Reducing Risk for Dairy Farms: An Analysis of the Milk Supply Response to Current and Proposed Policies‡

Uthra Raghunathan †

‡ The views presented here are those of the author and do not reflect the policy of AMS or USDA

† US Department of Agriculture, Agricultural Marketing Services, Dairy Programs, Washington DC

Dating back to 1949, a variety of government programs have been designed to support the dairy industry during times of extreme financial hardship. The dairy industry currently receives support from the government through programs such as those found in the Food, Conservation, and Energy Act of 2008 (Pub.L. 110-234). More specifically, the programs which are currently in effect are the Milk Income Loss Contract (MILC), Dairy Export Incentive Program (DEIP), and Dairy Product Price Support Program (DPPSP) (Food, Conservation, and Energy Act of 2008 (Pub.L. 110-234)). These programs work to combat volatility in the market, such as those experienced by dairy farmers in 2009 when low milk prices and high feed costs caused very low margins for dairy producers (Dairy Industry Advisory Committee Report, 2011). As the dynamics of the market change from being dominated less by cyclical patterns and more by increased volatility of both milk and feed prices, advocates in the dairy industry have become more vocal in their demands for a dairy policy that provides better support for the industry during times of extremely low margins (Peterson, Simpson Introduce The Dairy Security Act of 2011, 2011).

Starting from a new perspective, the Dairy Security Act (DSA) was adopted from the Foundation for the Future program introduced by National Milk Producers Federation (NMPF) (http://futurefordairy.com/program-details). This legislation was eventually introduced in 2011 by Rep. Collin C. Peterson, D-Minnesota. and Rep. Mike Simpson, R-Idaho. A version of the DSA was passed by the Senate as well as by the House agriculture committee in both 2012 and 2013.[1] The senate version DSA contains a voluntary margin insurance program that if participants elect includes a required market stabilization program. The benefits of this program were debated in the current Congress with general support for some type of margin insurance programs, however some contention exists regarding the market stabilization aspects. Since the first introduction of DSA, researchers have developed extensive literature that explores the impacts of margin insurance on prices,

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[1]The 2013 legislation passed the Senate and the House, in very different forms. The Senate version included both the margin insurance and the market stabilization aspects, but the house version only included a margin insurance version.

government spending, and general producer welfare in the program. Less research has been conducted on the effect of the proposed market stabilization on the supply of milk.

In this paper, we attempt to estimate a farm level supply response to the DSA through dynamic programming. The model compares the simulated profit maximized production scenarios with the actual production in 2009; the different scenarios explained include the simulated current MILC program, the simulated production without any governmental support, and the simulated DSA production levels. We also examine a scenario of what results from having margin insurance without the stabilization program.

The results of this simulation show that the simulated MILC program has the most impact on some producers for increasing production. Conversely, the DSA (as it is currently stands in the passed Senate bill) encourages some producers to limit milk production, which theoretically should result in a faster increase in prices and a speedier recovery. Through this analysis, we also find that producer production levels are not drastically impacted by the market stabilization program. In the next section we discuss the details of the DSA, followed by a discussion of methodology. In section 4 and 5, we discuss the data used and the results, with thoughts and closing remarks following thereafter.

1 The Dairy Industry and the Dairy Security Act

In 2013, two versions of Farm Bill legislation were proposed (H.R. 1947 2013, and S. 954 2013) that included variations of the DSA, (which would be) the main governmental safety net available for dairy. Since 1996, the US Dairy industry has not proposed such a significant change in a policy as that of the DSA for the potential 2013 Farm Bill[2]. The DSA would substantially reshape dairy policy through the introduction of margin insurance (DPMPP) and market stabilization (DMSP) programs. In the proposed language under discussion here, these two voluntary programs go hand-in-hand since producers who register for the margin

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[2]While there is a document specifically titled "Dairy Security Act", we refer to the Dairy Security Act (DSA) as a general program which follows the structure as identified in H.R. 1947 2013, and S. 954 2013

insurance (which compensates farmers when margins between milk and feed prices are low) will also be required to enroll in the market stabilization program.[3]

The Dairy Security Act (DSA) is comprised of three major sections: (1) the base margin protection plan (BMPP), (2) the supplemental insurance plan (SIP), and (3) the dairy market stabilization program (DMSP). The Dairy Producer Margin Protection Plan (DPMPP) is comprised of the BMPP and SIP components. The purpose of the DPMPP is to provide a safety net based on the farmer's income over feed cost (IOFC) margin. However, to enroll in the DPMPP producers will also have to enroll in the DMSP. The DMSP is a market stabilization program which aims to raise milk prices through supply reduction[4]; this is accomplished by limiting the percentage of milk that can be paid for by processors. After the enrollment period has elapsed, for producers who choose to not participate in the DSA that decision is final for the remainder of the farm bill. However if a producer has enrolled in DSA, they will participate in DPMPP and DMSP for the life of the farm bill and have the yearly option to enroll in SIP.

