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Adoption of Milk and Feed Forward Pricing Methods by Dairy Farmers

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Increasing volatility in milk and feed prices has led to higher levels of market and financial risk for dairy farmers. We examine dairy farmer use of forward pricing methods for milk sales and feed purchases. Operators with larger herds, higher levels of education, and those farm businesses that were not organized as sole proprietorships were more likely to have used forward pricing. We also examine reasons dairy farm operators had not used these tools to date and find that the most common reason was lack of knowledge. These findings may be used to target educational seminars and outreach to dairy farm managers.

Key Words: dairy farmers, feed price, forward pricing, hedging, milk price, risk management

JEL Classifications: G13, Q12, Q13

Dairy farmers have received increasingly volatile cash milk prices and paid higher and more volatile cash feed prices in recent years. Much attention has been given to the increasing marketing and financial risks associated with this volatility. One measure of the variation of milk and feed prices at the farm level is income over feed cost, a commonly used proxy for dairy farm profitability (Wolf, 2010). The margin between milk price and feed cost is the amount available to pay for all other expenses, including labor and returns to management, capital, and unpaid labor. Figure 1 displays income over feed cost calculated as the U.S. all milk price less a weighted cost for corn and soybeans that the U.S. Department of Agriculture has used for many years to calculate the milk-to-feed price ratio.[1] For the United States, from 1990 through 2012, this monthly income over feed cost measure averaged $11 per hundred weight (data from USDA-NASS, 2013a). The relative variation in the series has increased over time. From 1990 through 1999, the monthly coefficient of variation—the standard deviation divided by the mean as a measure of percent variation—of this margin was 13.6%. From 2000 through 2012, the coefficient of variation increased to 20.4%.

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[1] Standard nomenclature is "income" over feed cost by which is meant gross income or what would often merely be called revenue. There are many different ways to define income over feed cost that use alternative milk prices (i.e., all milk, Class III or mailbox price) and feed price combinations (e.g., National Agricultural Statistics Service prices received or CME prices). The U.S. Department of Agriculture calculates the cost of 100 pounds of feed as composed of 51 pounds of corn, eight pounds of soybeans, and 41 pounds of hay. For this calculation of the margin, we leave hay out of the feed calculation. Therefore, the margin displayed here does not include all feed costs and will be larger than margins that do. Nonetheless, our margin is correlated with those other margins and captures the relevant variation.

This variation in margin occurred because variation increased in both the milk and feed prices. With respect to milk prices, one factor was that the Dairy Price Support Program had a farm milk price support that did not interfere with market prices in recent years (Chouinard et al., 2010). Feed crop price level and variation has increased for various reasons including weather events and energy costs. In 2009, a prolonged period of low—or negative—margins resulted in substantial financial losses on most dairy farms.[2]

There are many reasons that dairy farmers might use forward contracting tools, including attempting to increase profit and for tax management purposes, in the case of feed purchases.[3] However, given the recent increase in feed price levels and volatility in both milk and feed prices, it is likely that risk management has been an increasingly important motivation. Forward pricing tools U.S. dairy farmers might find useful include milk and feed cash forward contracts as well as futures and options contracts. With respect to output price risk, Class III milk price futures contracts and options for each calendar month are available 24 months into the future. Class III price is the Federal Milk Marketing Order-defined minimum farm price of milk used for cheese (and whey) and is the primary driver of farm milk prices in the United States. Class III is the primary driver of farm prices because cheese is the single largest class use of milk and because Class I (fluid) and Class II (soft manufactured product) minimum prices are established by formulas that use the Class III price.[4] Class III futures and options traded on the Chicago Mercantile Exchange (CME) are 200,000 pound monthly contracts that cash settle when the Class III price is announced for each month. The open interest and volume in Class III contracts has increased dramatically in the past decade reflecting the desire of both sellers (e.g., farmers and cooperatives) and buyers (e.g., cheese processors) of milk to mitigate milk price risk. Farmers are paid a mailbox milk price that includes the average milk marketing order blend price (where applicable) as well as farm-specific premiums (Maynard, Wolf, and Gearhardt, 2005). When farmers use Class III milk futures or options contracts to manage risk, basis risk (mailbox less Class III price) remains.

Cash forward contracts can overcome some of the problems farmers may have with hedging milk including lumpiness, margin calls, and basis risk. For example, many dairy cooperatives offer forward contracts that reflect either agreements with processors or retailers or are offset by futures and options contracts. The forward contracts through dairy cooperatives are often offered in smaller increments than the CME futures contracts—25,000 pounds is a common unit used for milk. Milk marketing cooperatives often have programs that handle margin calls for members using these programs. They also sometimes offer tools that resemble put options and more exotic tools.

Feed is the single largest cost of producing milk and, like in the case of the milk price, dairy farmers have the ability to mitigate at least a portion of energy and protein feed price risk by using, for example, corn and soybean meal contracts at the Chicago Board of Trade that shift at least a portion of feed price risk to others. Corn, in 5000-bushel contracts, is

[2] These losses directly contributed to the creation of the Margin Protection Program in the 2014 Farm Bill. The Margin Protection Program is a policy intended to protect milk income over feed margins. This program might be a disincentive for private risk management activities by dairy farmers.

[3] The use of cash accounting allows farms to prepay expenses—including feed—to lower taxable income for a given year. Prepaying feed in high profit years can assist in maximizing expected after tax income. We cannot separate the extent to which income smoothing was the motivation to use feed forward contracting as opposed to risk management. However, it seems likely that farmers using forward pricing feed contracts as tax management tools might use them for risk management purposes as well.

