Applied Economic Perspectives and Policy Advance Access published December 18, 2015
Applied Economic Perspectives and Policy (2015) volume 0, number 0, pp. 1–19.
doi:10.1093/aepp/ppv033

Submitted Article

Evaluating Policy Design Choices for the Margin Protection Program for Dairy Producers: An Expected Indemnity Approach

John Newton*, Cameron S. Thraen, and Marin Bozic

John Newton is the Senior Director of Economic Research for the National Milk Producers Federation. Work completed while the author was Clinical Assistant Professor in the Department of Agricultural and Consumer Economics at the University of Illinois Urbana-Champaign. Cameron S. Thraen is an associate professor in the Department of Agricultural, Environmental & Development Economics at the Ohio State University. Marin Bozic is an assistant professor in the Department of Applied Economics at the University of Minnesota–Twin Cities.
*Correspondence may be sent to: jnewton@nmpf.org.

Submitted 16 April 2014; accepted 22 October 2015.

Abstract *The Agricultural Act of 2014 replaced dairy product price supports and countercyclical income support payments with the Margin Protection Program for Dairy Producers. Using farm-level data, producer decisions and aggregate policy costs under a variety of risk environments and policy design alternatives are simulated. Fixed premium rates may result in budget outlays that are substantially higher than for equivalent variable-rate insurance subsidized at levels observed in revenue-based crop insurance policies. Due to the absence of adjusted gross income or production eligibility constraints, a significant portion of benefits may accrue to a small share of large dairy farms.*

Key words: Dairy, Margin Protection Program, Agricultural Act of 2014, Monte-Carlo simulations, farm program decisions.

JEL codes: Q11, Q12, Q13.

Dairy policy reform was a hotly-contested issue leading up to the passage of the Agricultural Act of 2014.[1] The request from the dairy industry to the U.S. Congress was to create a risk management tool that would offer effective protection against prolonged and catastrophic income-over-feed-cost margin declines (USDA Farm Service Agency 2011). The debate focused mostly on whether or not an insurance-style dairy margin protection program should be coupled with government-mandated milk supply controls to increase dairy commodity prices and limit the government's financial liability (Schnepf 2012; Newton, Thraen, and Bozic 2013). While the

[1] *Hereafter the Agricultural Act of 2014 will be referred to as the 2014 Farm Bill.*

2014 Farm Bill ultimately did not include a dairy supply management program, it nevertheless provided the most comprehensive reform to the U.S. federal dairy farm safety net seen in decades.

The 2014 Farm Bill replaced countercyclical income and commodity price support programs with the Margin Protection Program for Dairy Producers (MPP-D); MPP-D is a voluntary program that makes payments when the national average income-over-feed-cost (IOFC) margin index falls below a farmer-selected coverage level. Different coverage options reflect a dairy farmer's ability to protect different margin levels. Dairy producers pay premiums for coverage and must take an active role in selecting their coverage options each year. In short, MPP-D functions similar to a USDA sponsored put option that provides assistance to dairy farmers when the national measure of IOFC margins falls below the farmer-selected threshold. If the MPP-D margin does not fall below the farmer's coverage level, MPP-D expires worthless, and a farmer loses only the premium paid.

This article addresses specific MPP-D policy design choices that may substantially impact program costs and the distribution of financial benefits. First, in contrast to other Title I commodity programs and the previous Milk Income Loss Contract (MILC), there are no gross income limitations or production eligibility constraints.[2] Farms of all sizes can purchase protection near their maximum levels of historical milk production. The lack of production eligibility constraints is particularly relevant in the context of a highly-skewed distribution of dairy herd sizes. In 2012, farms with over 1,000 cows represented only 2.8% of U.S. dairy farms but owned 49% of the U.S. dairy herd (USDA 2014). Under MILC, eligibility was capped at 2.985 million pounds of milk per fiscal year, and a majority of benefits accrued to smaller dairy operations (D'Antoni and Mishra 2012). In contrast, under MPP-D, the lack of production eligibility or income constraints provides the opportunity for large farms to be represented in MPP-D proportionally to their share of U.S. milk production. However, privileged treatment of smaller dairy farms is not completely abolished as MPP-D premiums contain discounts as high as 74% for the first 4 million pounds protected under MPP-D (USDA FSA 2015). The effect these provisions have on the distribution of benefits across farm size categories are examined by simulating MPP-D policy benefits under the actual policy rules, as well as under modified policy rules that exclude two-tiered premiums and a counterfactual MPP-D policy design that imposes production eligibility constraints similar to MILC.

Second, while dairy producers are allowed to adjust coverage options during an annual open enrollment period, the MPP-D premium rates are fixed at predetermined levels for the duration of the farm bill. Since premiums do not adjust to reflect the anticipated risk environment, farmers may elect higher coverage levels in the face of imminent margin declines, and purchase less coverage when margins are expected to be much above MPP-D coverage thresholds. To address adverse gaming identified by Newton, Thraen, and Bozic (2014) and confirmed by Bozic et al. (2014),

[2]The 2014 Farm Bill Price Loss Coverage and Agricultural Risk Coverage programs have payment limitations of $125,000 for any crop year and have adjusted gross income limitations of $900,000 per crop year. MILC benefits were available on up to 2.985 million pounds of milk per fiscal year for producers with an adjusted gross non-farm income under $500,000.

MPP-D implementation rules stipulate a three-month gap between the annual election period and the coverage start date.[3,4] Dairy margins are mean-reverting (Bozic et al. 2012; 2014) and more distant margin forecasts are less informative as to the certainty of benefit payments, so the three-month gap makes it more difficult for dairy producers to anticipate which MPP-D coverage option will maximize expected net benefits. However, monthly USDA supply and demand projections for milk and feed commodities are available during the open enrollment period and help reduce uncertainty with respect to the direction and severity of MPP-D margins.[5] To examine the combined effect of fixed premiums and flexible coverage election rules, the participation incentives and policy costs under several counterfactual gaps between the coverage election period and the coverage start dates were simulated. In addition to alternative time horizons, participation incentives and program costs were evaluated under variable rate premiums with subsidy rates similar to those observed in revenue-based crop insurance.