Margin Insurance

There are two parts to the Dairy Producer Margin Protection Program (DPMPP) aspect of the DSA: base and supplemental margin insurance. The base margin insurance pays an indemnity when milk price over feed costs (using national prices published by USDA) is less than $4 per cwt. for a two month period.[5] The two month periods are defined as: (1) January and February, (2) March and April, (3) May and June, (4) July and August, (5) September and October, and (6) November and December. The average of each defined period has to

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[3]For a comprehensive summary of the program see http://dairy.wisc.edu/PubPod/Pubs/IL12-03.pdf, accessed: 6-21-2013

[4]Questions About Dairy Market Stabilization Program, 2013. http://www.futurefordairy.com/faqs/dairy -market-stabilization-program.html, accessed: 6-21-2013, National Milk Producers Federation

[5]The margin is calculated as margin per hundredweight (cwt). = (all milk price - 1.0728*price of corn per bushel - 0.00735* price of soybean meal per ton - 0.0137*price of alfalfa hay per ton)

be \$4 or under for the indemnity (under the base margin) to be paid.[6] If June and July are averaged to be less than \$4, but periods 3 and 4 are not, then no indemnity payment is calculated. Other than a small administrative fee, there are no costs to the producer for the base margin insurance. A dairy producer has a specified amount of time to register for the program and if they elect to participate (or not participate) they must do so for the life of the farm bill.

Research by Novakovic and Stephenson (2012), Nicholson and Stephenson (2011), and Brown (2012) indicates that to benefit more from DSA, the producers would most likely sign up for supplemental insurance. Unlike the base margin which, if elected, lasts for the life of the farm bill (if the producer registers for the program), supplemental insurance is optional and can be elected once a year during a time period specified by the Secretary of Agriculture. The program provides margin protection above the \$4 per cwt base margin protection. The supplemental insurance is provided at a fee, which is based on the level of protection. The margin insurance ranges from \$4.50 to \$8.00 per cwt. in \$0.50 increments. The fee charged depends on the version of the DSA[7]. In addition to the margin protection level, producers can choose to cover anywhere from 25% to 90% of their marketed milk.[8] Under the supplemental insurance program the indemnity payment equals the insured margin level minus the observed margin, multiplied by the coverage percentage. If the base margin insurance program is in effect, the supplemental indemnity is the supplemental protection level minus \$4 multiplied by the coverage level. If a producer decides to maintain the same level of supplemental insurance over the life of the farm bill, then Novakovic and Stephenson (2012) and Brown (2012) suggest that \$6.50 is in the range of an advisable coverage level.[9]

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[6]The base margin uses as it's production base the higher annual production for the producer in the last 3 years. This base production level is calculated when the producer signs up. If an indemnity will be paid out, the producer gets 80% of their base divided by 6 (to get the bimonthly amount) or their current marketings level for the consecutive period, whichever is less.

[7]The 2012 Senate and House versions had different fees for the protection levels

[8]The base production level for the supplemental insurance is the annual production level from the previous year divided by 6. The indemnity payment will be made on the coverage level chosen times either the base or the actual milk marketings for the consecutive period, whichever is least.

[9]This is because of how the fee levels are incremented. At \$6.50 the fee level jumps from 9 cents to 40 cents for the first 4 million pounds and from 29 to 62 cents for any milk over 4 million pounds

Market Stabilization

The Dairy Market Stabilization Program (DMSP) is required if a producer registers for the DPMPP. The stabilization program is triggered when either (1)the previous month's margin is $4 or less or (2) the preceding two months margin are $6 or less. When the stabilization is triggered, the producer will only be paid for 92% to 98% of their milk marketings depending on the severity of the low margin and their decision to use their actual marketings or their chosen base.[10] The DMSP does not prevent farmers from producing and even marketing as much milk as they can or want, but it does create an upper bound on the percentage of milk for which producers can be paid when they are subject to DMSP penalties. The DMSP will be suspended for two reasons (1) when margins return to over $6 for two consecutive months or (2) the US dairy product prices are equal to or greater than the world prices[11].