[4] Class IV (butter and nonfat dry milk) minimum price can also be used to set Class I (fluid) minimum milk prices. Class IV futures and options are also traded at the CME. However, Class III markets are much larger and more liquid. For example, at the time of this writing, the open interest in Class III futures and options was approximately eight times as large as the open interest in Class IV futures and options. Still the futures and options market for both contracts remains thin as a percentage of total milk produced.

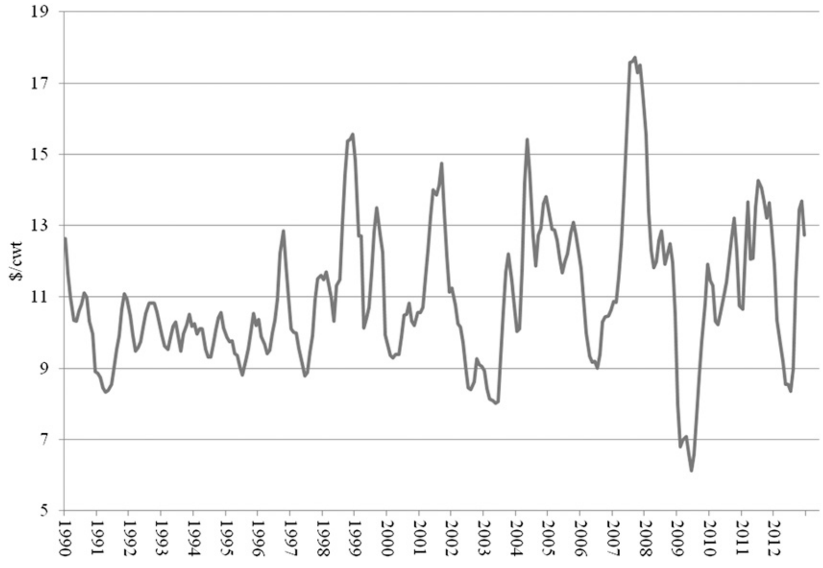

Figure 1. U.S. Income Over Feed Cost, 1990–2012

traded for five calendar months each year, whereas soybean meal, in 100 short ton contracts, is traded for eight months each year. Both corn and soybean meal futures and options contracts are traded for up to four years into the future. The existence of these futures and options contracts facilitates forward contracts by local feed providers and cooperatives. The ability to forward contract feed and milk price risk allows producers to potentially manage price risk around a milk-to-feed price margin.

The increasing volatility in milk and feed prices has led many to the conclusion that current dairy policies aimed to support milk price—rather than the margin between milk and feed price—are insufficient. Government responses have included the Dairy Options Pilot Program (DOPP), which included educational programs and subsidized trading in milk put options. More recently, an insurance program to protect the difference between Class III milk price and a weighted corn and soybean meal feed price has been created. The adoption of this policy, called Livestock Gross Margin Insurance for Dairy (LGM-Dairy) insurance, has been limited because of factors such as lack of funding (Bozic et al., 2012).

Despite both the ability and incentive to offset input and output price risk, use of these forward pricing tools by dairy farmers has been limited. This research uses survey results from dairy farmers in five states in 2012 to examine the extent to which forward pricing methods were used. The objectives were to understand: 1) how many farmers had used milk and feed forward pricing methods; 2) operator and farm characteristics related to their use; 3) factors related to timing of method adoption; and 4) reasons farmers had not used these methods to date. We find that dairy farms with larger herds, with operators who had education beyond high school, and operations not organized as sole proprietorships were more likely to have used forward pricing methods. With respect to reasons that farms had not used these contracts to date, the most common reason was lack of understanding of those tools. Considering the role of producer education, we examine factors related to targeting educational meetings, seminars, or classes for forward contracting methods.

Previous Research on Farmer Forward Pricing

There is an extensive literature related to farmer use of forward pricing methods, which include the use of futures and options contracts as well as cash forward contracts offered by, for example, cooperatives, elevators, and other agribusinesses. This literature is often normative modeling the farm risk management or profit problem and prescribing optimal use. In contrast, our application is a positive analysis that examines how dairy farm managers have used these pricing methods. A brief review of the literature related to forward pricing, contracting, and marketing in agriculture in general, and dairy in particular, helps to establish that these methods have a role in modern U.S. dairy farm management and provide expected signs associated with the explanatory variables used in the study.

Many previous studies have focused on the use of price contracting tools for farm output. Shapiro and Brorsen (1988) found that Indiana farmer use of hedging was affected by many farm operator and operation characteristics including experience, education, leverage, and farm size. Goodwin and Schroeder (1994) examined forward contracting use by grain farmers in Kansas. They found that more than 30% of those farms used forward pricing. Participation in educational programs was found to be a key driver of this use. Sartwelle et al. (2000) concluded that Texas, Kansas, and Iowa grain producer marketing practices depended on farm size, specialization, and farming experience. Katchova and Miranda (2004) used 1999 U.S. Department of Agriculture Agricultural Resource Management Survey data to examine the marketing contract decisions of corn, wheat, and soybean farmers. Their results indicated that personal and farm characteristics did not necessarily increase the quantity contracted but did increase the probability of adopting marketing contracts.

