Livestock Gross Margin – Dairy

An Assessment of Assumptions and Performance

Presented by
Cameron Thraen
Agricultural, Environmental & Development Economics
The Ohio State University

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LGM-Dairy Research Team

- Dr. Marin Bozic –Applied Economics, University of Minnesota.
- http://marinbozic.info/
- Mr. John C. Newton and Dr. Cameron Thraen –Agricultural, Environmental & Development Economics, The Ohio State University.
- http://aede.ag.ohio-state.edu/programs/OhioDairy/
- Dr. Brian W. Gould – Agricultural and Applied Economics, University of Wisconsin
- http://future.aae.wisc.edu/index.html

Background

- Research paper "*Examining Distributional Assumptions of Livestock Gross Margin for Dairy Cattle*." NCCC-134 Applied Commodity Price Analysis, Forecasting, and Market Risk Management Conference, St. Louis, MO April 16-17, 2012.
- Paper will be published on the University of Illinois ***FarmDoc*** website (available early June): http://www.farmdoc.illinois.edu/nccc134/paperarchive.html

Summary of Key Features

- Basket Option (Asian style)
  - A custom PUT option on gross margin (net price x quantity)
    - Strike is the expected contract total (gross) margin
  - Uses futures average prices (through time)
  - Portfolio (milk, corn, soybean meal prices)
- Market-based tool
  - Based on futures and options prices
    - Price forecast and price volatility (implied)
  - Actuarially fair (conditional on assumptions)
- Revenue smoothing & safety-net policy tool
  - Reinsured by RMA, includes subsidized premium
  - Catastrophic Risk Insurance

LGM-Dairy Rating Method Assumptions

- Information from futures and options prices can be used to fit the moments of the milk and feed price distributions,
- Terminal prices are distributed log-normally,
- Rank correlations are used to preserve price dependency,
  - Data post 2005 does not inform the price relationships,
- Milk-feed price correlations are zero.

We have investigated each of these assumptions to determine the impact on the structural performance of LGM-Dairy product.

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LGM-Dairy Rating Method Assumptions How do these fair?

- Lognormality: a reasonable assumption
  - Relax this assumption using the Generalized Lambda Lognormal distribution and the Generalized Lambda Flexible distribution with high-frequency futures and options data
    - GLD-Lognormal uses marginal GLD distributions but fixed moments to match lognormal
    - GLD-Flexible uses marginal GLD with flexible higher moments estimated with high-frequency data
  - *Volatility Skew* is not reflected in the current RMA ratings method.
    - Only at-the-money puts and calls are used to estimate variance of the terminal prices.
    - The rating methods should reflect higher volatilities for price spikes as shown in this example for corn.

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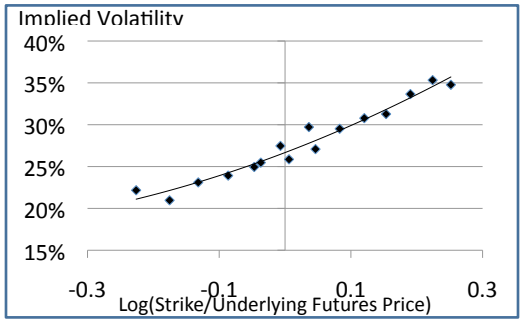
Does it matter if marginal distributions are in fact not lognormal?



Example of Volatility Skew:
Date: Jun 26, 2006
Contract: Corn, Dec '06
Futures Price: $2.49

- *Volatility Skew* is not reflected in the current RMA ratings method.
  - Only at-the-money puts and calls are used to estimate variance of the terminal prices.
  - The rating methods should reflect higher volatilities for price spikes as shown in this example for corn.