National Milk Producers Federation (NMPF) has suggested that by enacting the market stabilization program, farmers will be encouraged to cut back on their milk production and thereby improve prices and margins (Questions About Dairy Market Stabilization Program, 2013).[12] Some sources seem to support the margin and market stabilization legislation (or some variation of it). Determining the potential supply response is fundamental to the ongoing discussion, as this understanding will lead to better insight on the effects of such support programs on current and future markets.

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[10]The market stabilization base is either a three month rolling average or the previous year's production for the same month. The producer gets to choose annually which base option he prefers. Once the market stabilization is announced the base for that month is maintained until the stabilization is suspended.

[11]There is a tiering scheme for the suspension that involves both the US margin and what percent above the US price is compared to the international price

[12]http://www.futurefordairy.com/faqs/dairy-market-stabilization-program.html, National Milk Producers Federation, accessed: 6-21-2013

2 Methodology

In this section, we develop a framework to evaluate the impacts of the DSA program on the supply response. In particular we focus on the effect of the market stabilization on the supply from producers of different sizes. The methodology used for this analysis is a stochastic dynamic optimization, which breaks the optimization problem into smaller subproblems and allows for shocks to be incorporated without re-estimating the entire objective function. A Bellman equation

$$V(x_0) = \max_{a_0} \left(F(x_0, a_0) + \beta V(x_1) \right) \tag{1}$$

$$s.t. \quad x_1 = T(x_0, a_0) \tag{2}$$

measures the current maximized value and the discounted future value in the future time periods. The control variable in equation 1 is a_0, while x_0 is the state variable. The current state variable (x_0) and the current control variable (a_0) influence the state variable in the next period x_1. Equation 1 can be rewritten as

$$V(x_0) = \max_{a_0} \left(F(x_0, a_0) + \beta V(T(x_0, a_0)) \right) \tag{3}$$

The following constraints were imposed on this analysis to maintain a realistic theoretical framework which is applicable to real world scenarios.

1. While there are a large range of farm sizes from a few cows to many thousand, we separate the farms into three sizes: (1) small-under 1.4 million lbs. of milk a year, (2) medium-1.4 to 13.6 million lbs. of milk a year, and (3) large-13.7 and more million lbs. of milk a year.

2. We use a percent change for the choice variable in the transition equation to ensure a continuous and concave function.

3. Since we use the percent change as the choice variable, we cannot disaggregate costs into cow and feed costs. Therefore, we combine the costs into a value for how much it costs for one more unit of milk production.

4. Since we are here interested in the effect of DSA on farm-level production, one often suggested margin is \$6.50 cwt at maximum (90%) coverage level[13] we use this margin insurance and coverage level for our analysis.

5. Since we are particularly interested in the effect of DSA on production (and to simplify the modeling) we use the margin and "other costs"[14] as opposed to price and costs.

These assumptions allows us to conform to the standard microeconomic assumptions:

1. The value function is continuous in the control and state variables.

2. The value function is concave in the control and state variables.

3. The decision makers optimize the sum of the discounted values.

With these assumptions we can now write our Bellman equation for each producer as:

$$V(q_{ti}) = \max_u \left[f(q_{ti}, u_{ti}, m_{t-1}, c_{i,t}) + \beta V(q_{t+1,i}) | q_{t+1,i} = g(q_{ti}, u_{ti},) \right] \tag{4}$$

Where q_{ti} is the production level at time t for farm size i, u_{ti} is the percent change desired for next month's production for farm size i, $c_{i,t}$ is the non-feed costs for each different farm size[15], β is the discount factor (set at 0.943), and $m_{t-1,i}$ is the margin payment at time $t-1$ and varies based on the farm size[16]. The margin payment is lagged one month behind due

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[13]This is one suggested option if the producer has no sense of what the future prices will be. (Novakovic and Stephenson (2012) and Brown (2012))

[14]Other costs are estimated monthly and are allowed to vary per farm size; it is supported by ERS data on dairy farm costs

[15]This cost number is taken from ERS's dairy farm cost of production numbers and is allowed to vary monthly.