Recent literature on U.S. dairy policy examined producer preferences for policy options (Wolf and Tonsor 2013), welfare and efficiency effects of dairy supply management (Balagtas and Sumner 2012), potential reasons for conflict over proposed dairy stabilization program (Jackson, Thraen, and Bozic 2013), and spatial distribution of policy benefits (Woodard and Baker 2013). This article, however, is the first to use farm-level milk production data to examine implications of MPP-D policy design on expected policy costs and the distribution of policy benefits. The article proceeds with a discussion of the dairy title in the 2014 U.S. Farm Bill, followed by a review of the MPP-D forecast methodology and the decision framework used to evaluate MPP-D participation decisions. In the next two sections, farm-level U.S. milk production data is used to simulate MPP-D participation decisions, estimate aggregate policy costs, and simulate the distribution of policy benefits across farm size categories under the actual and counterfactual policy design frameworks. The article concludes by demonstrating the economic consequences of several contract design elements with respect to program participation and outlays, and by suggesting policy modifications that may improve MPP-D.

The New Dairy Farm Safety Net

Historically, U.S. federal dairy policy has included a variety of programs designed to directly or indirectly enhance dairy farmer income. These programs have included the milk and dairy commodity price support programs, export incentive programs, ad hoc disaster payments, and direct payment programs (Price 2004; Bryant, Outlaw, and Anderson 2007; D'Antoni and Mishra 2012; Schnepf 2012). The MILC program enacted with the 2002 Farm Bill provided countercyclical income support based on a target milk price. Designed for an economic environment with stable feed

[3] *From Newton, Thraen, and Bozic (2014): "adverse gaming emerges when MPP-D coverage decisions are made based only on expected returns to participation and not on risk management needs."*

[4] *During the first year of MPP-D, the open enrollment period was from September 2, 2014 to December 19, 2014 for the 2014 and 2015 coverage years. Participation decisions for 2014 and 2015 are independent. For 2016 MPP coverage, the open enrollment period was from July 1, 2015 to November 20, 2015.*

[5] *Each month USDA issues the World Agricultural Supply and Demand Estimates that contain projections for old- and new crop corn and soybean balance sheets, as well as calendar year projections for dairy supply and demand.*

Figure 1 MPP-D consecutive two month income-over-feed-cost margin, January 2000 – June 2015

Note: The solid black line represents the consecutive two-month MPP-D margin, while the dashed line represents the maximum $8 MPP-D coverage option.

costs, the MILC program did not provide protection against increased variability in livestock feed prices. As a result of the rapid increase in corn use for ethanol, the 2008 Farm Bill modified MILC to adjust the reference price higher as the costs of a 16% dairy ration increased above threshold levels. Following this modification, MILC remained the primary dairy income support instrument through 2014.

The 2014 Farm Bill repealed MILC and in its place introduced MPP-D as the primary dairy farm safety net program; MPP-D is based on an IOFC margin defined as the difference between the national average all-milk price and the formula-derived estimate of total herd feed costs (Newton and Hutjens 2015). The MPP-D margin is given by the following formula: $M = p_{AMP} - (1.0728 \times p_C + 0.00735 \times p_{SBM} + 0.0137 \times p_H)$, where p_{AMP} is the USDA National Agricultural Statistics Service's (NASS) announced all-milk price per hundredweight (cwt), p_C is the USDA NASS announced corn price per bushel, p_{SBM} is the USDA Agricultural Marketing Service's (AMS) announced central-Illinois high protein soybean meal price per ton, and p_H is the USDA NASS announced alfalfa hay price per ton.[6] Figure 1 illustrates the MPP-D margin from 2000 to 2015.

Payments are made when the MPP-D margin falls below a farmer-selected coverage level that ranges from $4 to $8 per cwt in 50¢ increments. To determine how much is paid to a participating dairy operation, MPP-D margins are averaged for consecutive two-month intervals such that up to six payments are possible for each calendar year.[7] In order to participate in MPP-D, participating farm operations must annually pay an administrative fee of $100. The administrative fee provides dairy producers with catastrophic coverage of $4 per cwt. Additional margin protection on levels above $4 per cwt can be selected by participating dairy farmers at supplementary costs. Premiums rates are fixed, but are structured at a lower tier for the first four million pounds of covered production.[8]

[6]*The MPP-D margin formula includes the costs of feeding milking cows, hospital cows, dry cows, and replacement heifers.*
[7]*Consecutive two-month periods are defined as January-February, March-April, ..., November-December.*
[8]*The premium rates are fixed for the life of the Farm Bill, but premium discounts of 25% were specified for the 2014 and 2015 calendar years for all but the $8 level. Tier 1 and Tier 2 premium rates for MPP-D are presented in Novakovic (2014).*

Once enrolled in MPP, participating dairy operations may not opt out of the program. Instead, in years following the first year of enrollment, participating dairy operations may choose during an open enrollment period what level of MPP protection to purchase and how much milk to cover for the following calendar year. The open enrollment period occurs each year from July 1 to September 30. Dairy farmers may purchase coverage on 25% to 90% of their milk production history in 5% increments. Combined, there are 126 MPP-D coverage options.[9] The dairy farm's production history is determined at sign-up in the first year of the program, and is defined as the highest level of annual milk production during the 2011, 2012, or 2013 calendar years. In subsequent years, to reflect the increase in national average milk production, the USDA will update a farm's production history.

Simulating MPP-D Participation Incentives

The MPP-D benefits and premium costs are independent of actual milk production and the only uncertainty in benefit determination arises from changes in the MPP-D margin. As a result, uncertainty in milk and feed prices contribute to the MPP-D coverage options selected by the dairy farmer. Price expectations are important because the MPP-D coverage levels used to determine benefits are fixed for the year once they are selected by the dairy farmer.

For this article the conceptual framework for evaluating MPP-D decisions incorporates price uncertainty in evaluating the expected utility of wealth for each MPP-D coverage option (e.g., Nelson and Loehman 1987; Coble et al. 1997; Just, Calvin, and Quiggin 1999; and Esuola et al. 2007). Under the expected utility framework a rational dairy farmer will select the MPP-D coverage option that maximizes the certainty equivalent wealth conditional on expected uncertainty in milk and feed prices.[10] The assumption is made that all dairy producers share similar expectations on the distribution of MPP-D commodity prices, and that they use all available information when forming expectations of returns from MPP-D.

Tomek (1997) provides a review of the empirical evidence on futures markets as commodity price forecasts. A general conclusion that can be drawn from this literature is that detailed structural models do not succeed in outperforming futures prices as a short-term forecasting tool. Therefore, to forecast the MPP-D margin and simulate participation decisions, the joint distribution function of MPP-D commodity prices is constructed in three steps. First, following Hart, Babcock, and Hayes (2001), and Valvekar, Gould, and Cabrera (2010), information from futures and options markets is used to fit marginal distributions for both milk and feed prices during the coverage period. Next, a copula method that allows for tail dependence is used to model the dependence structure between milk and feed variables (Bozic et al. 2014). Bozic et al. (2014) found that milk-feed correlations increase with time to maturity and that co-dependence was much stronger in the lower tail. A Gaussian copula exhibits zero tail dependence (Joe 1997);

[9]Farmer choice variables include the coverage level and coverage percentage. Dairy farmers may choose from among 9 coverage levels and 14 coverage percentages with a total of 126 possible combinations.