LGM with flexible marginal distributions

	Minimum Feed		Maximum Feed	
Deductible	**$0.00**	**$1.10**	**$0.00**	**$1.10**
Rank	$14,998	$7,719	$16,439	$9,504
GLD-Lognormal	$14,936	$7,616	$16,386	$9,454
GLD-Flexible	15,156	$7,896	$16,309	$9,404

GLD: Generalized Lambda Distribution

- GLD-Lognormal uses marginal GLD distributions but fixed moments to match lognormal
- GLD-Flexible uses marginal GLD with flexible higher moments estimated with high-frequency data

LGM-Dairy Rating Method Assumptions How do these fair?

- Log - normality: a reasonable assumption
  - Relax this assumption using the Generalized Lambda Lognormal and GDL Flexible distributions
- Milk-feed price correlation is zero:
  - For the 1998-2005 time period, this was a reasonable assumption, but not after 2005,
  - Milk-feed price rank correlation is decidedly non-zero, and exhibits larger correlations when post 2005 data is incorporated.
- ✓ Rank correlations: are not suitable to capture the dependency between milk and feed prices.
  - ✓ Non-elliptical, non-linear, tail dependence present
  - ✓ Requires the representation of a more complex dependence structure and methods to capture this structure.

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Milk and feed futures price deviates do not exhibit zero correlation.

Spearman's rank correlation 1998-2011		Corn				
		1st nearby	2nd nearby	3rd nearby	4th nearby	5th nearby
Milk	1st nearby	0.07	0.11	0.05	0.06	0.08
	2nd nearby	0.13	0.21	0.17	0.21	0.17
	3rd nearby	0.14	0.23	0.23	0.28	0.24
	8th nearby	0.11	0.22	0.26	0.32	0.35
	9th nearby	0.10	0.23	0.32	0.34	0.40
	10th nearby	0.14	0.21	0.35	0.37	0.45

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LGM-Dairy Rating Method Assumptions How do these fair?

- Log - normality: a reasonable assumption
  - Relax this assumption using the Generalized Lambda Lognormal and GDL Flexible distributions
- Milk-feed correlation is zero: This is not a reasonable assumption.
  - Milk-feed price correlation is decidedly non-zero, and exhibits larger correlations when post 2005 data is incorporated.
- Rank correlations: do not adequately reflect the dependency between milk and feed prices,
  - Non-elliptical, non-linear, tail dependence present
  - Requires the representation of a more complex dependence structure and methods to capture this structure.
    - Use Rank Correlation and Empirical Copula

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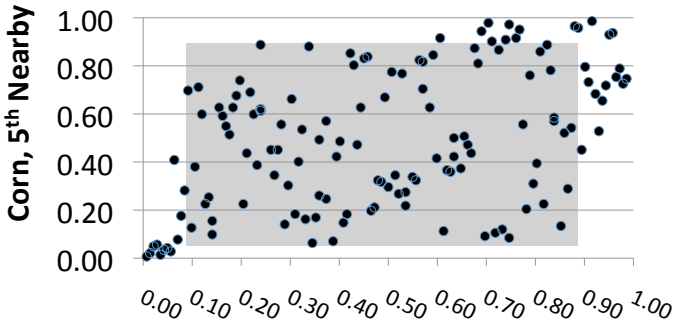
Milk-Corn prices exhibit 'tail dependence': a non-linear, non-elliptical dependent structure



- Extremal dependence present in both tails, asymmetric, and almost no dependence "in the middle"
- Requires an empirical or data-based rating method

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Effect of non-linear dependence on LGM premiums

	Minimum Feed		Maximum Feed	
Deductible	**$0.00**	**$1.10**	**$0.00**	**$1.10**
Official RMA Method	$14,569	$7,380	$20,350	$13,308
Rank Correlations	$14,998	$7,719	$16,439	$9,504
Empirical Copula	$15,286	$8,219	$15,478	$8,246

LGM Contract: Insuring 16,000 hundredweights, spread equally over all 10 insurable months / Average over all 2011 contracts

- Increase (3% to 11%) LGM premiums to producers using the insurance product as a Class III PUT (minimum feed)
- Significantly reduce (19% to 38%) the premium to producers incorporating the feed CALL side of the LGM contract.