[16]This price number is taken from ERS's annual dairy farm cost of production numbers.

to the nature of dairy purchases and payments. The milk check[17] is paid in two instances: (1) around the 15th of the current month and (2) at the beginning of the following month.

Equation (4) takes on the functional form

$$V(q_{ti}) = \max_u \left[q_{ti}(1 + u_{ti})(m_{t-1} - c_{i,t}) + \beta V(q_{t+1,i}) | q_{t+1,i} = q_{ti}(1 + u_{ti}) \right] \tag{5}$$

which can be simplified into

$$V(q_{ti}) = \max_{q_{t+1}} \left[q_{ti} \left(\frac{q_{t+1,i}}{q_{ti}} \right) (m_{t-1} - c_{i,t}) + \beta V\left(q_{t+1,i}\right) \right] \tag{6}$$

With this specification, we will run a theoretical model and then extend the analysis to an empirical application for 2009. The main hypothesis is that simulations will show the reduction in production by large and small producers will be gradual while medium sized producers will be more likely to reduce production at a quicker pace.

3   Data

Two sources of data were used: (1) producer data and (2) USDA's Economic Research Service (ERS) data. The data sources are detailed below with the ERS data used for general numbers like cost of production data and the producer data used for the simulations through setting the initial milk production variable levels for December 2008.

ERS Data

ERS[18] data provides the estimated costs for different sized farms. They provide this data annually. They also supply a monthly cost of production for dairy farms, but it does not break the data into different farm sizes. The annual data (with the different cost of

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[17]This is the conventional term used to describe the bimonthly payments farmers receive from milk processors

[18]see http://www.ers.usda.gov/, accessed: 4-20-2013

productions) was used to estimate the cost and margins for the different farm sizes ($c_{i,t}$ and $m_{i,t}$) and the monthly cost of production was used to estimate the non-feed costs for dairy farms. The fixed costs varied monthly and for each farm size over the course of the analysis. To calculate the monthly margin and fixed cost estimates, a ratio of the farm size over the weighted average was calculated from the annual breakdown provided by ERS.

Producer Data

The data were collected from the records of three Federal Milk Marketing Orders (FMMO or FO): the Upper Midwest (FO 30), the Northeast (FO 1), and the Southwest (FO 126). The Upper Midwest Order includes most of the milk produced in Wisconsin and Minnesota and portions of the milk produced in Iowa and the Dakotas. The Northeast Order includes most of the milk produced in the Northeastern states ranging from Maryland to Maine. Considerable shares of milk from the Middle Atlantic states are also included, primarily from Virginia. The Southwest Order encompasses most of the milk produced in Texas and New Mexico.

Thus, this data set represents 1) a large number of farms, 2) a high percentage of farms from the respective regions, and 3) farms from a fairly diverse area in the US. By virtue of farm sizes in these three regions, the vast majority of farms are in the traditional milk producing areas of the Upper Midwest and Northeast. In 2010, each Market Administrator (MA) was asked to provide data for farms that were continuously pooled from January 2000 through 2009. New entrants are ignored. Exiting farmers are ignored. Although this analysis uses the data for 2009, it does not include any producers who entered the market after 2000.

One reason for the continuous pooling requirement was to control for farms whose pool status switches temporarily. Farm milk is priced based on the location of the plant from which it is shipped. If a farmer changes customers or if a marketing cooperative changes its distribution patterns, a farmer may find that his milk is priced under a different order.

This can be a permanent or temporary shift. Pool qualification criteria have become stricter, especially in northern orders, but historically there would likely be a considerable number of farms that were de-pooled for periods of time. The criteria for selecting farm records was intended to reduce the chance of mistaking a change in milk marketings that were the result of a change in pool status as opposed to farm production.

In providing the data, each MA office employed a slightly different selection rule that should be understood in interpreting the data and consequent results. FOs 126 and 30 included monthly total payroll pounds per farm that continuously marketed milk between 2000 and 2009. FO 1 supplied monthly data for farms that were continuously pooled from 2000 to 2009, but they also excluded any farm associated with a year-over-year production increase of more than 500%. It may have excluded farms that made very large expansions, but this would be a small number of farms. The 2009 calendar year was chosen for the following analysis because it was the most recent year in which DPMPP and DMSP programs would have been triggered and for which we have data. These programs would also have been triggered in 2012; however, we do not have farm records for 2012.