Related to dairy farms, Bosch and Johnson (1992) found that hedging feed purchases by dairy farmers was an efficient and useful risk management strategy for a range of risk preferences. Frechette (2001) examined the use of futures and options for hedging corn (input) price risk on Pennsylvania dairy farms. He found that the optimal hedging portfolio for those dairy farms included both futures and options. Frechette also determined that hedging demand could be stimulated by a reduction in the perceived cost of trading through educational programs. Maynard, Wolf, and Gearhardt (2005) examined minimizing downward milk price risk with put options. They concluded that optimal hedge ratios were directly proportional to the share of milk used in Class III (milk for cheese) and therefore varied by state and region. Wolf, Black, and Hadrich (2009) determined that milk price was the primary driver of dairy farm income variation. Neyhard, Tauer, and Gloy (2013) compared selling milk and procuring inputs (e.g., feed) on a monthly cash basis to hedging with futures and options contracts. Neyhard, Tauer, and Gloy concluded that these risk management activities did not result in a significant change to the level or variance of net farm income.

Forward Pricing Adoption and Estimation Procedures

Agricultural producers face uncertain outcomes when adopting new techniques. Farmers choose to adopt a technique if their expected utility of profits with the technique exceeds their expected utility of profits without adoption. Following Goodwin and Schroeder (1994) and Katchova and Miranda (2004), farmers are assumed to make decisions on adoption of milk and feed price forward contracting by comparing expected utility of farm profit from different outcomes. Define

$$\pi_{ij} = ZB_i + e_{ij}, \tag{1}$$

where π_{ij} is the expected utility of the present value of farm i profit associated with the jth price risk management outcome, Z is a $(1 \times k)$ vector of explanatory variables, B is a vector of coefficients, and e_{ij} is a random disturbance term. Adoption of forward contracts by farmers can be modeled as a one- or two-step process. These models can also include decisions on quantity, frequency, and contract type (Katchova and Miranda, 2004). This exercise applied to output (milk) or input (feed) price tools leads to adoption and use decisions about forward pricing methods.

Dairy farms may adopt milk and feed forward pricing tools simultaneously to manage a milk price less feed price margin. With milk the largest source of revenue and feed the largest expense on most dairy farms, the milk to feed margin is a logical benchmark to protect farm profitability (Wolf, 2010). Past research has modeled profit margin hedging using a target margin applied to historical data. Protecting a profit margin with input and output contracts has been shown to potentially be profitable for example in feeding cattle (Leuthold and Mokler, 1980), feeding pigs (Kenyon and Clay, 1987), and soybean crushing (Johnson et al., 1991).

We examine two models of forward pricing adoption by dairy farmers. Both models use multinomial logit estimation but deal with different issues related to forward pricing adoption.[5] The first separates farms into four groups to examine whether the farms had adopted the forward pricing methods for milk, feed, both, or neither. The second estimation separates the farm respondents into three groups to examine when they adopted milk and feed forward pricing methods (never, early, or recent adopters). Knowledge about the relative frequencies of these behaviors reveals more about the dynamics of the adoption of these methods than a simple binary analysis.

When considering whether dairy farms adopt milk and/or feed price contracting tools, there are four possible outcomes: neither milk nor feed price tools are adopted, only milk price risk tools are adopted, only feed price risk tools are adopted, or both milk and price risk tools are used. Define

$$D_{ij} = 1 \text{ if } \pi_{ij} = \max(\pi_{i1}, \pi_{i2}, \pi_{i3}, \pi_{i4}) \quad 0 \text{ otherwise}, \tag{2}$$

$i = 1, \ldots, n$; $j = 1, \ldots, 4$. Thus, for example, D_{i3} is a binary variable taking a value of one when the adoption of only feed price contracting tools results in the largest expected utility of profit. The second estimation is similar with respect to whether farmers were nonadopters, early adopters (defined as before 2007—a year chosen because of the increased volatility in feed prices and thus margin in the period that followed), or recent adopters (since 2007) for a total of three classes with nonadopters the omitted category.

The discrete decision of whether to adopt forward pricing methods can be estimated using many different functional forms depending on the density function of the error term. For example, past studies have used a probit model when the disturbances are assumed to be distributed normally (Goodwin and Schroeder, 1994) or a logit model when the distribution is assumed logistic (Asplund, Forster, and Stout, 1989). When the random disturbance e_{ij} has the density function $f(u) = e^{(-u_j - e^{u_j})}$ and distribution function $F(u_j < u) = e^{e^{-u}}$, the probability that the i^{th} farmer makes the j^{th} choice for forward pricing adoption can be written as a multinomial logit function (Maddala, 1983):

$$\text{Prob}\left(\text{D}_{ij}\ 1|Z\right) = \frac{e^{Z_i \text{B}_j}}{\sum_{j=1}^{J} e^{Z_i \text{B}_j}}, \tag{3}$$

where Z is a vector of farm and farmer characteristics; $i = 1, \ldots, n$; $j = 1, \ldots, J$, and J is three or four in this case depending on the number of outcomes. To examine these decisions by dairy farmers, we surveyed farm managers about their use of forward pricing methods.

