ABSTRACT

Given the revenue and cost volatility with resulting tight profit margins in dairy farming, it is increasingly important to measure, monitor, and understand farm financial risk. Solvency, liquidity, debt repayment capacity, and financial efficiency measures can reveal potential problem areas and assist in financial risk management. Financial risk is defined as uncertainty about interest rates, willingness of lender to keep or put money into the business, ability to meet cash flow needs, and the market value of collateral. Financial resilience is defined as the ability to withstand events that impact firm net income. Solvency was measured by equity to asset ratio. Liquidity was measured by current ratio. Repayment capacity was measured by debt coverage ratio. Financial efficiency was measured by operational expense ratio and net farm income ratio. Critical thresholds for these farm financial measures include those determined by US agricultural lenders since maintaining access to outside capital is important for farm financial management. To demonstrate these concepts and measure financial risk and resilience, this research uses farm data from a balanced panel of 105 New York dairy farms from 2010 through 2019. Results reveal that there were 4 average, 2 good, and 4 poor financial years for these operations on average as measured by farm profitability. Solvency positions were relatively stable being based on long-term asset and liability values. During the poor years, the percent of farms below danger thresholds for liquidity and debt repayment capacity spiked.

Key words: financial resiliency, financial risk, liquidity, repayment capacity, solvency

INTRODUCTION

Risk is defined as exposure to harm or loss. In the case of farm management, risk includes all potential outcomes that might damage the business. Risk management for businesses includes identifying, forecasting, and evaluating risks as well as finding procedures to avoid or minimize their impact.

Dairy farms have many sources of risk including weather, diseases, pests, technology, consumer attitudes and preferences, regulation and policy changes, and labor issues. Categories of farm business risk can be broadly categorized as production, market or price, human or personal, and institutional and financial (USDA Economic Research Service, 2022a). Production risk includes crop and milk yield risks due to numerous factors including weather, pests, and diseases. Market and price risk includes uncertainty about market prices, input or output, and market access. Human resource management risk includes activities keeping human resources in harmony with the farm business. Legal, policy, and institutional risk includes those created by regulations and legal liabilities (e.g., environmental regulations).

The final category of farm business risk is financial risk. Financial risk is defined as uncertainty about interest rates, willingness of lender to keep or put money into the business, ability of the business to meet cash flow needs from operations, and the market value of collateral. Modern commercial milk production is capital intensive. The key to long-term farm financial viability is making sound investments in productive assets. Money borrowed or external equity provided creates risk through interest rates, asset values, and cash flow implications. In addition, financial risk may increase because of increasing interest rates, higher cash demand for family needs, disruptions to earnings, and lack of adequate cash or credit reserves. Tools for managing financial risk include financial reserves, savings, lines of credit, and the financial structure of the farm business.

Farm financial risk can be assessed using financial statements. Trends in performance and benchmarks
relative to similar farm businesses and industry standards are useful for management decisions. A second place to look for guidance about financial risk measurements and thresholds is lender evaluation of loan default risk, which directly affects access to and cost of borrowed capital. Successful lending relies on accurate assessment of loan risk (Barry and Ellinger, 1989). The majority of farm businesses need access to affordable outside capital for large expenditures and investments. If a farm business is viewed as too risky by lenders, interest rates will be increased to reflect risk premiums or additional borrowing capacity will be restricted or even denied.

With existing volatility in farm milk and feed prices, dairy producers must increasingly consider whether and how they should be using available tools to potentially minimize market and price risk (Wolf, 2012). As producers examine these issues, it is imperative to evaluate and understand farm financial risk. The primary management questions are as follows: What is the farm’s financial risk exposure? How large is the potential loss a farm business can afford? And how will the farm business deal with the losses if they occur? Higher degrees of financial risk can indicate that it is important to manage milk price risk but will not determine which or how much management is required.

Risk can be managed by either decreasing the likelihood of an adverse event or decreasing the impact if an adverse event occurs. One concept that is particularly useful in understanding the need for farm risk management is resiliency. For our purposes, financial resiliency is defined as the capacity over time of a farm business to either avoid financial distress in the face of revenue or cost volatility and/or recover from any distress that occurs. If that capacity is and remains high over time, then the farm business is resilient. Thus, farm financial resiliency may be briefly defined as the ability to withstand and recover from adverse financial shocks.