4   Analysis

In this section, we maximize the Bellman equation (eq. 6). We first present descriptive statistics for the data we used. Following the discussion of the polynomial approximation we discuss the results from the optimization and the simulations. To compute the stochastic, dynamic programming we used a polynomial approximation (as introduced by Howitt, et al., 2002) that is further described below.

Descriptive Statistics

For this analysis we used daily production levels to mitigate calendar composition is-

sues[19]. Since we only had monthly production data, we calculated the daily production numbers as the monthly production divided by the number of days. Since we only have production data we used the daily production averages for a cluster analysis to determine how to group the different farms. Table 1 shows that these three farm sizes (small, medium, and large) are distinct groups.

Table 1: Producer Data Daily Production, lbs per day

Farm Size	Mean	Std. Dev	Min	Max
Small	3,882	157	3606	4088
Medium	37,395	6,097	27,198	45,080
Large	153,296	20,290	119,321	177,818

For the simulation we used the observed margin levels as defined by the 2013 Senate Farm Bill specifications for data year 2009. Those margin levels ranged from $2.25 to $8.69 with the months May through July being the months with the lowest margins. 2009 was chosen as the sample year because of its uniqueness to the dairy industry as one of the worst years in recent history for dairy farmers. In 2009, many dairy farms either went out of business or acquired additional debt. The current proposed programs aim to provide impactful risk mitigation for the dairy industry.

Polynomial Approximation

Polynomial approximation is a method developed by Howitt et. al (2002) that provides a numerical approximation for the infinite horizon value function approach. The orthogonal polynomial approximation maps the relationship given by $V^{s+1} = TV^s$ where T maps such that a stable value holds between the next approximation and the current approximation such that $V = TV$. The Chebychev polynomial is chosen to map the approximations and

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[19]Calender composition issues arise since milk is produced every day and changes in production can be obscured by the number of days in a month.

takes the form $V(x) = \sum_p a_p \phi_p(M(x))$ where a_p is the coefficient of the pth polynomial term $\phi_p(M(x))$. The Chebychev polynomial, which is defined on [-1,1] interval can be expanded by the numerical recursion relationship:

$$\phi_1(\hat{x}) = 1 \tag{7}$$

$$\phi_2(\hat{x}) = \hat{x} \tag{8}$$

$$\phi_3(\hat{x}) = 2 \cdot \hat{x}\phi_2(\hat{x}) - \phi_1(\hat{x}) \tag{9}$$

$$\phi_n(\hat{x}) = 2 \cdot \hat{x}\phi_{n-1}(\hat{x}) - \phi_{n-2}(\hat{x}) \tag{10}$$

As seen above the polynomial is sinusodial in nature and has a relationship as $\phi_n(\hat{x}) = \cos(n \cdot \cos_{-1}(\hat{x}))$. The steps involved in using this polynomial approximation are:

1. Estimate the nodes at which the value function approximation is evaluated.

2. Solve the Bellman equation at each of the nodes identified above and save the maximized values to be used as the initial values for the next iteration.

3. Use the polynomial coefficient values to obtain the updated value function for use in the next iteration.

4. Iterate the procedure until the polynomial coefficients numerically converge.

For more details on this methodology see Howitt et al. (2002). Using this method we first optimize the model which incorporates a probability distribution for the margins as calculated using the 2013 Senate Farm Bill specifications[20]. After the optimization model we simulate the model using the actual margins in 2009 and the Federal Order data to set the initial values.

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[20]See the Senate bill S.954, http://www.gpo.gov/fdsys/pkg/BILLS-113s954pp/pdf/BILLS-113s954pp.pdf, accessed: 6-21-2013

For the stochastic aspect we calculated probabilities of expected margins using data from 2000 to 2013. Table 3 shows the probabilities where, as expected, the probabilities are highest in the middle ranges. It is interesting that the left tail does seem a little fatter than the right tail which implies that lower margins are slightly more probable than higher margins.

Table 2: Margin Probabilities

Margin Band	Probability
1.55 - 3.80	0.062
3.81-5.35	0.037
5.36-6.90	0.142
6.91-8.45	0.321
8.46-10.00	0.259
10.01-11.55	0.086
11.56-13.10	0.056
13.11-14.65	0.037

Using these probabilities as the stochastic element we maximize Bellman equation (eq. 6) so that the future present values are optimized along with the current period. One of the more interesting results from the optimization is that the small and large farms tend to behave similarly as compared to the medium sized farms (Table 3). This may be because both the smaller farms and larger farms are not trying to grow as fast nor have as much concern about losing their businesses, although for very different reasons. The small farms tend to have lower total debt while the bigger farms may be "too big to fail" for the banks (Harris et. al, 2009).