Discussion of Survey Data

Data were collected using a mail survey of 2419 dairy farms from five states, which included California, Florida, Indiana, Michigan, and Wisconsin. Together these states accounted for 40.9% of U.S. milk production in 2012 (U.S. Department of Agriculture, National Agricultural Statistics Service, 2013b). The list of licensed milk producers was obtained from each state's respective Department of Agriculture in April 2012. After adjusting for bad addresses and farm exits, the number of operations surveyed by state were 468 from California (~25% of operations with a license to ship milk), 115 from Florida (100% of licensed

[5] We also estimated a Heckman two-step model to examine both adoption and percent of milk or feed protected. However, there were no significant explanators of the quantity (percent) of milk or grain price protected. The quantity contracted was related to other factors that we did not observe such as price levels and market opportunities. Therefore, we focus strictly on the adoption of these methods.

operations), 410 from Indiana (~25% of licensed operations), 450 from Michigan (~25% of licensed operations), and 984 from Wisconsin (~10% of licensed operations). The Dillman method was used with an initial survey in May 2012 followed by a reminder card two weeks later and a second survey two weeks after the reminder (Dillman, Smyth, and Christian, 2009).

Respondents identified operator characteristics (age, education, experience) and operation characteristics including herd size, acres operated, percent of feed purchased, farm business organization, cooperative membership, and farm financial solvency situation. Dairy producer respondents also were asked whether they had used milk or feed price instruments including cash forward, futures, or options contracts in the past year (2011), past five years (2007–2011), or before 2007. Finally, those who had not used forward pricing methods to date were asked for reasons why they had not. Of the 2419 farms surveyed, 662 were returned for a 27.4% response rate. By state the response rate ranged from 16.5% in California to 34.1% in Indiana.[6]

Past research has shown that dairy farmer adoption of management practices is related to a set of socioeconomic and financial variables including years of experience dairy farming, education, net farm incomes, and debt-to-asset ratios (Paudel et al., 2008). Summary characteristics of the sample farms are displayed in Table 1. These statistics reflect expected patterns in operation and operator characteristics consistent with national summaries from the U.S. Department of Agriculture. For example, the largest herds on average were in California and Florida. Indiana had the smallest average herd size and youngest average operator age. Operator education was, on average, higher in California and Florida respondents. The percent of sole proprietors, as opposed to partnerships,

[6] Response rates were reasonable for mail surveys that asked for financial information (eg, debt-to-asset ratio) and summary statistics suggest that the mean and range for herd size and other characteristics were also reasonable. However, we did not examine nonrespondents and cannot speak authoritatively about nonresponse bias in these results.

Table 1. Summary Statistics

Variable	Description	California	Florida	Indiana	Michigan	Wisconsin	Five States
		Mean (standard deviation)					
Herd size	Milk cows	1,497 (2,156)	1,257 (1,792)	123 (235)	220 (343)	160 (569)	360 (1,018)
Acres operated	Acres	1,121 (1,974)	903 (1,258)	326 (464)	617 (524)	424 (457)	652 (3,004)
Operator age	Years	53.4 (14.8)	56.5 (13.5)	48.7 (12.5)	52.3 (12.2)	50.4 (12.1)	51.0 (12.7)
Operator education	Years	14.25 (2.29)	14.12 (2.78)	11.93 (2.11)	13.43 (1.84)	12.52 (1.88)	12.66 (2.20)
Sole proprietors	Percent yes	36.8 (62.9)	26.1 (44.9)	80.1 (45.2)	58.3 (49.4)	77.7 (41.7)	67.6 (49.7)
Dairy cooperative member	Percent yes	66.2 (47.6)	95.4 (21.3)	91.4 (28.1)	94.8 (28.3)	66.8 (47.2)	78.7 (41.7)
Milk/cow	Pounds milk/cow/year	23,848 (3,900)	19,906 (3,030)	19,010 (4,264)	21,634 (4,732)	20,732 (5,662)	20,940 (5,109)
Purchased feed	% Of feed purchased	60.6 (24.5)	69.7 (19.0)	34.0 (21.8)	28.6 (22.2)	22.0 (18.2)	32.1 (24.8)
Solvency risk	Debt-to-asset ratio (%)	31.7 (21.6)	42.2 (25.2)	24.5 (19.1)	26.8 (21.7)	24.1 (21.6)	26.3 (21.5)

limited liability companies, and incorporated operations were higher in the Upper Midwest states than in California and Florida. California and Florida also purchased a larger percent of their feed requirements and had higher debt-to-asset ratios on average. The operation and operator characteristics summarized in Table 1 are used as explanatory variables in the regressions to explain forward pricing method adoption.

Table 2 displays the percent of herds using milk and feed pricing tools in 2011, between 2007 and 2011, and before 2007. Average use of both milk and feed price tools was higher in 2007–2011 than in earlier periods. This was expected because of the increasing amount of price volatility. Cash forward contracts were more commonly used than futures and options contracts. More operators had used feed price risk methods than milk price risk methods.

Table 2 also displays the average amount that was forward priced annually between 2007 and 2011 for those herds that used the method in question and across all herds. Respondents that had used milk pricing tools had contracted and average of 34–45% of their milk production in the five-year period. However, because a smaller percentage of herds had used these milk pricing methods, only 3–5% of milk production from all respondents was contracted during this period. The average amount of feed requirements contracted for the operations that used those methods was approximately 35%, but because more herds had used these methods, the amount contracted across all herds was over 10% only in the case of forward contracting. We would expect that the amount contracted to depend on the market opportunities, cost of production, and other market and farm-specific factors.[7] Finally, 6.4% of respondents had used dairy LGM at some point since it became available (on a limited basis for the first couple of years) in 2008.