[10]The certainty equivalent wealth is the amount of income that must be provided to the farmer in order to forego MPP-D coverage. Thus, for any two coverage levels 1 and 2, if $CE_1 > CE_2$, coverage level 1 is preferred to 2.

thus, following Bozic et al., an empirical copula is used to capture lower tail dependence and model the dependence structure of the milk and feed variables. To remain consistent with Hart, Babcock, and Hayes (2001) and Bozic et al. (2014), the MPP-D price distributions were discretized to 5,000 points. Finally, the MPP-D guarantee is specified in terms of the USDA announced prices, yet none of the four government-reported prices are used to settle any futures contract. As a consequence, futures prices for USDA all-milk, corn, soybean meal, and alfalfa hay cannot be directly observed. However, futures contracts do exist for class III and IV manufacturing milk, corn, and soybean meal. Thus, to transform futures prices into USDA announced milk and feed prices, the USDA prices were regressed against futures prices and other conditioning information.[11] These simulated milk and feed prices were used in a Monte Carlo experiment to model the uncertainty in MPP-D margins and to evaluate the implications of current and alternative MPP-D policy design specifications on farm-level participation and aggregate policy costs.[12]

Fixed MPP-D Premiums and Aggregate Policy Costs

To examine how fixed premiums and lack of production eligibility constraints may impact MPP-D government outlays and the distribution of program benefits, producer decisions under actual and counterfactual policy rules were simulated. All policy experiments used USDA AMS-Dairy Programs farm-level milk production data collected for 34,220 dairy farms over the period 2009–2012. The milk production data from these farms represented approximately 70% of U.S. dairy herds, and 60% of the total U.S. milk production over this time period (USDA NASS 2014). The farm production history was approximated by taking the maximum level of calendar-year milk production data during 2009–2011. Herd sizes were approximated using USDA NASS state-level milk production per cow estimates. Table 1 includes the distribution of dairy farms, milk production, and approximated production history by herd size.

Using the farm-level data and the expected utility framework, MPP-D participation decisions were estimated under several forecast MPP-D margin scenarios corresponding to dates during the open enrollment period. Then, to examine the impacts of fixed MPP-D premium rates and flexible decision making, four policy alternatives were evaluated: *No Sign-Up Gap*, *3-month Sign-Up Gap*, *6-month Sign-Up Gap*, and *Variable Rate Premiums*. A *No Sign-Up Gap* policy experiment envisions the annual coverage election period ending on the first business day of January of the coverage year. The *3-month Sign-Up Gap* evaluates policy costs using the actual USDA rules on MPP-D, with the coverage election period closing on the last business day of September of the year preceding the coverage year. For the *6-month Gap*, the last day of the coverage election period is assumed to be the first business day of July of the year preceding the coverage year.

[11] *An online supplementary appendix accompanying this article details the conceptual framework for evaluating MPP-D decisions and the MPP-D price forecasting model used to conduct this analysis.*

[12] *For sensitivity, the analysis was also conducted under alternative degrees of risk aversion, utility frameworks, and farm-level wealth assumptions. Results of the sensitivity analysis suggest that aggregate participation patterns do not appreciably differ among the various simulation assumptions. As a result, simulation results are presented from a constant relative risk aversion framework with risk aversion equal to 2.*

Table 1 USDA Distribution of Farms and Milk Production by Herd Size

	1–49 head	**50–99 head**	**100–499 head**	**500–999 head**	**1000+ head**	**Total**
Farms[a]	14,426 (42%)	9,571 (28%)	8,076 (24%)	1,075 (3%)	1,072 (3%)	34,220
Production (bil. lbs.)[a]	8.7 (7%)	13.6 (11%)	32.3 (26%)	16.0 (13%)	53.6 (43%)	124.3
Avg. Herd Size (cows)[b]	29	71	195	706	2,298	
Avg. Annual Production (mil. lbs.)[b]	0.6	1.4	4.0	15.0	50.1	
Production History (bil. lbs.)[c]	10.0	14.3	32.3	15.7	52.1	124.6

Source: Dairy farm statistics provided by USDA Agricultural Marketing Service-Dairy Programs-Federal Milk Marketing Orders. Superscript [a]indicates that Data reflects 2012 statistics. Percentage of farms and percentage of milk production included in parenthesis; [b]approximated using USDA NASS Milk Production, Disposition, and Income 2012 Summary data; [c]estimated by aggregating across all farms the maximum calendar year milk production for 2009, 2010, 2011, and multiplying by 90%.

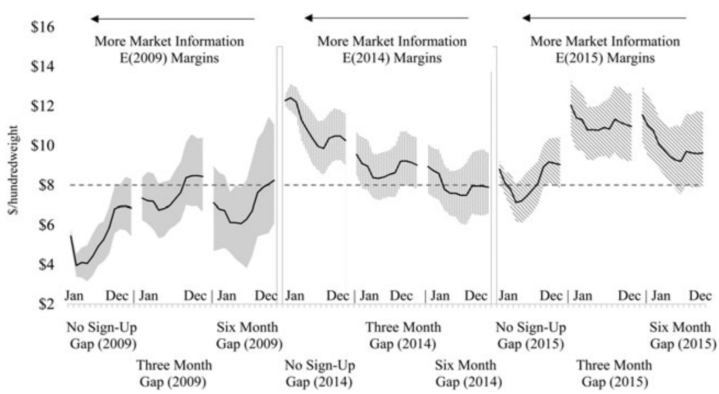
Finally, *Variable Rate Premiums* are evaluated for all time horizons with premiums set at the model-implied actuarially-fair level, less an explicit subsidy rate that progressively declines for higher coverage levels.

The impact of these policy alternatives were evaluated under three risk environments, corresponding to the 2009, 2014, and 2015 calendar years. In 2009, the U.S. dairy sector experienced severely reduced margins due to global macroeconomic shocks. In 2014, favorable crop production and robust international demand for U.S. dairy products resulted in record-high dairy margins. The environment heading into 2015 was characterized with progressively deteriorating expected 2015 margins due to surging milk production in major dairy exporting counties, with simultaneous reductions in demand from the world's two biggest dairy importers in China and Russia. Figure 2 depicts forecasts of 2009, 2014, and 2015 MPP-D margins using futures market data on the last day of the coverage election period under three alternatives described above (*No Sign-Up Gap*, *3-month Gap*, and *6-month Gap*).