When the model is maximized for the expected net present value the optimal level of increasing production is 3.761% for small farms, 29.974% for medium sized farms and 54.488% for large sized farms. The maximized expected net present value shows, as expected, the large farms having the greatest dollar value ($6,710,100) with the small farms having the least ($5,867,500).

Table 3: Marginal values for the transition equation for the 8 margin scenarios

Margin Band	Small	Medium	Large	Probability
1.55 - 3.80	-1.392	-1.186	-1.591	0.062
3.81-5.35	0.004	0.003	0.014	0.037
5.36-6.90	0.091	0.076	0.127	0.142
6.91-8.45	0.379	0.321	0.452	0.321
8.46-10.00	0.445	0.38	0.497	0.259
10.01-11.55	0.195	0.167	0.210	0.086
11.56-13.10	0.155	0.133	0.163	0.056
13.11-14.65	0.123	0.106	0.128	0.037
Weighted Average	0.194	0.165	0.226	

Simulation Results

The simulation results compares the actual average production for each farm size against different simulation scenarios: (1) simulated with no government program, (2) simulated with MILC payments, (3) simulated with margin insurance alone, (4) simulated with margin insurance and market stabilization. The lower bounds on the daily milk production for all three sizes is 1,000 lbs. per day. The upper bounds for the daily milk production is 5,000, 50,000, and 180,000 for the small, medium, and large farm sizes, respectively. We also limit the increase and decrease of u_{ti} to the average increase and decrease for the 2009 period for each farm size. This keeps the producers from increasing or decreasing their production at an improbable rate.

It is assumed that the small farms get the MILC payments for every month that payments are announced; but due to the larger production levels, medium farms only get MILC payments for March, April, May and part of June, while large farms only elect the MILC payments for June (and only for half of one month's production). This is due to the MILC payment caps on production. For the medium and large sized farms it is assumed that the producers will average their MILC payments to ensure they meet their costs over the length of the low margin months in 2009. We make a similar assumption in the DSA simulation.

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Figures 1, 2, and 3 show the different simulation scenarios for small, medium and large farms. The simulation results show drastic reductions between the amount of production with MILC and without any government support program. These results are different from what we would expect to see in reality in a couple of ways: (1) There would be an offsetting price impact and (2) producers would not necessarily extend marginal output reductions deep into their core production.[21] This analysis should be used as a way to qualitatively compare different policies. All of the three figures tell a similar story that the MILC program has production at the highest level while having no government program drops the production levels. The interesting aspect of the simulation is that the producers percent change in production between the margin insurance with and without market stabilization is negligible in this simulation.

The simulated results show that the medium sized farmers reduce production the most when the market is bad and increase the most when the government programs are enabled. This agrees with the hypothesis that small and large farmers make production changes slower than the medium sized farms. It is also interesting to note that the actual data and the simulated MILC payments track each other closely. Figure 3 shows that in this simulation the large producers would have produced at about the same level regardless of margin insurance or MILC. This is because other than a few months, the large producers are able to meet their costs of production.

Another analysis that was done, but not shown in the figures below, looked at how the margin insurance payment schedule could affect the production of milk. If the producers expect to receive their payments in one lump sum and immediately reinvest the payments into their farm to produce more milk, the end result would be higher volatility in the "realized margin"[22] and overall lower production levels at the end of the year. However, if the producers either get their indemnity payments over a period of two months (or decide

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[21]However, it's also true that there is no recent historical basis for knowing how producers would respond to effective margins that were even lower than the supported margins of 2009, so knowing what response at the farm-level would have been is difficult.