Empirical Results

Adopting Milk and Feed Forward Pricing

Table 3 presents the multinomial logit estimation results of whether the forward pricing tools had been used to date.[8] These respondents had used feed or milk price contracts at some point in the past. If they had used dairy LGM, which has been available to some degree since 2008, then they were considered as having used both milk and feed contracts because dairy LGM protects the margin between milk and feed price.[9] The omitted category was nonadoption of the forward pricing tools and Wisconsin was the omitted state dummy variable. Relative to nonadopters, those that had only used milk forward pricing methods managed larger herds, had higher levels of operator education, and higher milk production per cow. Relative to Wisconsin respondents, California and Michigan respondents were less likely to have used only milk forward pricing methods. The respondents that had only used feed forward pricing methods to date had cows with higher milk yield and purchased more of their feed requirements than those that had not adopted either of the pricing methods. Operators that had adopted both milk and feed pricing methods managed larger herds, operated more acres, had more years of operator education, were less likely to be sole proprietorships, and had higher debt-to-asset ratios.

Managers of larger herds were more likely to have used milk forward pricing methods, either alone or in conjunction with feed forward pricing methods. Managers of larger herds may find milk pricing contracts of a size that is

[7] One pattern that was evident in the percent contracted for both milk and feed was that it tended to be clustered at common share reference points. That is, farms tended to contract 20%, 25%, 40%, 50%, and so on.

[8] The independence of irrelevant alternatives assumption (IIA) was tested using the Hausman and McFadden (1984) test. The tests failed to reject the IIA null hypothesis for the multinomial estimations in Tables 3 and 4.

[9] When the grouping is milk only, feed only, both, or neither, it seems logical that LGM-Dairy would be categorized as "both." Although our intention was not to assess the performance of LGM-Dairy, we did estimate the likelihood of respondents having used LGM-Dairy using a probit model (Appendix 1). Dairy farmers operating more acres, with higher milk per cow, and with higher debt-to-asset ratios were more likely to have used LGM-Dairy.

Table 2. Use of Forward Pricing Methods by Dairy Farmers in Five States

Milk Price Risk Tools	Cash Forward Contracts	Futures Contracts Percent Used	Options Contracts
In 2011	6.4	4.8	4.4
2007–2011	11.2	8.3	7.3
Before 2007	5.3	2.9	1.5
Ever	14.7	10.3	8.9
		Percent Average Annual Milk Sold 2007–2011	
Respondents that used	44.9	34.1	39.5
Across all respondents	5.4	3.4	3.2
Feed price risk tools		% used	
In 2011	12.6	4.5	2.4
2007–2011	20.9	8.0	4.5
Before 2007	8.8	1.8	1.0
Ever	23.6	8.8	5.0
		Percent Average Feed Purchased 2007–2011	
Respondents that used	37.5	35.5	37.8
Across all respondents	10.3	2.8	1.8
		Percent Used	
LGM-Dairy[a]		6.4	

[a] LGM-Dairy has been available since August 2008.

relatively easier to use than managers of smaller herds. For example, if the farm manager wishes to hedge 20% of milk production, those with larger herds have more options with fixed contract sizes to do so than smaller herds. Similarly, operators with more education were more likely to use milk forward pricing methods either alone or in conjunction with feed forward pricing. Dairy farmers had limited motivation to worry about milk price risk until recent years particularly when the Dairy Price Support Program was regularly interfering with milk market prices (Chouinard et al., 2010). Operators that want to successfully understand and use milk contract pricing tools have invested time and effort into ramping up their knowledge in the area. Those with higher education have shown a willingness and ability to pursue higher levels of learning and may be more able and inclined to learn about alternative milk forward pricing methods. Higher milk per cow likely captured the effect of management ability and attention to detail about production processes. With respect to location, because of high use of milk for cheese, Wisconsin farms face a more direct hedge using existing Class III milk contract tools than do other states. In particular, California operates a separate State Order pricing system and Florida farm milk goes largely to fluid consumption resulting in a higher degree of cross-hedging for these operators than those in Wisconsin, Michigan, and Indiana when using the Class III (milk for cheese in Federal Orders) contract. Higher relative basis risk in this case depresses the motivation to use these methods compared with Wisconsin, which has a high Class III use rate. Farms operated as sole proprietorships likely had smaller management teams where a manager may have been less likely to focus on risk management and forward pricing methods.

The increased focus on risk management in recent years and fiscal difficulties likely explains the relationship to debt-to-asset ratio—which was used to measure solvency risk—being positively related to farms that used both milk and feed forward contracts. These farms may have been explicitly protecting a milk over feed cost margin.

Timing of Adoption

Table 4 presents multinomial logit estimates of early (before 2007) and recent (2007–2011) adopters of forward pricing contracts relative to nonadopters. Separate estimations were run for

Table 3. Multinomial Logit Estimation of Forward Pricing Adoption (n = 662)