Under the *No Sign-Up Gap* alternative, MPP-D margin forecasts accurately foreshadowed the severely low margins of 2009, the favorable U.S. dairy margins in 2014, and declining margins going into 2015. Longer forecasting horizons (*3-month Gap* and *6-month Gap*) are noisier and carry progressively less information about margin direction and severity of price shocks. To determine how the sign-up gap may alter MPP-D participation incentives, expected benefits were evaluated for each of the three previously-identified enrollment periods. Table 2 reveals that farmer participation incentives and expected government outlays change substantially with the length of the sign-up gap.

The *No Sign-Up Gap* allows for more certainty in the direction and magnitude of MPP-D margins. During 2009, the actual MPP-D margin averaged \$4.58 per cwt, while for 2014 the MPP-D margin averaged \$13.57 per cwt. Accordingly, the optimal MPP-D coverage levels under *No Sign-Up Gap* would have suggested higher MPP-D coverage for 2009, and the minimum no-cost \$4 coverage for the 2014 coverage year. When futures indicate imminent margin declines, expected benefits increase under higher-priced

Figure 2 Expected January through December MPP-D margin distribution during the enrollment period and at the coverage start date for 2009, 2014, and 2015 coverage years



Note: The solid black lines represent the mean MPP-D margin, the dashed line represents the MPP-D payment trigger of \$8/cwt., and the shaded (dashed) regions represent the middle 50% of MPP-D forecast observations.

Table 2 Optimal MPP-D Coverage Levels and Net Expected Benefits by Herd Size under Different Sign-up Gaps and Risk Environments

	No Sign-up Gap E(January)					**Three-month Gap E(September)**					**Six-month Gap E(July)**				
Herd Size *head*	**CL**[a] *$/cwt*	**CP**[b] *%*	**Cost** *$/cwt*	**Net** *$/cwt*	**Share Benefit** *%*	**CL**[a] *$/cwt*	**CP**[b] *%*	**Cost** *$/cwt*	**Net** *$/cwt*	**Share Benefit** *%*	**CL**[a] *$/cwt*	**CP**[b] *%*	**Cost** *$/cwt*	**Net** *$/cwt*	**Share Benefit** *%*
	2009 MPP-D Margin Forecast														
1–49	8.00	90	0.49	2.22	10	8.00	90	0.49	0.64	14	8.00	90	0.49	1.25	11
50–99	8.00	90	0.48	2.23	14	8.00	90	0.48	0.64	20	8.00	90	0.48	1.26	16
100–499	8.00	90	0.62	2.09	30	8.00	83	0.48	0.64	38	7.94	90	0.54	1.12	31
500–999	8.00	90	1.09	1.62	11	7.97	32	0.50	0.55	7	6.56	90	0.25	0.74	10
1000+	8.00	90	1.28	1.43	34	6.61	79	0.21	0.20	22	6.50	90	0.27	0.70	32
Total (Mil. $)			**1,043**	**1,999**				**344**	**415**				**428**	**1,034**	
Milk Covered[c]				112.1					95.9					112.0	
	2014 MPP-D Margin Forecast														
1–49	4.00	90	0.02	−0.02	42	6.50	90	0.11	0.03	10	8.00	90	0.49	0.39	13
50–99	4.00	90	0.01	−0.01	28	6.50	90	0.10	0.03	20	8.00	90	0.48	0.39	20
100–499	4.00	90	0.00	−0.00	24	6.50	82	0.09	0.04	42	8.00	82	0.48	0.40	37
500–999	4.00	90	0.00	−0.00	3	6.26	33	0.07	0.03	7	7.74	39	0.34	0.27	7
1000+	4.00	90	0.00	−0.00	3	4.14	86	0.00	0.01	21	5.71	88	0.08	0.13	23
Total (Mil. $)			**3**	**−3**				**49**	**22**				**285**	**260**	
Milk Covered[c]				112.1					97.5					99.3	
	2015 MPP-D Margin Forecast														
1–49	8.00	90	0.49	0.66	16	4.00	90	0.02	−0.02	43	6.00	90	0.07	0.05	10
50–99	8.00	90	0.48	0.67	23	4.00	90	0.01	−0.01	28	6.00	90	0.06	0.06	16
100–499	8.00	83	0.49	0.67	44	4.00	90	0.00	−0.00	24	6.00	83	0.06	0.06	32
500–999	7.99	32	0.53	0.58	8	4.00	90	0.00	−0.00	3	5.70	41	0.03	0.05	7
1000+	7.26	57	0.33	0.10	10	4.00	90	0.00	−0.00	2	4.04	89	0.00	0.03	35
Total (Mil. $)			**376**	**374**				**3**	**−3**				**31**	**46**	
Milk Covered[c]				88.6					112.1					99.9	

Note: Superscript [a]indicates coverage level; [b]coverage percentage; [c]billion pounds.

coverage options, and farmers may buy additional protection to enhance farm revenue. For example, from September 2008 to January 2009 (*3-month Gap* vs. *No Sign-Up Gap)*, the forecasted annual average 2009 MPP-D margin declined by 23%; thus, within the simulation model, farmers elected higher levels of MPP-D coverage and net expected aggregate policy costs increased more than 380%, from $415 million to $2.0 billion dollars. Likewise, when margins improve, expected benefits for the higher-priced coverage options decline and farmers may opt for lower-priced coverage options. Consider the information revealed between July and September 2013 (*6-month Gap* vs. *3-month Gap)*, as favorable crop growing conditions pointed toward a record 2014 crop, livestock feed prices declined, and as a result the forecasted annual average 2014 MPP-D margin increased by 36%. Following the increase, simulation results indicated lower-priced coverage options were optimal for farms of all sizes. Lower-coverage options would have reduced the premiums collected from $285 million dollars to $49 million dollars. By January 2014, additional improvements in expected margins due to increased U.S. exports and higher milk prices, on top of lower feed prices, would have resulted in an optimal coverage level of $4 for all farms. Under this scenario, only the $100 administrative fee would have been collected from participating farms.

