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Estimation of risk management effects on revenue and purchased feed costs on US dairy farms[1]

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ABSTRACT

Variations in milk and feed prices directly affect dairy farm risk management decisions. This research used data from the 2010 US Department of Agriculture–Agricultural Resource Management Surveys phase III dairy survey to examine how risk management tools affected revenues and expenses across US dairy farms. The survey was sent to 26 states and collected information on costs and returns to individual dairy farms. This research used the information from milk sales, crops sales, feed expenses, and farm and operator characteristics, as well as the use of risk management tools. Matching methodology was used to evaluate the effect of 5 independent risk management tools on revenues and expenses: selling milk to a cooperative, using a commodity contract to sell grain, feeding homegrown forage at a basic and intensive level, and use of a nutritionist. Results showed that dairy farms located in the Midwest and East benefit from selling milk to a cooperative and using commodity contracts to sell grain. Across the United States, using a nutritionist increased total feed costs, whereas a feeding program that included more than 65% homegrown forages decreased total feed costs. Results point to benefits from educational programming on risk management tools that are region specific rather than a broad generalization to all US dairy farmers.
Key words: dairy, risk management, matching methodology

INTRODUCTION

Feed cost management has been cited as one of the most important input cost control measures for dairy operations because it accounts for the largest share of total costs across herd sizes (USDA-ERS, 2007). Dairy farmers have been using various means of input quantity control measures to manage this large input cost, but even with these measures, purchased feed costs increased by 115% in California, by 56% in Wisconsin, and by 140% in New York from 2005 to 2010 (USDA-ERS, 2005, 2010). These states are typically the top 3 milk-producing states in the United States and represent small-scale (e.g., Wisconsin and New York) and large-scale (e.g., California) operations. In regions such as the Midwest (e.g., Wisconsin) and the East (e.g., New York), dairy farms typically have smaller herd sizes and raise their own feed for dairy cows, whereas in the West (California), herd sizes are larger than average, with feed typically purchased rather than grown on the farm (McDonald et al., 2007). The differing structure of dairy farms across the United States and the wide variation in purchased feed cost changes in these 3 states demonstrate the need for further analysis to determine how this variation may affect dairy input risk management decisions.

Dairy farmers commonly state they are most concerned with input, commodity, and milk price risk (Wilson et al., 1993; Harwood et al., 1999; Wolf and Olynk Widmar, 2014). Wilson et al. (1993) surveyed large-scale dairy farmers and found that older dairy producers preferred to be low-cost producers to manage risk, whereas younger dairy producers found forward contracting and debt management to be the 2 most important strategies. Additional price risk management tools included using insurance products to manage net farm income fluctuation, signing up for government program payments, or using commodity contracts as a hedging or speculating tool to stabilize profit, among other tools (Patrick and Musser, 1997; Harwood et al., 1999; Meuwissen et al., 2001; Khanal et al., 2010; Chang and Mishra, 2011; D'Antoni and Mishra, 2012; Kuethe and Morehart, 2012). Not all farms adopt risk management practices and some may choose to adopt multiple tools, whereas others may focus on one strategy. By using these different tools, dairy farms can help control input costs while stabilizing net farm income.

Previous studies evaluating risk management for dairy farms have shown that farm location and type

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affect farmers' perceptions of risk and risk management. To understand the difference between these risk management choices, it is important to compare similar farms with similar producer characteristics within a region. Most studies make this comparison at the herd-size level. A more robust analysis would make this comparison on multiple characteristics, such as herd size and farm location, as well as experience and education level of the principal operator. This analysis uses matching methodology, which allows us to evaluate the effect of risk management tools on farms with multiple similar characteristics (Imbens, 2004). Matching methodology has been applied to the dairy industry to demonstrate that using recombinant bovine somatotropin (rbST) resulted in increased production per dairy cow, decreased cost of production per hundredweight of milk produced, and increased labor and management income per operator on dairy farms in New York State (Tauer, 2009). Organic production was studied using matching methods and it was found that organic cow-calf operations experienced higher allocated costs compared with conventional operations (Gillespie and Nehring, 2012) and that organic crop producers did not realize increased incomes compared with conventional crop producers (Uematsu and Mishra, 2012). Mayen et al. (2012) found that organic technology was less productive than conventional farm technology when matching on-farm and operator characteristics using technical efficiency measures.

This study extends previous work by using matching methodology (Abadie et al., 2004; Imbens, 2004) to evaluate the effects of using 5 independent price risk management techniques on dairy farms across 8 states. The objective of this research was to identify the types of risk management strategies that are most effective in protecting the financial health of dairy producers across the United States. This provided us with an opportunity to compare risk management adoption data collected by the US Department of Agriculture-Agricultural Resource Management Surveys (**USDA-ARMS**) to understand how risk management varies at the state and herd levels. The results of this analysis also provided insights into what dairy producers are doing as opposed to what producers could do to manage risk.

MATERIALS AND METHODS

Data Analysis Methods

Matching methodology provides a method to estimate the effect of treatments and compare differences in performance across 2 similar groups. One group adopts the technology (treatment group); the other group does not (control group). The methodology is then used to estimate the direct average effect of a binary treatment on a scalar performance measure, which allows comparison of outcomes across pairs of matched treated and nontreated observations (Imbens, 2004).

Following Abadie et al. (2004) and Imbens (2004), let there be 2 potential outcomes:

$$Y_i\left(W_{ij}\right) = \begin{cases} Y_i(0) & \text{if } W_{ij} = 0 \\ Y_i(1) & \text{if } W_{ij} = 1 \end{cases}, \quad [1]$$

where Y_i is the performance measure, $W_{ij} = 1$ if risk management tool j was used on farm i, and $W_{ij} = 0$ if risk management tool j was not used for farm $i = 1, \ldots, N$. For each farm that uses risk management tool j, a matching farm is identified that does not use that tool. Because $Y_i(0)$ and $Y_i(1)$ are observable, the effect of the risk management tool on the performance measure is directly observable, such that $[Y_i(1) - Y_i(0)]$. The average treatment effect (**ATT**) for the subpopulation of the farms that adopted risk management tool j can be represented as follows:

$$ATT\ \left(risk\ management\right) = \frac{1}{N_1} \sum_{i|W_{ij}=1} \left[Y_i(1) - Y_i(0)\right], \quad [2]$$

where $N_1 = \sum_i W_{ij}$ is the number of farms using risk management and $W_{ij}(1)$ indicates that the risk management tool was used. Specifically, ATT measures the effect of the group adopting the risk management tool using the tool on a performance outcome. The average treatment effect for the controls (**ATC**)—those farms not using risk management—is calculated as in equation [2] except that N_1 is replaced with N_0 to represent the number of farms that did not use risk management and $W_{ij} = 0$ to indicate that the treatment was not received. Again, ATC measures the effect of the control group using the risk management tool on a performance outcome.

Matching estimators allowed us to find matched farms in the sample based on the set of specified characteristics. In nonmatching methodology papers, comparisons across groups are typically made comparing one characteristic, such as size of the operation; matching methodology allows us to match on multiple farm and operator characteristics, giving us more robust results. Because more than one variable was used for matching, we used a weighting matrix to match farms using risk management tools with those farms that do not use these tools. Following Abadie et al. (2004) and Imbens (2004), a weighting matrix was used to match farms in the opposite group that is the mth closest (or nearest)