	Adoption Outcomes					
	Milk Forward Pricing Methods Only		Feed Forward Pricing Methods Only		Both Feed and Milk Forward Pricing Methods	
Variable	Coeff. (SE)	Marginal Effects	Coeff. (SE)	Marginal Effects	Coeff. (SE)	Marginal Effects
Constant	–7.5276* (2.2606)		–8.7973* (1.7427)		–8.0618* (1.6046)	
Cows	0.0011* (0.0004)	0.00005*	−0.0002 (0.0003)	–0.00005*	0.0007* (0.0004)	0.00008*
Acres	−0.0001 (0.0004)	−0.00002	0.0003 (0.0003)	0.00001	0.0005* (0.0003)	0.00005*
Operator age	−0.0227 (0.0186)	−0.0012	0.0150 (0.0147)	0.0017	−0.0041 (0.0125)	−0.0005
Operator education	0.2233* (0.1131)	0.0082	0.1292 (0.0802)	0.0063	0.1685* (0.0780)	0.0128
Sole proprietor	−0.2475 (0.5280)	0.0098	−0.3271 (0.3808)	0.0052	–1.2105* (0.3371)	–0.1333*
Coop member	−0.1287 (0.4708)	0.0012	−0.3649 (0.3962)	−0.0253	−0.3334 (0.3470)	−0.0275
Milk/cow	0.0002* (0.00006)	0.000004*	0.0002* (0.00005)	0.00001*	0.0002* (0.00004)	0.00002*
Purchased feed	0.0009 (0.0121)	−0.0001	0.0154* (0.0080)	0.0013*	0.0059 (0.0080)	0.0002
Solvency risk	0.0129 (0.0108)	0.0004	0.0024 (0.0089)	−0.0003	0.0149* (0.0077)	0.0015*
California	–2.6047* (0.9897)	–0.1162*	0.1508 (0.6830)	0.0727	–1.4011* (0.6559)	–0.1298*
Florida	−16.8854 (446.55)	−0.8156	0.5610 (0.9932)	0.3194	–5.3548* (1.8743)	−0.3752
Indiana	−0.9220 (0.6854)	−0.0456	0.8915* (0.4505)	0.1097*	−0.5389 (0.4967)	−0.0760
Michigan	–2.3517* (1.0773)	–0.1232*	0.4620 (0.4755)	0.0700	−0.3321 (0.4111)	−0.0133
Pseudo R^2	0.2283					
n	41		81		101	

Note: All coefficients are expressed relative to the nonadoption of both milk and feed forward pricing methods. Wisconsin is the omitted state.
* That variable or effect was significant at the $p = 0.10$ level.
SE, standard error.

Table 4. Multinomial Logit Estimation of Timing of Forward Pricing Contract Adoption (n = 662)

	Milk Forward Pricing[a]		Feed Forward Pricing[a]	
	Early Adopters	Recent Adopters	Early Adopters	Recent Adopters
Constant	–4.8782* (0.1.6462)	–8.2617* (1.8728)	–5.1880* (1.5142)	–10.7336* (1.7455)
Cows	0.0010* (0.0004)	0.0010* (0.0004)	−0.0003 (0.0003)	−0.00006 (0.0002)
Acres	0.00004 (0.0003)	0.0002 (0.0003)	0.0004* (0.0002)	0.0004* (0.0002)
Operator age	−0.0103 (0.1410)	–0.02780* (0.0145)	0.0107 (0.0128)	−0.0049 (0.0131)
Operator education	0.1196 (0.0840)	0.2754* (0.0929)	−0.0217 (0.0740)	0.2057* (0.0773)
Sole proprietor	–0.9326* (0.3660)	–1.2424* (0.4076)	–0.7844* (0.3333)	–1.0295* (0.3436)
Coop member	−0.4159 (0.3617)	−0.0222 (0.4071)	−0.3205 (0.3489)	−0.1530 (0.3716)
Milk/cow	0.0001* (0.00004)	0.0002* (0.00005)	0.0002* (0.00004)	0.0003* (0.00005)
Purchased feed	−0.0032 (0.0093)	0.0018 (0.0090)	0.0078 (0.0076)	0.0068 (0.0078)
Solvency risk	0.0041 (0.0084)	0.0167* (0.0086)	0.0045 (0.0077)	0.0048 (0.0081)
California	–2.9972* (0.8407)	–2.0812* (0.7079)	−0.0641 (0.6073)	0.0464 (0.5368)
Florida	–5.0277* (2.0828)	−18.8882 (709.94)	0.2894 (0.8983)	−0.6223 (1.0550)
Indiana	−0.6162* (0.4706)	–1.2416* (0.6310)	0.2994 (0.4241)	0.7556* (0.4599)
Michigan	−0.6054 (0.4387)	–1.26814* (0.5215)	0.2674 (0.4093)	0.1256 (0.4457)
Pseudo R^2	0.2413		0.2072	
n	71	71	81	101

[a] Dependent variable was whether respondents had not used milk or feed forward pricing (omitted category), had used it in the period before 2007 (early adopters), or had adopted in the period 2007–2011 (recent adopters). Wisconsin is the omitted state.

* That variable was significant at the $p = 0.10$ level.

milk and feed forward pricing adoption. Relative to the nonadopters, both early and recent adopters of milk forward pricing methods operated larger herds, were less likely to be sole proprietorships, and had higher producing cows. Recent adopters of milk forward pricing methods were younger, had higher education, and their dairy farm businesses had higher debt-to-asset ratios. Because nonadopters are the omitted class in both regressions, it is not surprising that the results have similarities to the previous estimation. For example, the influence of herd size on the adoption of milk forward pricing methods and acres on the adoption of feed pricing are similar to the previously mentioned estimation, although note that the influence of these factors is much larger in the case of recent adopters than early adopters.

Business organization had a large influence on the timing of adoption for both milk and feed forward pricing. Businesses organized as sole proprietorships were less likely to have used forward pricing of milk and feed even controlling for farm size measures. Operator age had a negative effect on recent adoption of milk price tools, whereas operator education had a positive effect on recent adoption of milk forward pricing methods. Solvency was a significant explanatory of recent adopters of milk forward pricing, perhaps reflecting the volatility and financial distress caused by 2009. California farm managers were less likely to use milk forward pricing methods, whereas Indiana and Michigan farm managers were less likely to be recent adopters of milk forward pricing relative to the omitted state of Wisconsin. There were no significant differences across states for feed forward contracting adoption timing.