The policy design choice to implement the *3-month Sign-Up Gap* increases uncertainty and limits the ability of farmers to only buy supplemental protection in the face of near-certain declines in dairy margins. However, as demonstrated above, it does not completely remove the ability of dairy producers to predict the following year's margins. A large portion of feed price uncertainty is resolved as projections for crop supply and demand conditions are released by the USDA prior to the close of MPP-D enrollment. Absent unanticipated shocks to feed supply or demand, favorable growing conditions will provide stability in livestock feed prices until information on the following planting and growing season is available. Thus, in nearby months when milk prices are high and risk in feed markets is low, the probability of indemnification is reduced and farmers may not purchase protection against unforeseen milk price declines due to the negative expected benefits (i.e., negative implied subsidy).

Variable Rate Premiums

The final policy experiment sets the MPP-D premium rates equal to the expected benefit less an explicit subsidy rate, that is, it makes the MPP-D program subsidized at the level observed for revenue-based crop insurance policies (Glauber 2004; Shields 2013; Du, Feng, and Hennessy 2014). Table 3 presents the premium subsidy levels for different crop insurance coverage levels, as well as the expected subsidies on the last day of sign-up for each of the three years analyzed, for both a 150- and a 3,000-cow operation. The implied MPP-D subsidy rates were much higher for small dairy herds and were often negative for large dairy herds due to the higher premium rates.[13] When margins were anticipated to be catastrophically low, the implied subsidies for small herds exceeded those found under traditional revenue-based crop insurance programs. For large farms, implied subsidy rates were in line

[13]*These subsidy rates do not include the 25% premium discount applied to Tier 1 premiums during the 2014 and 2015 coverage years.*

Table 3 Policy Experiment: Pricing MPP-D Similar to Crop Insurance

Crop Insurance		**Margin Protection Program for Dairy Producers**								
Premium Subsidies for Crop Insurance		**MPP-D Coverage Options**		**2009 Expected Subsidies[b]**		**2014 Expected Subsidies[b]**		**2015 Expected Subsidies[b]**		**Counterfactual: Variable Rate Premiums**
Coverage Level (%)	**Premium Subsidy**	**Coverage Level $/cwt**	**As Pct. Of Avg. Margin[a]**	**150 cows**	**3,000 cows**	**150 cows**	**3,000 cows**	**150 cows**	**3,000 cows**	**Premium Subsidy**
50%	67%	$4.00	48%	100%	100%	100%	100%	100%	100%	100%
55%	64%	$4.50	55%	93%	86%	59%	21%	−71%	−231%	64%
60%	64%	$5.00	61%	87%	80%	40%	7%	−50%	−134%	64%
65%	59%	$5.50	67%	85%	65%	38%	−49%	−11%	−166%	59%
70%	59%	$6.00	73%	85%	60%	42%	−55%	21%	−112%	59%
80%	48%	$6.50	79%	82%	45%	35%	−101%	30%	−116%	48%
85%	38%	$7.00	85%	68%	−16%	−10%	−301%	1%	−260%	38%
N/A	N/A	$7.50	91%	66%	−13%	−5%	−253%	15%	−186%	20%
N/A	N/A	$8.00	97%	59%	−12%	−14%	−212%	12%	−141%	10%

Notes: Superscript [a]indicates that coverage as percentage of average margin is calculated by dividing dollar margin coverage by the long-run average margin ($8.25), for example, $7.00/$8.25 = 85%; [b]2009 and 2014 expected subsidies based on the 3-month sign-up gap provisions. 2015 expected subsidy based on the no-gap sign-up provisions. Expected subsidies are defined as the ratio of net benefits and total government payments for a MPP-D coverage option.

with those found under revenue-based crop insurance programs for deep-loss coverage options only, and only when margins were anticipated to be below MPP-D thresholds. Under all other conditions, and for shallow-loss coverage, implied subsidies were negative due to the higher premium rates.

In this policy experiment the subsidy for each coverage level was equal to the rate matching the equivalent coverage level in crop insurance, and all farmers paid similar premium rates. For example, given the historical average MPP-D margin of $8.25 per cwt, the $7 coverage level corresponds to 85% of the historical average, and is given the same subsidy rate as the 85% coverage level in crop insurance. When establishing MPP-D subsidies in line with those found under revenue-based crop insurance programs, the utility maximizing MPP-D coverage level was consistently found to be $6.50 or $7 with 90% of the milk covered, as these coverage options carried the greatest dollar per cwt subsidy amount.[14] Similar participation strategies have been observed in crop insurance where rational farmers strategically select their coverage parameters in order to maximize the insurance premium subsidy (Du, Feng, and Hennessy 2014). For example, during September 2008 the actuarially fair premium for $7 coverage was $0.64 per cwt, and a 38% subsidy resulted in a premium of $0.40 with expected net benefits of $0.24 per cwt. Model results presented in Table 4 indicated that when premiums were set based on anticipated risk in milk and feed markets, dairy farmers no longer alternated MPP-D coverage options based on positive or negative expected benefits because expected returns to participation were always positive and equal to the subsidy amount.

Importantly, with more actuarially sound premium rates more milk is covered, while the potential exists for expected government outlays to decrease considerably. For example, under a *3-month Gap* for 2009 coverage, expected outlays decrease by $487 million dollars when premium rates are established based on the anticipated risk environment. Additionally, there is no incentive to lower the coverage percentage in an effort to achieve lower aggregate premium costs. The reductions in expected outlays occur because farmers pay higher premiums for a lower weighted average coverage level. An increase in premiums due to improved rating methodology, combined with the current sign-up gap, would facilitate the accumulation of reserves necessary to fund MPP-D during unanticipated catastrophic events. For example, in September 2013 the subsidized premium for $7 coverage during 2014 was $0.12 per cwt and totaled $134 million dollars; however, as margins improved by January 2014 the likelihood of MPP-D payments decreased and would have allowed these monies to accrue to premium reserves, helping the USDA to balance holding risk across calendar years. Without premiums established in an actuarially sound manner, when risk to dairy margins below MPP-D thresholds is low and the probability of indemnification is reduced, farmers may not purchase protection against unforeseen milk price declines. Under the current policy environment, if an unforeseen adverse event is experienced and farmers have simultaneously opted for low cost MPP-D coverage options, ad hoc disaster payments may be requested if payments based on farmer-selected MPP-D coverage is deemed to be insufficient.[15]

[14]The difference in net expected benefits for July 2008 was $0.01/cwt, favoring $6.50 coverage over $7.

[15]During 2009 the Dairy Economic Loss Assistance Program authorized $290 million in the form of direct payments to dairy producers. These direct payments were, in addition to $700 million dollars, distributed through the MILC program (USDA FSA 2010).