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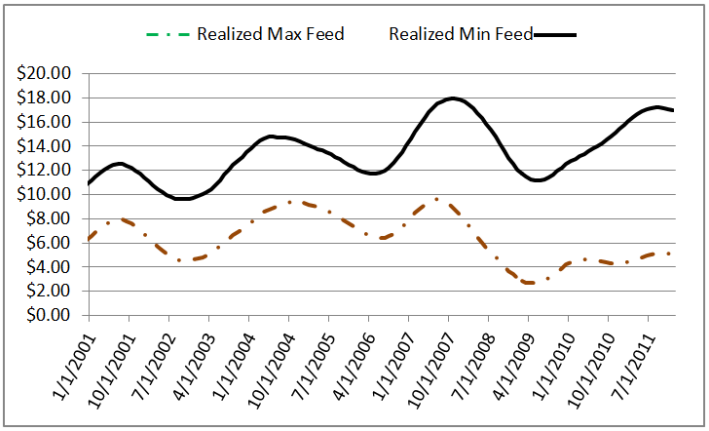
Can LGM-Dairy be used to effectively stabilize margins?



What is the nature of the 'risk' in the dairy sector?

Grow feed? LGM as a PUT on Class III price?
Buy feed? LGM as a PUT on IOFC (margin)?

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- Comparison of net indemnity and premiums by rating method: RMA, Rank, Data Based, Bundled Option.

- Comparison of net revenue generated by three LGM contracts

Contract 1: 'up-front': months 1,2,3 insured
Contract 2: 'middle': months 4,5,6 insured
Contract 3: 'looking ahead': months 8,9,10 insured
Contract Size 24,000 cwt.
Payout and premium at $1.10 deductible
Premium subsidy at 50%
Time period 2005 - 2011

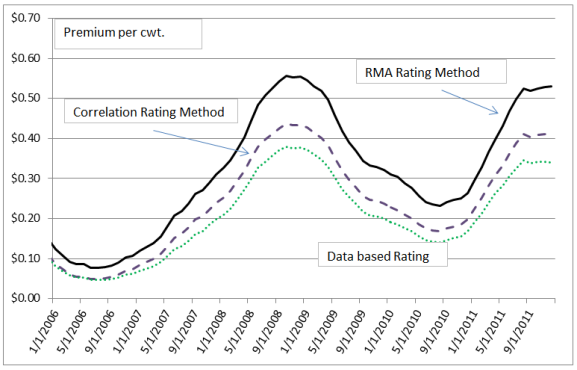
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Purchase at End of Month	No Coverage	1	2	3	4	5	6	7	8	9	10

'Up Front' LGM contract 24,000 cwt per contract, $1.10 deductible, no-subsidy

Cummulative Indemnity & Premium Cost 2005 - 2011

	Total Indemnity Earned	Cost Advantage over BOS	Cost Advantage over RMA
RMA Rating Method	$603,982	55%	--
Correlation Rating Method	$459,823	66%	24%
Data Based Rating Method	$391,190	71%	35%
Bundled Option Strategy#	$1,355,041	--	

Bundled Option Insures both sides(milk and feed) and over insures



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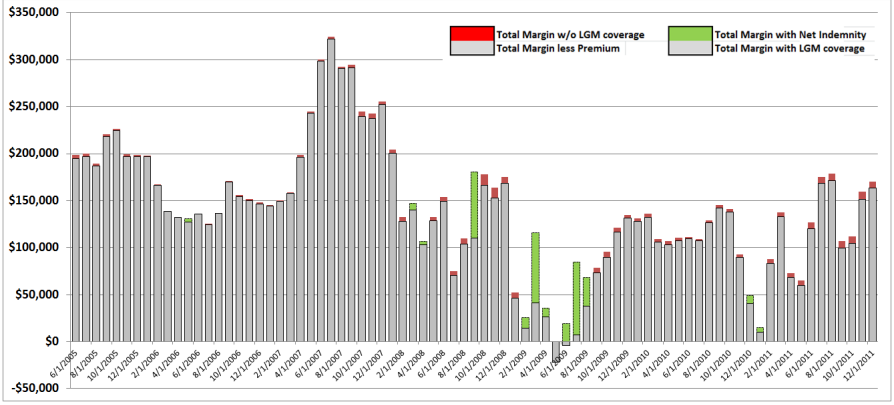
Net Margin with LGM contract: 'Up Front' 2005 - 2011



24,000 cwt per contract, $1.10 deductible, 50% subsidy.