Reasons Dairy Farmers Had Not Used Forward Pricing Tools

Futures and options have existed for many years with a large and liquid market for many commodities. Past research has examined farmer use of hedging instruments. In particular, many studies have examined the contradiction between the risk reduction effects that may be possible using hedging and the relatively small proportion of farmers that use those instruments (Carter, 1999). Some research has attributed farmer aversion to hedging to lack of understanding, margin calls, and basis risk (Frazier, 1984; Pennings and Meulenberg, 1997). One proposed solution for lack of understanding is education for farm managers. Tomek (1987) suggested that perhaps farmers were not underusing futures and options as much as some normative models implied was optimal because those models ignored important costs of hedging such as transactions costs. Bond and Thompson (1985) and Newbery and Stiglitz (1981) suggested that producer use of futures markets was influenced by size of operation, transaction costs, the cost of information, and the perception of bias in futures markets.

With respect to farm milk price, Maynard, Wolf, and Gearhardt (2005) concluded that many existing dairy policies including pooling milk revenues in milk marketing orders and the Milk Income Loss Contract (MILC) offset milk price risk and diminished the motivation for dairy farmers to use milk futures and options. However, increasing price volatility in recent years may provide sufficient motivation to overcome these policy offsets.

Table 5 displays the reasons that dairy farm managers provided for not using any milk forward pricing tools to date. There were 519 respondents who had used neither type of risk management tool to date with most indicating more than one reason. As a share of the total responses (n = 1090), the most common reason given was lack of knowledge representing approximately one-fourth of the responses. As was mentioned, farm milk price volatility in the range that crops such as corn and soybeans realize is a relatively recent event. The milk futures contract that is most readily used by dairy farmers began in 1997. Thus, dairy farm managers are relative newcomers to using forward pricing methods for their primary farm product (milk). Lack of knowledge was the most mentioned reason in all five states with the lowest frequency in Wisconsin (21%) and the highest frequency in Michigan (33%). Because lack of knowledge was such an important

Table 5. Reasons Dairy Farmers Had Not Used Forward Pricing Methods by State

	California		Florida		Indiana		Michigan		Wisconsin		Five States	
	Milk	Feed	Milk	Feed	Milk	Feed	Milk	Feed	Milk	Feed	Milk	Feed
Reason	Percent of Responses[a]											
Lack of knowledge	24.3	26.3	29.7	24.2	28.8	26.1	33.3	28.9	21.4	22.3	25.9	24.8
Basis risk	11.2	12.5	13.5	12.1	6.7	13.0	9.2	11.8	12.0	13.5	10.3	12.9
Cost	15.9	11.3	8.1	18.2	6.7	9.2	7.7	9.9	14.8	11.4	11.6	10.9
Lack of management time	12.1	16.3	5.4	15.2	10.4	14.1	9.2	15.8	10.2	12.5	10.1	13.9
Contracts too large	2.8	2.5	2.7	12.1	7.5	8.2	8.7	9.9	9.0	8.8	7.8	8.4
Inconvenient	7.5	8.8	2.7	6.1	7.1	9.2	5.3	5.3	8.4	8.3	7.2	7.9
Difficult to use	6.5	8.8	5.4	6.1	4.6	3.8	5.3	5.9	5.8	6.2	5.5	5.9
Cooperative markets milk	11.2	__	21.7	__	19.2	__	15.0	__	8.2	__	12.7	__
Grow own feed	__	0	__	0	__	3.8	__	6.6	__	9.9	__	6.6
Other	8.4	13.8	10.8	6.1	9.2	12.5	6.3	5.9	10.0	7.0	9.0	8.6
Total Responses	107	80	37	33	240	184	207	152	499	385	1,090	834

[a] Percent of responses indicate the share of the responses to the question many respondents provided multiple responses.

factor for farmers that had not used forward pricing, educational programming is an obvious prescription. Goodwin and Schroeder (1994) found that attendance at educational seminars greatly increased the adoption of forward pricing methods.[10] Ibendahl, Maynard, and Branstetter (2002) found that training dairy farmers for the DOPP greatly increased their comfort level with hedging milk price. Many cooperatives, brokers, and University Extension personnel have presented programs to dairy farmers in the past dozen or so years but clearly there may be a need for continued education if, as expected, the milk and feed prices continue to be a source of volatility in farm profitability. If forward pricing methods are to become widely adopted by dairy farmers, then the education should be targeted to farm operators that have been unwilling or unable to attend previous educational programs.

In addition to the relative stability of milk prices historically, another reason that farmers may lack knowledge in milk forward pricing is that the majority of them rely on milk marketing cooperatives to perform these duties. The second most common reason that farmers had not used milk forward pricing methods was that they viewed marketing milk and accompanying price negotiations to be the job of their milk marketing cooperative (12.7% but more common in Florida and Indiana). That said, most dairy marketing cooperatives offer milk forward pricing tools to members with brokerage assistance, reduced (or no) milk price basis considerations, and flexible contract size. Thus, one could view the cooperative as facilitating milk forward pricing by members as well as potentially substituting for those efforts.