This research examines measures and implications of dairy farm financial risk and resiliency. We consider how loans are assessed and how farm financial position affects access to and cost of borrowed capital. We analyze measures, distributions, and dynamics of farm measures related to financial risk for a set of dairy farms over time. We also demonstrate methods to stress-test and measure financial resiliency on farms. Finally, we suggest guidelines for understanding the relationship between farm financial position and risk management priorities. To accomplish these objectives, data from 2010 to 2019 from New York dairy farms are used. These data reveal patterns and distributions of farm financial measures of profitability, solvency, liquidity, and debt repayment capacity. The data also reveal magnitude of changes in farm financial measures over a decade of varying financial risk.

**MATERIALS AND METHODS**

**Data**

Cornell Dairy Farm Business Summary data describe in detail the farm financial performance of a set of voluntarily participating New York dairy farms. The data include accrual adjusted income statements and market value balance sheets and allow a detailed look at cost, revenue, and profit as well as solvency, liquidity, and debt repayment capacity on these farms. Cornell has been collecting and summarizing dairy farm financial data for decades to facilitate extension, research, and teaching related to the dairy farm industry. Similar dairy farm business financial information is summarized by other universities (e.g., University of Minnesota, Center for Farm Financial Management, 2022), agricultural lenders, and accounting firms.

Key financial statements for analyzing farm financial performance, risk, and resiliency include the market value balance sheet and income statement. The market value balance sheet and income statement are the most common financial statements compiled and utilized by farmers (Wolf et al., 2011). A market value balance sheet summarizes the value of all farm-owned assets and all of the debts or liabilities held by the farm business. Assets are physical or financial property that has value and is owned by the farm business. Liabilities are debts that must be paid by the farm business in the future. The difference between the total farm assets and total farm liabilities is owner equity, which is also called net worth. Balance sheets can be used to generate farm financial measures.

An income statement reports the profit the business generated over a specific time period. Generally, income statements are prepared on an annual basis. An income statement measures flow revenues and expenses in addition to capturing the changes in grown and purchased inventory, account receivables, and account payables. Thus, the income statement describes the flow of funds in and out of the farm business that takes place between balance sheets. An accrual adjusted income statement measures farm performance and profitability as it considers changes in inventory and accounts rather than only cash transactions.

For this analysis, annual financial summaries from a balanced panel of 105 New York dairy farms for 10 calendar years, 2010 to 2019, were used. As it is a balanced panel, we need not be concerned with farm entry or exit. These farms voluntarily participate in the Cor-
Measures of Farm Financial Risk

Because farms vary in size and scope and the economic landscape changes depending on price levels and other conditions, financial ratios are useful to standardize and facilitate comparison both across farms and over time. A single ratio by itself may have no significant meaning and may not facilitate decision making. Hence, a given ratio is benchmarked to either ratios from previous years or ratios of similar dairy farm operations. If the differences in the ratios are significant in that the difference is important enough to matter financially to the farm in question, more in-depth analysis must be done to address the issues revealed.

There are multiple dimensions to the financial condition of a farm business that relate to the ability to generate sufficient returns, pay bills as they come due, and maintain sufficient assets to adequately account for liabilities against the farm business (Farm Financial Standards Council, 2011). Lenders tend to rely more heavily on repayment capacity, solvency, and loan security than on the borrower’s profitability and financial efficiency (Featherstone et al., 2006). Collateral is also important but is specific to the loan in question.

When assessing farm financial risk, at least 4 areas of business performance are evaluated: solvency, liquidity, repayment capacity, and financial efficiency. Across these 4 areas there are many different measures that might be used. We examine selected measures for each dimension, including debt coverage ratio (DCR), equity to asset ratio (EA), current ratio (CR), operating expense ratio (OER), and net farm income ratio (NFIR). Note that these measures can all be equivalently expressed as a percent or a ratio. In this research, with the exception of rate of return on assets, we utilize ratios for the financial risk measures for consistency and simplicity.