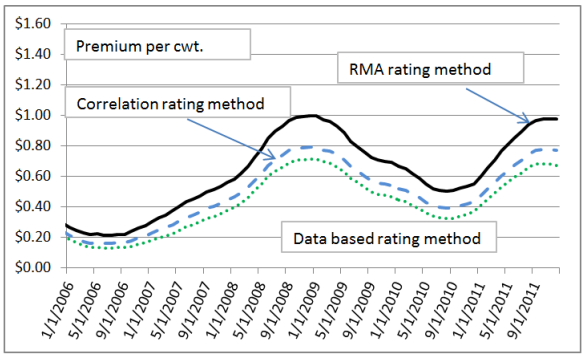
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Purchase at End of Month	No Coverage	1	2	3	4	5	6	7	8	9	10

'Middle' LGM contract 24,000 cwt per contract, $1.10 deductible, no-subsidy

Cummulative Indemnity & Premium Cost 2005 - 2011

		Cost Advantage over BOS	Cost Advantage over RMA
Total Indemnity Earned	$803,423		
RMA Rating Method	$1,104,780	47%	--
Correlation Rating Method	$869,719	59%	21%
Data Based Rating Method	$754,639	64%	32%
Bundled Option Strategy#	$2,101,087	--	

Bundled Option Insures both sides(milk and feed) and over insures



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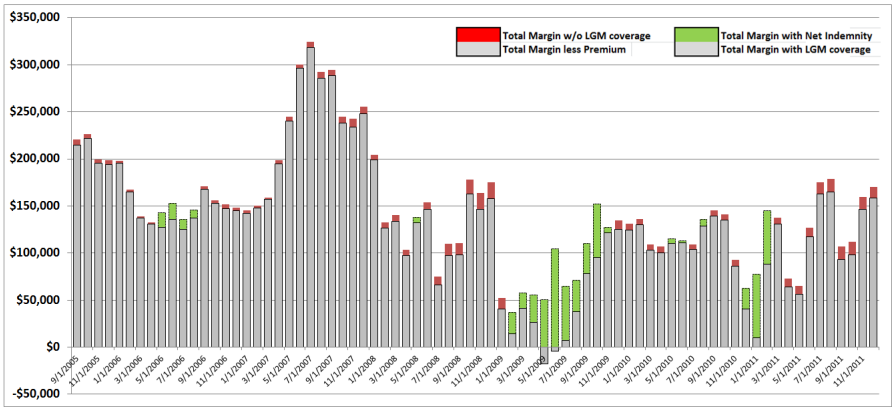
Net Margin with LGM contract: 'Middle' 2005 - 2011



24,000 cwt per contract, $1.10 deductible, 50% subsidy.

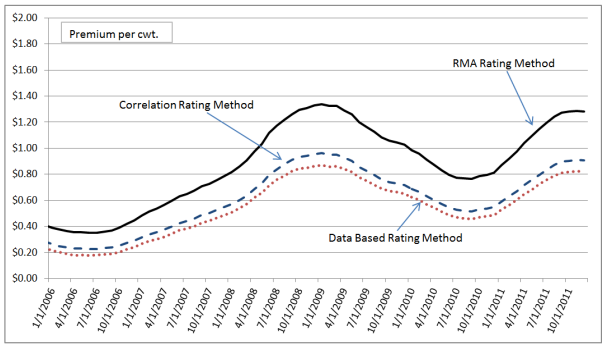
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Purchase at End of Month	No Coverage	1	2	3	4	5	6	7	8	9	10