[22]Realized margin = observed margin + average margin insurance payment

to average their reinvestment into the farm over two months) then the production curve is what is shown in the figures 1, 2, and 3 for the margin insurance line. This curve contains fewer production swings which, one could reason, lead to less price volatility. This would imply that the impact of this program on volatility will depend on how producers view the indemnity and what short term spending habits they decide to follow.
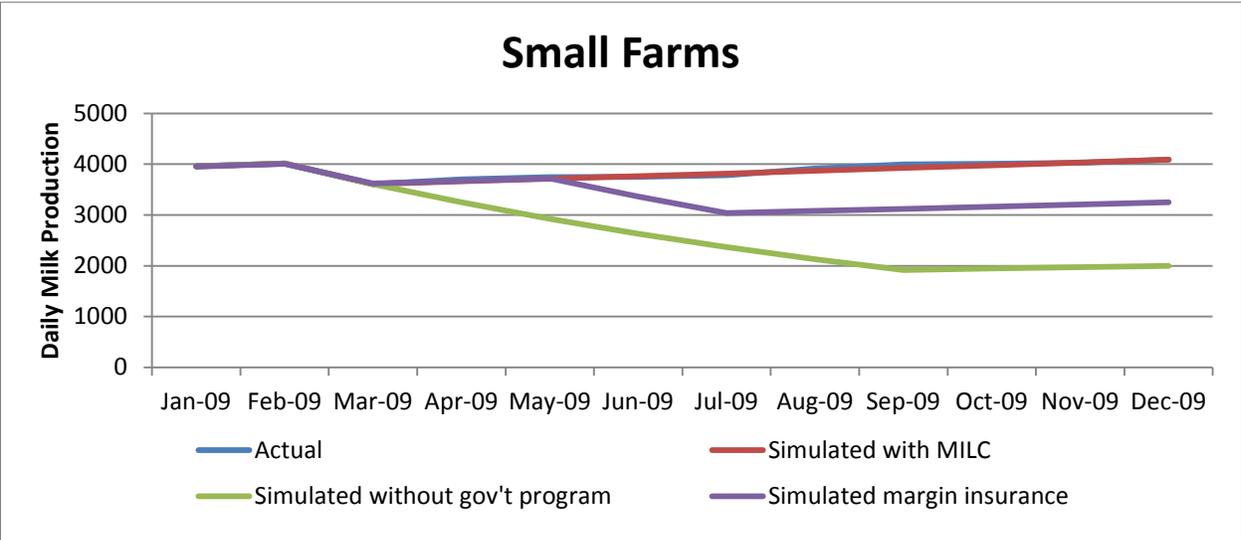
Figure 1: Comparing actual production against <u>simulated</u> governmental policies for small farms
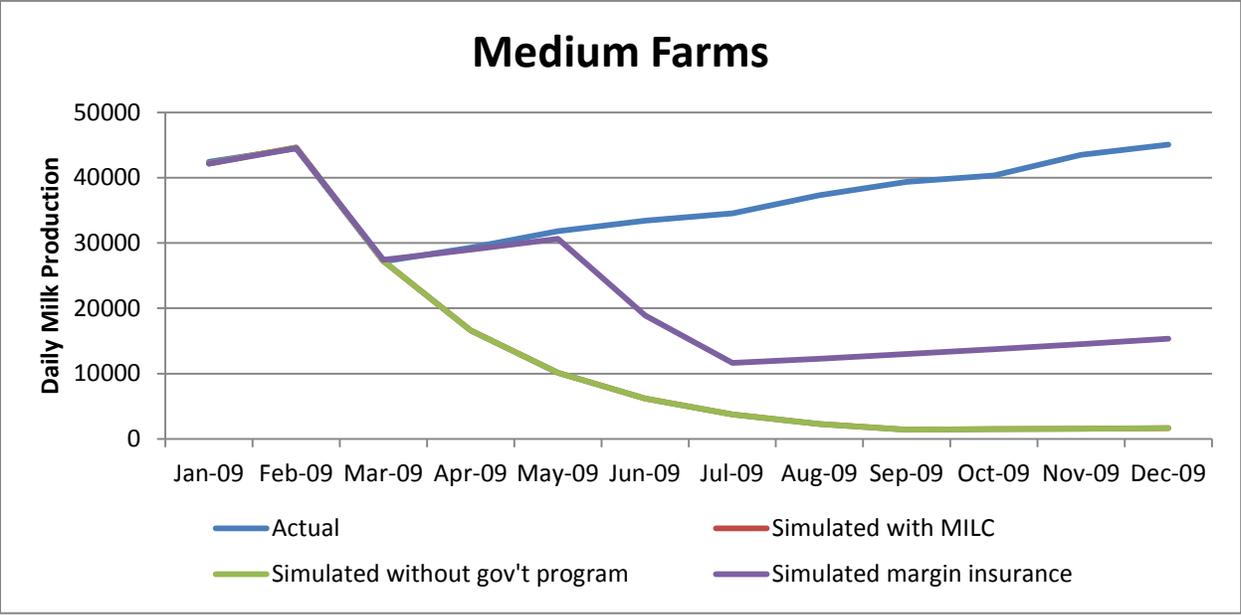