Solvency is the ability of the business assets to cover all liabilities if the farm business exits (Kay et al., 2008). Solvency measures considers the relationship between assets and liabilities. Percent equity, or EA, represents the portion of the assets on a market value basis that would be returned to the family after paying all liabilities (i.e., assets owned free and clear). The EA ratio is calculated by dividing total net worth by total assets from the market value balance sheet. The higher the EA ratio, the less risk there would be for covering all liabilities (with the exception of deferred tax liabilities) at the time of business exit, if that occurred. Equity to asset ratio is calculated as

\[
EA = \frac{\text{total farm equity}}{\text{total farm assets}}.
\]

A larger EA value indicates greater farm equity and less risk of insolvency. Lenders use EA, or similar measures of net worth such as debt to asset ratio (DA), to assess insolvency risk and charge higher interest rates to farms above established risk thresholds. One common benchmark value is to maintain an EA value above 0.50 with lower values indicating more risk. Of course, farm operators might set their own target below that benchmark, particularly if they are risk averse. Similarly, lenders may tolerate lower EA if debt repayment capacity or other key factors are judged to be exceptionally high. Farm solvency measures are primarily driven by debt, and asset values are specific to the farm investment situation and are more appropriately benchmarked to lender or industry standards.

Liquidity is the ability of the business to meet financial commitments over the next 12 mo (Kay et al., 2008). Liquidity considers whether the business has the ability internally to absorb any negative impacts that might occur. Current ratio is calculated as

\[
CR = \frac{\text{current farm assets}}{\text{current farm liabilities}}.
\]

Current assets are cash equivalents plus those assets that are expected to be available for sale in the next year, while current liabilities are those to be paid in the next year (including the current portion of long-term loans). If CR >1.0, then the farm has more current assets available than expected liabilities. If there are not sufficient current assets and the current liabilities cannot be covered from current operations, then the farm must either use off-farm income, sell longer-term assets or borrow (i.e., an operating loan). Higher CR values indicate less risk.

Repayment capacity is the ability of the business to service debt payments over the next 12 mo. Repayment capacity considers whether there is sufficient or excess cash or earnings after expenses and family withdrawals
to cover planned principal and interest payments. The measure used in this research is DCR, which is defined as

\[
DCR = \text{capital debt repayment capacity} / \text{planned principal and interest payments.}
\]

The numerator, capital debt repayment capacity, is net farm income plus net non-farm income less family living and income draws plus interest paid on term loans. The denominator is planned principal and interest on term debt plus planned reductions in operating debt or account payables. The DCR is based on earnings, so it does not reflect cash that may have come in through other sources, such as sale of capital assets or contributed capital. The higher the DCR, the less risk that farm may have for meeting debt payment obligations.

There are multiple ways to measure financial efficiency. Two measures of financial efficiency are examined here: OER and NFIR. Operating expense ratio is calculated as

\[
OER = (\text{total operating expense} - \text{interest} - \text{depreciation}) / \text{gross income}.
\]

Depreciation is the using up of the value of longer-term assets including breeding livestock, machinery, equipment, buildings, and other assets. Gross income is farm revenue before any expenses are taken out. The OER measures how much of each dollar of revenue is used to cover operating expenses before interest and depreciation. The lower this value, the greater the ability of the farm to meet commitments without having to use working capital, which is the difference between current assets and current liabilities, or outside capital.

A second measure of financial efficiency, NFIR, represents how much of each dollar of revenue remains after expenses as returns to the family for labor, management, and capital. Net farm income ratio is calculated as

\[
NFIR = \text{net farm income} / \text{gross income}.
\]

Net farm income, measured here without asset appreciation, is cash farm revenue less farm cash expenses and depreciation adjusted for changes in grown and purchased inventory values, account receivables, and accounts payables. The higher the NFIR, the greater the ability to meet financial commitments without utilizing working capital or outside capital. Net farm income ratio greater than 0.15 is considered strong.

### Thresholds and Benchmarks for Farm Financial Risk

Business performance varies across farms due to external factors such as weather. However, performance differences between farms due to internal factors, such as managerial ability, also exist, making benchmarking performance across farms and over time a useful tool. It is important to benchmark against similar operations. The investment in cattle and facilities on modern dairy operations are unique to dairy farm operations. It is also important to the extent possible to compare with operations with relatively similar levels of diversification, with appropriate accrual adjustments, over the same time period. It is also advisable to benchmark over several years to assess true farm financial performance (Wolf et al., 2020).