'Looking Ahead' LGM contract
24,000 cwt per contract, $1.10 deductible, no-subsidy

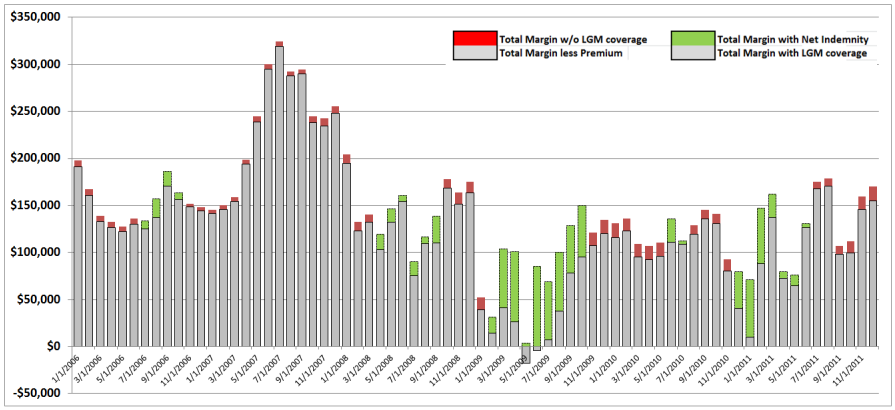
Cummulative Indemnity & Premium Cost 2005 - 2011

	Total Indemnity Earned	Cost Advantage over BOS	Cost Advantage over RMA
RMA Rating Method	$1,421,597	45%	--
Correlation Rating Method	$987,153	62%	31%
Data Based Rating Method	$877,404	66%	38%
Bundled Option Strategy#	$2,567,520	--	

Bundled Option Insures both sides(milk and feed) and over insures

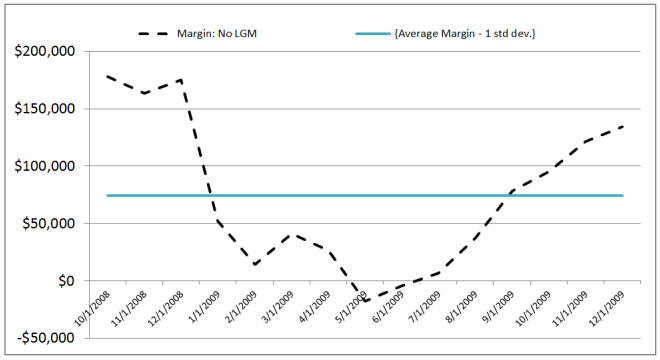


Net Margin with LGM contract: 'Looking Ahead' 2005 - 2011



24,000 cwt per contract, $1.10 deductible, 50% subsidy.

October 2008 – December 2009 Realized Margin– Without LGM



- **2005-2011**
  - **Average = $145,000 / Standard Deviation = $70,728 / 1sd below mean = $74,320**

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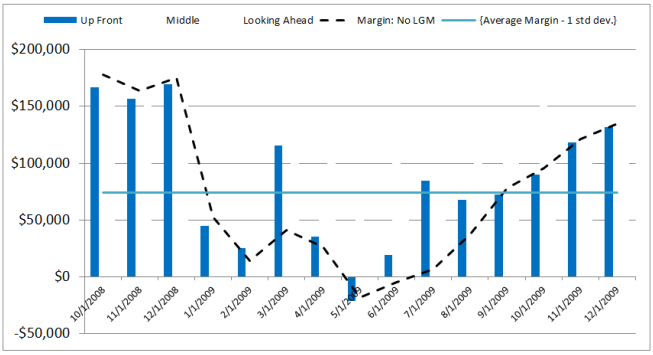
LGM 'Up Front'

10/2008 – 12/2009



	Average Value 10/08 – 12/09
Margin without a hedge	$73,518
Margin plus LGM net payout	$85,137