Figure 2: Comparing actual production against <u>simulated</u> governmental policies for medium farms
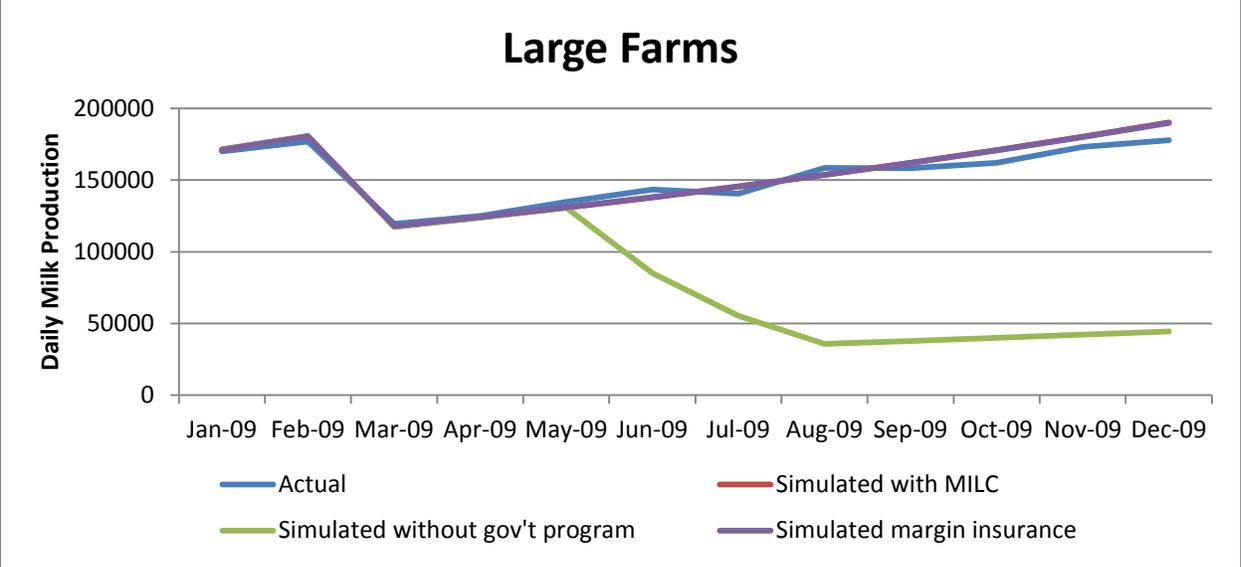

Figure 3: Comparing actual production against <u>simulated</u> governmental policies for large farms

5 Conclusion

In this paper we studied the supply response of current and proposed programs through stochastic dynamic programming. The optimization and simulation models indicate that the proposed margin insurance and stabilization program would have reduced the output in 2009 and theoretically improved milk prices sooner through the reduced supply. We also found in the simulation that there was no significant difference between a program with just margin insurance versus a program with margin insurance and market stabilization. Due to the constraints of the model, expected behavior of the producers may be significantly different if the program goes into effect due to unseen effects of human behavior. Payment timing of the margin insurance is critical when the model is optimized. If the producers reinvest all of their indemnity payments, then supplies become volatile, potentially impacting prices with increased volatility.

By focusing on farm performance based on farm size, it was determined that medium sized farms were the quickest to respond to both low and higher margins, whereas small and large farms responded slower and with less intensity. The simulation of the milk production without governmental support programs, predicted that the medium sized farms decreased production the most which indicates that medium producers would be the most at-risk group of shutting down without any governmental support.

As a tool to examine policy, this analysis contributes to the current discussion on margin insurance and market stabilization by presenting a new perspective on the potential impacts that various policy changes can have on farmers. This research, in addition to the current knowledge base examining government spending and general producer welfare in the program, provides an important dialog on how to best proceed when it comes to dairy policy in the present and for years to come. There are more avenues to research in dairy policy, such as the addition of parameters like seasonality, utilizing ARMS data[23], and relaxing the u_{it}

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[23]Agricultural Resource Management Survey is a product provided by ERS and NASS. See http://www.ers.usda.gov/data-products/ for more information., accessed: 7-10-2013

assumptions to contribute new dimensions to the discussion.

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