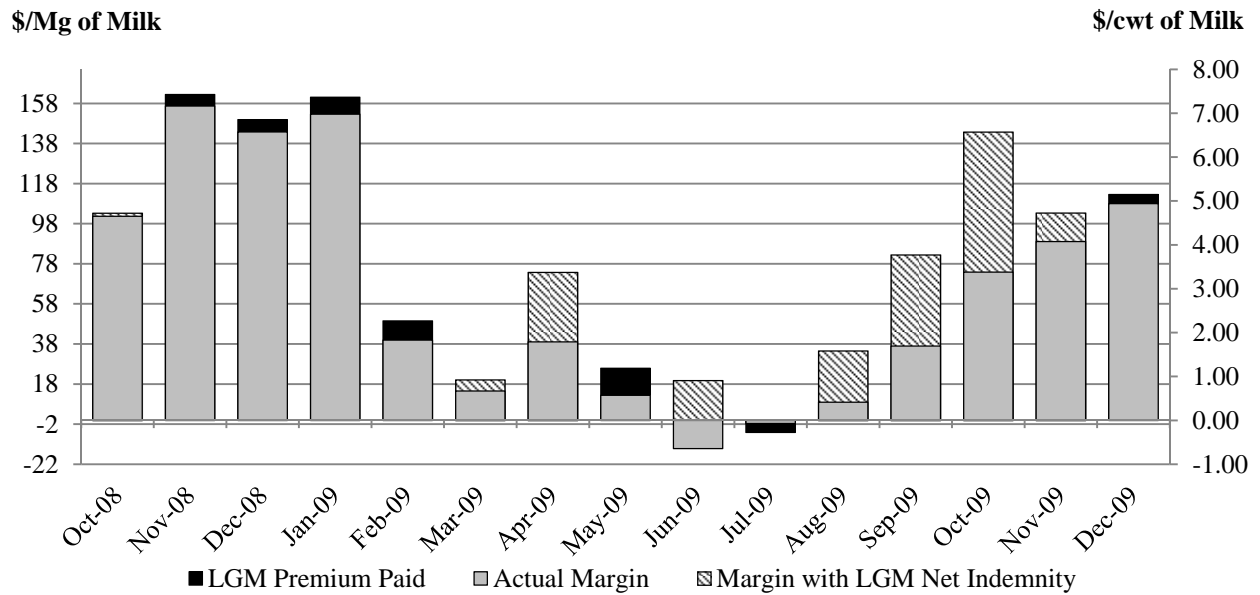### 6.d. *Flat 10* Strategy: Covering all 10 Insurable Months via LGM-Dairy

Table 1. Regression of U.S. Alfalfa Hay Prices ($/ton) on U.S. Corn and Soybean Meal Prices

Variable	Coefficient	Standard Error	T-statistic
Intercept	72.639	5.703	12.736
Soybean meal price ($/ ton)	-0.135	0.031	-4.300
Corn price ($/bu)	25.956	1.669	15.551
Number of Observations	90		
R^2	0.82		

Table 2. Evaluating effectiveness of LGM-Dairy under alternative insurance strategies.

Profile	Average 2007-2011	2007					2009				
		No-LGM	Flat 10	Up Front	Middle of the Road	Looking Ahead	No-LGM	Flat 10	Up Front	Middle of the Road	Looking Ahead
Home-feed $/Mg	$329.58	$369.85	$368.61	$368.26	$367.19	$366.52	$234.34	$290.07	$251.05	$293.04	$323.17
($/cwt)	($14.97)	($16.78)	($16.72)	($16.70)	($16.66)	($16.62)	($10.63)	($13.16)	($11.39)	($13.29)	($14.66)
Market-Feed $/Mg	$121.33	$210.73	$208.31	$208.29	$206.44	$205.58	$50.10	$65.96	$64.33	$79.89	$83.23
($/cwt)	($5.50)	($9.56)	($9.45)	($9.45)	($9.36)	($9.33)	($2.27)	($2.99)	($2.92)	($3.62)	($3.78)