Table 4 Average MPP-D Coverage Levels, Premiums, and Net Expected Benefits under Alternative Policy Design Framework

	No Sign-up Gap E(January)					**Three-month Gap E(September)**					**Six-month Gap E(July)**				
			Premium					**Premium**					**Premium**		
	CL[a] *$/cwt*	**CP**[a] *%*	*$/cwt*	*Mil $l*	**Net** *Mil $*	**CL** *$/cwt*	**CP** *%*	*$/cwt*	*Mil $l*	**Net** *Mil $*	**CL** *$/cwt*	**CP** *%*	*$/cwt*	*Mil $l*	**Net** *Mil $*
	2009 MPP-D Margin Forecast														
Current[b]	8.00	90	0.93	1043	1999	7.19	84	0.36	344	415	7.15	90	0.38	428	1,034
Actuarial[c]	6.50	90	0.77	864	797	7.00	90	0.40	447	274	6.50	90	0.51	567	523
All Tier 1[b]	8.00	90	0.48	536	2505	8.00	90	0.48	536	727	8.00	90	0.48	536	1,415
Eligibility	8.00	90	0.48	264	1225	8.00	90	0.48	264	354	8.00	90	0.48	264	691
	2014 MPP-D Margin Forecast														
Current[b]	4.00	90	0.00	3	−3	5.29	85	0.05	49	22	6.73	85	0.29	285	260
Actuarial[c]	7.00	90	0.02	17	10	7.00	90	0.12	134	216	7.00	90	0.30	339	208
All Tier 1[b]	4.00	90	0.01	3	−3	6.50	90	0.09	104	44	8.00	90	0.48	536	446
Eligibility	4.00	90	0.01	3	−3	6.50	90	0.09	53	20	8.00	90	0.48	264	217
	2015 MPP-D Margin Forecast														
Current[b]	7.43	81	0.42	376	374	4.00	90	0.00	3	−3	5.01	85	0.03	31	46
Actuarial[c]	7.00	90	0.35	389	239	7.00	90	0.03	34	21	7.00	90	0.12	137	84
All Tier 1[b]	8.00	90	0.48	536	755	4.00	90	0.00	3	−3	6.00	90	0.06	65	69
Eligibility	8.00	90	0.48	264	268	4.00	90	0.00	3	−3	6.00	90	0.06	34	32

Notes: Superscript[a] reflects a weighted average of the sample;[b] average coverage level reflects average weighted by covered milk production;[c] actuarially fair premium includes subsidy identified in table 3.

Lack of Production Eligibility Constraints and the Distribution of MPP-D Policy Benefits

Under MILC the limit for benefits each fiscal year was capped at 2.985 million pounds per farm. Using data provided by the USDA Farm Service Agency, Newton, Thraen, and Stephenson (2014) found that from 2009 to 2013 47,000 dairy operations received MILC benefits totaling $1.6 billion dollars. Of the $1.6 billion dollars, farms with greater than 2.985 million pounds per month (1,641 cows) received only 7% of the total MILC benefits paid to dairy farmers, reducing the effective support price under MILC for larger dairy farms.

MPP-D does not include hard caps on eligible milk production as it allows coverage on up to 90% of the farm's production history. To measure the effect of removing production eligibility constraints on aggregate payments and the distribution of benefits, a counterfactual policy design was simulated using actual MPP-D rules, modified to limit eligible production to four million pounds per calendar year. Under this scenario all farms pay lower-tier premiums and per cwt benefits are uniform for farms selecting similar coverage options. Such a policy design has three key results: first, the share of production history covered under MPP-D is capped at 44% of the aggregate production history of 124.3 billion pounds. Under the current MPP-D framework, the average volume of production history covered among herd sizes ranged from a low of 32% to a high of 90%, and in aggregate ranged from 70% to 90% of production history. By capping milk eligible for benefits, the production constraint helps to shift the proportion of milk receiving benefits onto smaller dairy farm operations. Second, by reducing the amount of milk eligible for coverage, expected outlays are reduced by hundreds of millions of dollars for a 2009-like risk environment. Finally, by reducing the amount of milk eligible for coverage from larger farms, the distribution of financial benefits more closely aligns with those under MILC such that benefits are skewed toward smaller farms. The lack of production eligibility constraints under the current policy design allows more milk to be covered and may lead to higher policy costs and a higher proportion of MPP-D benefits accruing to larger farm operations compared to MILC. During a single year, if farmers accurately anticipate a margin decline, the lack of production eligibility constraints creates a scenario where MPP-D has the potential to provide financial benefits exceeding those provided by the MILC program over the entire 2009 to 2013 period. For example, model simulations using only 60% of U.S. milk supply identified expected returns during a single year, E(2009), as high as $2.0 billion dollars. Extrapolated to 100% of the U.S. milk supply, net benefits have the potential to exceed $3 billion dollars during a single calendar year.[16] Most notably, these simulation results suggest levels of financial exposure which are appreciably different from Congressional Budget Office estimated costs of $1.3 billion over ten years (Congressional Budget Office 2014).

No Price Discrimination

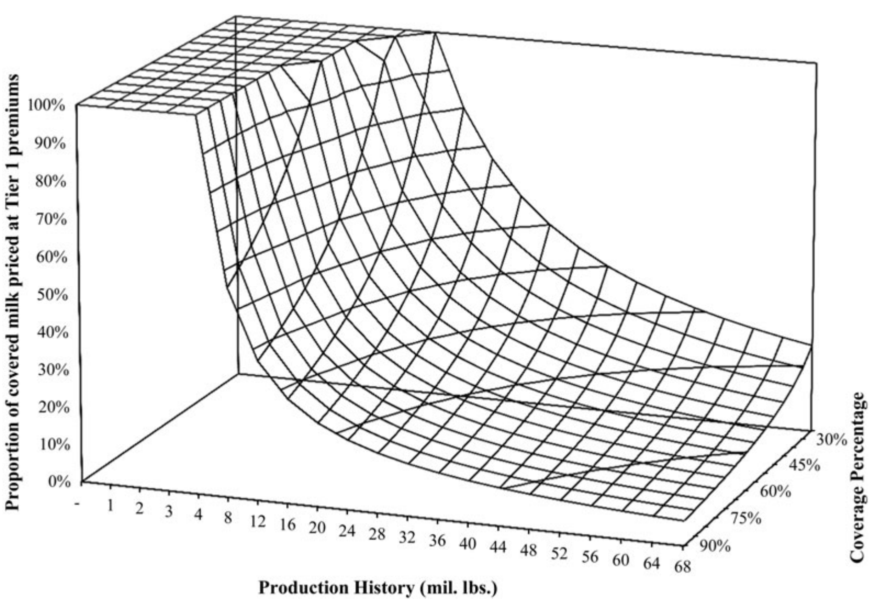
While MPP-D rules impose no production eligibility constraints, privileged treatment of smaller dairy farms is not completely abolished as MPP-D premiums contain premium discounts for the first 4 million pounds