### Credit Rating and Loan Cost

To set parameters to evaluate farm financial risk, it is useful to consider the farm financial position from the perspective of a lending institution. Given the large costs and investments that modern commercial dairy farms incur, virtually all commercial farms use outside capital in some way from operating loans to funding expansion. In fact, it is almost always preferable to use at least some borrowed capital as long as the cost is less than the return that can be generated by investing it in the farm business. This is particularly true when income tax implications, such as deductible interest payments and accelerated depreciation, are considered. The average DA for all US farms is about 0.14 (USDA Economic Research Service, 2022b) but for commercial dairy farms, such as those considered here, it tends to average about 0.30 (Karszes and Augello, 2021). Thus, the ability to maintain access to outside capital is essential to farm businesses.

Lending is also very much about risk management from the lender’s perspective. Experience from the farm crisis in the 1980s had profound effects on agricultural lender loan assessment. Up to the 1980s, agricultural lending largely focused on market value balance sheet of farms (solvency) (Briggeman et al., 2009). Market signals and government policy in the 1970s increased US farmland values with many purchases being highly leveraged (Barnett, 2000). Massive loss of farm asset market value during the 1980s recession precipitated a crisis as decreasing value of farmland—the largest asset value on most balance sheets—caused financial insolvency on many farms (USDA Economic Research Service, 2022b). Widespread insolvency at the farm level resulted in agricultural loan portfolio insolvency for many lenders. At least in part because of the consequences of that farm crisis, agricultural lenders today focus on several factors including solvency but also profitability, liquidity, and debt repayment capacity (Briggeman et al., 2009).
Lenders assess the likelihood that a loan will perform in that it will successfully be repaid as opposed to defaulting. Lenders use several factors to assess the risk of a potential loan. These factors are often described as the 5 C’s of credit: capacity, capital, collateral, conditions and character (Laughton, 2017). Capacity refers to lender ability to repay the loan, which is measured using cash flow and debt repayment measures. Capital is the amount of money invested by the owner measured by solvency and wealth related indicators. Collateral are the assets that are used to guarantee or secure a loan. Conditions refers to the business, what the funds will be used for, as well as industry trends and how these factors might affect ability to repay the loan. Finally, character is the lender’s view of a borrower’s general trustworthiness, credibility, and personality. Lenders use different measures of these factors and continually examine the factors and models that they utilize to improve accuracy and utility (Gustafson et al., 2005).

Loan applications are scored based on expected loss, which is a function of probability of default (Barry and Ellinger, 1989; Jouault and Featherstone, 2011). Farm balance sheet and income statement information are used to examine solvency, profitability, liquidity, and debt repayment capacity. Expected loss score largely determines whether the loan application is approved and at what interest rate (cost of capital). There are many systems to calculate these scores and the factors, measures, and weights change over time and across industries.

The literature examining agricultural credit rating systems reveals several important factors and considerations. Zech and Pederson (2002) investigated factors that should be used by lenders in risk-rating farm customers. Linear and logistic regression models were used to identify the DA as a significant predictor of repayment ability. In addition, the rate of asset turnover and family living expenses were strong predictors of farm performance (Zech and Pederson, 2002). Walraven and Barry (2004) found that banks consistently charged higher rates of interest for the farm loans they characterized as riskier, with an average difference in rates between the most risky and least risky loans of about 1.5 percentage points (Walraven and Barry, 2004). Jouault and Featherstone (2011) found that leverage, profitability, and liquidity at loan origination were statistically significant indicators of the probability of farm loan default. As leverage increased, profitability decreased, or as liquidity decreased, the probability of default increased. Featherstone et al. (2017) predicted probability of default ratings using farm financial information including inverse CR, the DA, the gross profit to total liabilities ratio, the inverse DCR, working capital to gross profit, and funded debt to earnings before interest, taxes, depreciation, and amortization (EBITDA). Results indicated that financial ratio information, including DA, gathered today did a good job forecasting probability of default ratings up to 3 yr in the future. In contrast, CR information did not forecast accurately 5 yr into the future. Thus, there is an important need to update financial information on a regular basis (Featherstone et al., 2017).