Other common reasons were cost, basis risk, and lack of management time. Using these tools includes fees for trades in the case of futures and options. Other costs might include the opportunity cost of management time, which was included as a separate reason. Basis risk was found to be an impediment to milk forward pricing methods in the past (Wolf, 2012). When a farmer uses a futures or options contract, they are locking in that portion of their milk or feed price risk but the relationship between the cash

[10] Goodwin and Schroeder (1994) tested and rejected endogeneity between educational program participation and use of forward pricing and so used that as an explanatory variable. We also collected information on participation in educational programs related to milk and feed forward contracting. However, we could not reject endogeneity. Thus, participation in educational seminars was not included in estimations of forward pricing method use.

and futures price (i.e., the basis) can be uncertain. Past research has examined the relative amount of basis risk in milk futures and its role in adoption of these tools (Maynard, Wolf, and Gearhardt, 2005). For milk, the basis is usually defined as the difference among the cash price received for milk by farmers, the mailbox price, and the Class III price, which is traded in the futures and options market. Because Class III is a major component of milk price in most states and regions that use Federal Milk Marketing Orders (Florida, Indiana, Michigan, and Wisconsin here), we expect that to cover a large portion of the mailbox milk price variation. The basis, then, is the portion of the mailbox milk price that is not covered when the Class III price is hedged. Each farm has its own basis because of individual protein, fat, and somatic cell premiums as well as hauling costs. Because no marketing order is 100% milk used for cheese, using the Class III futures contract is to some extent a cross-hedge for all farmers. The basis risk has both intertemporal and spatial dimensions across farms and region of the United States. Class III price reflects the cheese price, which is national in nature. The basis reflects regional and local considerations including over-order and quality premiums. If basis risk is large relative to mailbox milk price risk, then there is little motivation to hedge milk price. Florida has the lowest percent of milk used for cheese among the states we examined here, which contributes to a larger and potentially more variable basis. California operates a state milk marketing order that has some differences from pricing in Federal Orders. Thus, although the milk prices are correlated, we would expect that basis risk is a relatively larger impediment to the use of milk forward pricing tools in California and Florida than Wisconsin.

An "other" category was included along with a space to provide an explanation. Although there was a wide variety of reasons given, some commonalities were evident. The most common were that others they talked with had "lost money" using these tools, that using these tools was too stressful, and that they were "opposed" to these tools (with some respondents indicating that this was for religious reasons).

Table 5 displays the reasons that respondents gave for not using feed forward pricing methods. There were 834 responses from 479 respondents who had not used feed forward pricing methods. The most common reason cited again was lack of knowledge followed by lack of management time, basis risk, and cost. The story with feed price tools is similar to the use of milk pricing tools. From the adoption equations previously, we know that farms not organized as sole proprietorships were more likely to have adopted these methods controlling for farm size and other factors. Farms organized as partnerships, corporations, or limited liability companies are much more likely to have multiply managers (and families) involved. Having a management team often allows for specialization and comparative advantages by the managers, which may help to facilitate learning about and using these methods.

Conclusions

Increasing milk and feed price volatility in recent years has led to frequent calls for dairy farm adoption of forward pricing tools by policymakers and industry leaders. This research examined the extent to which forward pricing tools had been used by dairy farmers in California, Florida, Indiana, Michigan, and Wisconsin. Farm managers that had used these tools were more educated, younger, operated larger herds and more acreage, produced more milk per cow, and were not organized as sole proprietorships. Dairy farmers from California were also less likely to have used milk forward pricing methods than Wisconsin farmers likely reflecting the fact that the Class III milk contract is more of a cross-hedge for dairy farmers from California. The most common reason that farm managers had not used forward pricing was lack of knowledge about the tools. These results might be used to target educational programs toward nonadopters.

U.S. agricultural policy can exacerbate or alleviate price and income variation. Past policies such as the MILC Program have sometimes served as substitutes for private risk management. By the same token, the government has periodically attempted to encourage dairy farmer adoption of risk management through programs such as the DOPP and subsidizing LGM-Dairy insurance. The new farm bill includes a proposal to subsidize margin protection insurance. If comprehensive margin protection is supplied at a highly subsidized rate, the incentive to adopt private risk management tools with milk and feed forward pricing contracts may decline.

Interesting related issues left to future research include: risk tolerance levels and attitudes of dairy farmers and whether these are changing; the cost of current dairy risk management tools relative to farmer willingness to pay; and the extent to which new government policies may crowd out private dairy farmer risk management.

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Appendix 1. Probit Estimates of Participating in LGM-Dairy Insurance Program, August 2008 to May 2012

Variable	Coefficient (standard error)
Constant	–3.8508* (1.1368)
Cows	−0.0001 (0.0001)
Acres	0.0003* (0.0001)
Operator age	0.0017 (0.0091)
Operator education	0.0141 (0.0536)
Sole proprietor	−0.3642 (0.2367)
Coop member	0.1593 (0.2505)
Milk/cow	0.0001* (0.00003)
Purchased feed	0.0076 (0.0049)
Solvency risk	0.0123* (0.0050)
California	0.0259 (0.3450)
Indiana	−0.7390 (0.4551)
Michigan	0.1445 (0.2652)
Pseudo R^2	0.2339

Note: All coefficients are expressed relative to the nonadoption of both milk and feed forward pricing methods. Wisconsin is the omitted state. Florida was dropped because the estimation perfectly explained the outcome.

* That variable was significant at the $p = 0.10$ level.

LGM-Dairy, Livestock Gross Margin Insurance for Dairy.