[16]USDA Farm Service Agency MPP-D participation data reveals that 55% of licensed dairy operations and 80% of 2015 milk production enrolled in MPP-D.

protected under MPP-D. Premium discounts range from a low of 38% for $5 coverage to a high of 74% for $7 coverage. Two-tiered premiums rates raise the cost of MPP-D for large dairy farms, and reduce their expected benefits of participation. Price discrimination effectively serves to reduce the financial incentive for larger dairy farmers to purchase higher levels of MPP-D coverage. This feature is best demonstrated in figure 3 when comparing the proportion of covered milk priced under Tier 1 premiums. For example, a farm with a production history of 16 million pounds selecting the 25% coverage percentage can cover 100% of enrolled milk at Tier 1 premium rates. If the same farm elected the 90% coverage percentage, then only 28% of the enrolled milk would be eligible to be priced at Tier 1 premiums. Table 2 confirms the impact of the premium discount on MPP-D participation, as farms with 500 to 999 milking cows can achieve lower pro rata premium rates for higher coverage options by selecting lower coverage percentages. As production history expands (1,000+ head) the pro rata premium discount represents less of the total premium costs, and optimal participation moves to lower coverage levels with a higher coverage percentage.

By reducing the financial incentive for large farms to purchase higher MPP-D coverage options, the distribution of program benefits is shifted from larger dairy farmers to smaller producers such that program benefits are unlikely to follow the distribution of milk production. For example, given the no-gap forecast of 2015 margins, 90% of program benefits accrue to the bottom 94% of dairy farmers (<500 cows) who account for 44% of the milk produced. Higher premium rates discourage participation at higher coverage options for large farms, resulting in 10% of program benefits accruing to the top 6% of dairy farmers (≥500 cows) who account for 56% of the milk produced. However, when the probability of positive net expected benefits at higher coverage options is high enough, large farms are incentivized to purchase supplemental coverage. Under such a scenario, the distribution of policy benefits is shifted toward larger farms more proportional to their level of milk production. For example, given the July 2008 forecast of

Figure 3 Proportion of covered milk priced under Tier 1 premiums



2009 margins, 32% of program benefits accrue to the top 6% of dairy farmers who account for 56% of the milk produced.

To evaluate the effect of price discrimination on MPP-D participation, a counterfactual MPP-D policy was designed without price discrimination such that all farmers paid Tier 1 premium rates for coverage. Model results indicate that without price discrimination the expected returns from MPP-D participation among all coverage options are uniform for all participating dairy farms. Uniformity in expected benefits increases the financial incentive for large dairies to buy higher levels of MPP-D coverage and has the potential to increase net expected benefits by hundreds of millions of dollars per year. Absent price discrimination in the premium rates, and given rational dairy farmer participation, the distribution of program benefits closely follows the distribution of milk production such that the top 6% of dairy farm operations produce 42% of the milk and receive 42% of program benefits. Thus, price discrimination in the premiums helps to shift the MPP-D benefit distribution away from large-scale dairy operations such that the distribution of benefits favors small-scale dairy operators relative to their share of milk deliveries.

Summary

MPP-D represents a significant shift in dairy farm safety net support and has the potential to succeed in providing financial relief to farmers during both deep- and shallow-loss margin environments. However, this article has demonstrated that several contract design specifications may substantially increase the costs of this program to the taxpayer relative to the previous dairy safety net.

First, fixed premiums combined with publicly available information from futures markets shifts the emphasis of the MPP-D participation decision from risk management to one of strategic use of MPP-D as a means to enhance farm revenue through the maximization of expected program returns. By maximizing program returns dairy farmers may avoid the steady stream of small losses in years when they pay MPP-D premiums but do not receive payments; then, in the event of a foreseeable decline in national dairy margins they may still receive a large payment. Evidence of strategic maximization of returns in dairy farm safety net programs has been found by D'Antoni and Mishra (2012) and Newton, Thraen, and Stephenson (2014). D'Antoni and Mishra found farmer participation in MILC increased as milk price decreased, while Newton, Thraen, and Stephenson found that dairy farmers strategically timed MILC participation to coincide with the highest expected MILC payment rates. While MPP-D rules stipulate a 3-month gap between the end of the annual coverage election period and the start of the coverage year, this research demonstrates that the gap will reduce, but will not eliminate the ability to forecast MPP-D margins and returns to different coverage options.

Second, the lack of production constraints and means testing on income similar to other Title I commodity programs will likely increase the cost of the program to the taxpayer. Price discrimination in the premiums and the sign-up gap of three months reduces the probability for strategically-timed positive expected benefits of MPP-D at higher coverage options and may result in benefits that more closely align with those under the MILC program. However, if catastrophically low MPP-D margins are accurately anticipated, the distribution of benefits will shift toward larger dairy farm operators and program outlays will likely exceed U.S. Congressional Budget Office estimates.

If desired, policymakers have several options to limit taxpayer exposure by addressing the policy design elements analyzed in this article. First, future modifications of the program could mandate formal ratemaking procedures by replacing fixed premiums with variable rate premiums. By employing a sound premium rating methodology and explicitly setting premium rates at prices more in line with the fair market value, financial incentives would exist for dairy farmers to consistently purchase coverage to protect against unanticipated margin declines. Premium subsidies could be adjusted to achieve a target loss ratio or to change the probability that shallow-loss MPP-D coverage would be purchased by dairy farmers. Second, if the policy objective is to keep the premiums fixed, then a mechanism for reducing financial exposure would be to further exploit mean-reverting dynamics of dairy profit margins. This can be achieved by increasing the time between the sign-up date and the beginning of the coverage period, and would effectively make forward margins harder to forecast and coverage options would have less certain financial returns. Under each policy solution, government expenditures could be balanced across calendar years through the accumulation of premium reserves.

Funding

Newton and Thraen recognize financial support from USDA's Agricultural Marketing Service and Farm Service Agency. Bozic acknowledges support from USDA's Office of the Chief Economist under the Cooperative Agreement No. 58-0111-13-008.