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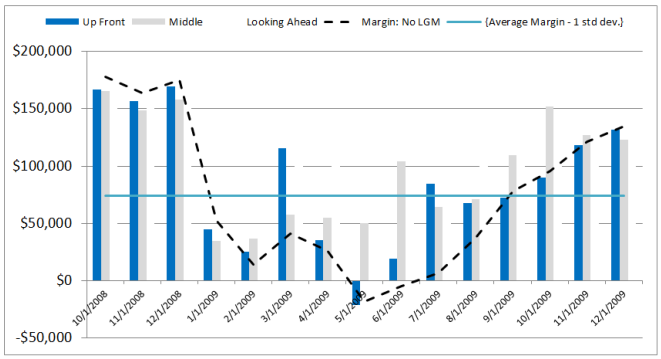
LGM 'Middle'

10/2008 – 12/2009



	Average Value 10/08 – 12/09
Margin without a hedge	$73,518
Margin plus LGM net payout	$97,175

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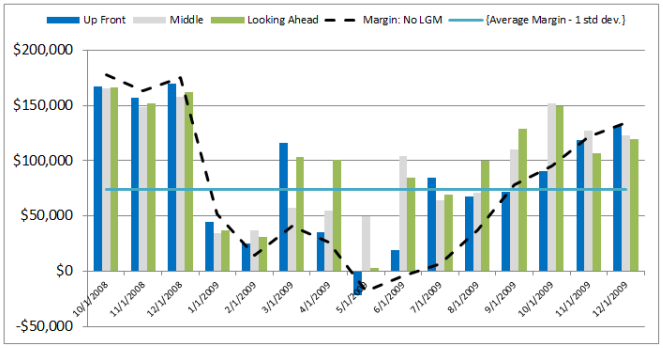
LGM 'Looking Ahead'

10/2008 – 12/2009



	Average Value 10/08 – 12/09
Margin without a hedge	$73,518
Margin plus LGM net payout	$100,969

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Benefit from LGM coverage

- Over this 10/2008 to 12/2009 period, what is the calculated benefit from using these three LGM contracts?

Accumulated gross margin 10/2008 - 12/2009				
Gross Margin No LGM		**'Looking Ahead'**	**'Middle'**	**'Up Front'**
	$1,102,771	$1,514,543	$1,457,635	$1,277,061
cwt	3.06	4.21	4.05	3.55
LGM improvement		37.3%	32.2%	15.8%

LGM can provide a safety net providing added margin when uncovered margins decline to financially ruinous levels. Looking ahead strategy appears to be preferred to a wait and act or up front approach.

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Conclusions

- In contrast to other portfolio situations where tail dependence increases portfolio risk, (magnifies losses) for gross margin insurance products extremal dependence can actually decrease portfolio risk.
- With appropriate adjustments to rating methods, and employment of smart insurance policy strategy, LGM can serve as actuarially fair and effective financial disaster insurance tool.
- Use of LGM requires a careful consideration of the firm's financial structure and risk management goals.
- Critical further research is needed on tail dependence between milk and feed markets, relaxing assumptions on marginal distributions and optimizing maximum length of contract. Additional research is needed on the impact of volatility measures and the term structure of premiums.

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Contact:
Dr. Marin Bozic
mbozic@umn.edu
(612) 624-4746
Department of Applied Economics
University of Minnesota-Twin Cities
317c Ruttan Hall
1994 Buford Avenue
St Paul, MN 55108

Contact:
Dr. Cameron Thraen
John Newton
Thraen.1@osu.edu
(614) 292-2702
AEDE
The Ohio State University
315 Ag. Admin. Building
2120 Fyffe Road
Columbus, Ohio 43210

Contact:
Dr. Brian Gould
bwgould@uwisc.edu
(608) 263-3212
Department of Agriculture & Applied Economics
University of Wisconsin-Madison
421 Taylor Hall
427 Lorch Street
Madison, WI 53706