Acknowledgments

The authors are grateful to Terrance Hurley, two anonymous referees, as well as various conference and seminar participants for valuable insights that have substantially improved this work. Financial support from the USDA's Agricultural Marketing Service and Farm Service Agency is gratefully acknowledged.

References

Balagtas, J.V., and D.A. Sumner. 2012. Evaluating U.S. *Policies and the Supply Management Proposals for Managing Milk Margin Variability.* American Journal of Agricultural Economics 94: 522–7.

Bozic, M., J. Newton, C.S. Thraen, and B.W. Gould. 2012. Mean-reversion in Income over Feed Cost Margins: Evidence and Implications for Managing Margin Risk by US Dairy Producers. *Journal of Dairy Science* 95: 7417–28.

——. 2014. Tails Curtailed: Accounting for Non-linear Dependence in Pricing Margin Insurance for Dairy Farmers. *American Journal of Agricultural Economics* 96: 1117–35.

——. 2014. *Parametric Bootstrap Tests for Futures Price and Implied Volatility Biases With Application to Rating Dairy Margin Insurance*. Selected Paper prepared the AAEA Annual Meeting, Minneapolis, MN.

Bozic, M., C. Wolf, F. Yang, J. Newton, and C.S. Thraen. 2014. *Margin Protection Program for Dairy Producers: Implementation, Participation and Consequences*. Selected Paper prepared the AAEA Crop Insurance Symposium, Louisville, KY.

Bryant, H.L., J. Outlaw, and D. Anderson. 2007. Aggregate Milk Supply Response to the Milk Income Loss Contract Program. *Journal of Agribusiness* 25 (2): 133–46.

Coble, K.H., T.O. Knight, R.D. Pope, and J.R. Williams. 1997. An Expected-indemnity Approach to the Measurement of Moral Hazard in Crop Insurance. *American Journal of Agricultural Economics* 79: 216–26.

D'Antoni, J., and A.K. Mishra. 2012. Determinants of Dairy Farmers' Participation in the Milk Income Loss Contract Program. *Journal of Dairy Science* 95: 476–83.

Du, X., H. Feng, and D. Hennessy. 2014. Rationality of Choices in Subsidized Crop Insurance Markets. Working Paper 14-WP 545, Center for Agricultural and Rural Development, Iowa State University.

Esuola, A., M. Hoy, Z. Islam, and C.G. Turvey. 2007. Evaluating the Effects of Asymmetric Information in a Model of Crop Insurance. *Agricultural Finance Review Fall* 341–56.

Glauber, J.W. 2004. Crop Insurance Reconsidered. *American Journal of Agricultural Economics* 86: 1179–95.

Hart, C., B.A. Babcock, and D.J. Hayes. 2001. Livestock Revenue Insurance. *Journal of Futures Markets* 6: 553–80.

Jackson, J., C.S. Thraen, and M. Bozic. 2013. Conflict Over Cooperation: Why So Much Disagreement Over the Proposed Dairy Market Stabilization Program? *Journal of Agricultural and Food Industry Organization* 11: 129–38.

Joe, H. 1997. *Multivariate Models and Dependence Concepts*. New York: Chapman & Hall.

Just, R.E., L. Calvin, and J. Quiggin. 1999. Adverse Selection in Crop Insurance: Actuarial and Asymmetric Information Incentives. *American Journal of Agricultural Economics* 81: 834–49.

Nelson, C.H., and E.T. Loehman. 1987. Further Toward a Theory of Agricultural Insurance. *American Journal of Agricultural Economics* 69: 523–31.

Newton, J., C.S. Thraen, and M. Bozic. 2013. *Whither Dairy Policy? Evaluating Expected Government Outlays and Distributional Impacts of Alternative 2013 Farm Bill Dairy Title Proposals*. Paper presented at AAEA Annual Meeting, Washington DC.

Newton, J., and M. Hutjens. 2015. One Safety Net, Two USDA Measures of Dairy Feed Costs. Farmdoc daily (5): 99, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign.

Newton, J., C.S. Thraen, and M. Stephenson. 2014. Adverse Gaming Incentives in Farm Safety Net Programs: Evidence from the Milk Income Loss Contract. Poster presented at AAEA Annual Meeting, Minneapolis MN.

Novakovic, A. 2014. Highlights of the FSA Final Rule on the Margin Protection Program for Dairy Producers (MPP-Dairy). The National Program on Dairy Markets and Policy. Information Letter 14–02.

Price, M. 2004. Effects of U.S. Dairy Policies on Markets for Milk and Dairy Products. Washington DC: USDA Economic Research Service Technical Bulletin No. 1910.

Schnepf, R. 2012. *Dairy Policy Proposals in the 2012 Farm Bill*. Washington DC: U.S. Congressional Research Service Report No. 42736.

Shields, D.A. 2013. *Federal Crop Insurance Background*. Washington DC: U.S. Congressional Research Service Report No. 40532.

Tomek, W.G. 1997. Commodity Futures Prices as Forecasts. *Review of Agricultural Economics* 19: 23–44.

U.S. Congress, House of Representatives, Agriculture Committee. 2002. Farm Security and Rural Investment Act of 2002. Washington DC: House Document 2646, 107th Congress, 2nd session.

——. 2014. Agricultural Act of 2014. Washington DC: House Document 2642, 113th Congress, 2nd session.

U.S. Congressional Budget Office. 2014. Effects on Direct Spending and Revenues of the Conference Agreement on H.R. 2642, as reported on January 27, 2014. Washington DC.

U.S. Department of Agriculture, Farm Service Agency. 2010. Historical Data Dairy Product Price Support Program Updated Through FY2010. Fact Sheet Dairy Product Price Support Program. Washington DC.

——. 2011. *Report of the Dairy Industry Advisory Committee*. Washington DC.

——. 2015. Results of 2015 MPP Enrollment. Washington DC.

U.S. Department of Agriculture, National Agricultural Statistics Service. 2014. 2012 Census of Agriculture – United States Summary and State Data, Volume 1. Washington DC.

Valvekar, M., B. Gould, and V. Cabrera. 2010. Identifying Cost-minimizing Strategies for Guaranteeing Target Dairy Income Over Feed Cost via Use of Livestock Gross Margin Dairy Insurance Program. *Journal of Dairy Science* 93: 3350–7.

Wolf, C.A., and G.T. Tonsor. 2013. Dairy Farmer Policy Preferences. *Journal of Agricultural and Resource Economics* 38: 220–34.

Woodard, J.D., and D. Baker. 2013. 2013 Farm Bill Dairy Title Proposals Redistribute Program Benefits toward States with Larger Farms. *Choices* 28 (3): 1–5.