**Year Effects.** Profitability is the extent to which net income is generated to adequately cover costs including a fair return to management and capital invested. To measure profitability, we use rate of return on assets without appreciation (ROA), defined as operating profit divided by total farm asset value, which controls for farm asset size. Rate of return on assets without appreciation measures before tax profitable earnings per dollar of investment in assets that reflects how efficiently the farm business uses all assets, whether borrowed or equity capital, to generate profit. Rate of return on assets without appreciation is calculated as

\[
ROA = \frac{(NFI + \text{farm interest expense} - \text{value of operator and unpaid family labor})}{\text{average total farm assets}},
\]

where NFI is net farm income defined as gross cash farm income less expenses adjusted for inventories, depreciation, and gain or loss in the sale of capital assets. The value of unpaid operator and family labor was measured using an opportunity cost approach rather than actual non-farm cash expenses. Because farm milk price is a primary driver of dairy farm revenue, year effects are important to consider when evaluating financial performance (Wolf et al., 2009). We divide the years into poor, average, and good years based on average farm profitability as measured by ROA.

**Farm Financial Risk and Resiliency.** Farm financial performance is also examined by calculating the deciles for each measure over all farms and years. This allows an examination of what percent of farms are above and below thresholds over the 10 yr examined. These deciles both describe the distribution and assist farm managers in locating their performance for benchmarking. Farm financial risk is also measured by considering what percent of the farms in the data were on the concerning side of industry performance thresholds for each measure annually.

To examine resiliency, we examine annual changes in the financial measures. The intent is to measure the decline in financial situation during poor years and the rebound in good years. The average percentage change
as well as the percent of positive changes are calculated for each year. By comparing the performance across years, the magnitude of expectation is assessed.

**RESULTS AND DISCUSSION**

Table 1 highlights selected measures in each of the 4 areas as well as performance thresholds. As the weak thresholds in Table 1 are approached for the measures, there may be increased challenges in meeting cash commitment needs. The perceived risk of default by lenders may also increase, affecting interest rates and access to capital. Thus, the closer the farm financials are to issues with repayment capacity, solvency, liquidity, or financial efficiency, the more important it is that tools be used to avoid crossing these thresholds. It may be the case that there are opportunities to use milk price risk tools to protect these values. In this way, the financial analysis alerts farm managers that they should allocate time and effort to risk management. For example, it may be increasingly important for farm managers to utilize crop insurance or futures and options to manage risk.

Farm financial measures that are primarily driven by debt and asset values are specific to the farm investment situation, such as EA, and are more appropriately benchmarked to industry standards or against the same farm historic performance. In contrast, measures of cost or financial efficiency such as OER and NFIR are best benchmarked against similar farms over the same period of time to account for industry price effects.

Of key importance for stress testing are the safety thresholds or limits that lenders place on the farm financial measures. These thresholds can change over time and can be adjusted by lenders depending on specifics related to industry and the farm operation (i.e., the 5 C’s discussed earlier). The minimum owner equity (EA) considered safe by many US agricultural lenders is 0.5 (Featherstone et al., 2006). Lenders prefer the CR value to be above 2.0 and become increasingly concerned as the value falls below that threshold, with 1.3 considered a critical level of liquidity risk. Minimum desirable repayment capacity (DCR) is 1.15 from Featherstone et al. (2006). Financial efficiency measures are highly reliant on farm type, production technology, and size. Based on these data, OER values above 0.85 are considered risky. Similarly, a NFIR below 0.05 is considered financially dangerous. Performance thresholds in the table were set based on the historic performance by the New York dairy farms in terms of high and low profits from 2010 through 2019. The performance thresholds generally align with lender safety thresholds in terms of weak compared with stable or strong.

Table 2 displays summary statistics in the form of means or medians for the financial measures across farms for each year. Mean values are reported for ROA, EA, OER, and NFIR. For CR and DCR, median values are reported because the distributions of these variables are highly skewed and quite volatile from year to year. Rate of return on assets without appreciation is expressed as a percent to allow more precise assessment of annual profit performance. Dairy farm financial performance in the United States in recent decades has witnessed boom or bust results largely related to milk price, which drives dairy farm revenues (Wolf et al., 2009, 2014). Because of this pattern, it is important to consider farm financial performance in good and poor profit years. For this research, strong and poor years were defined in terms of average profitability as when, across all farms that year, ROA average diverged from the long-term average of 4.71% by at least 1.50% (Wolf et al., 2020). Using this definition, there were 2 good years, 4 poor years, and 4 average years in the decade considered. Good or above average profitability years included 2011 and 2014. Poor or less profitable years included 2015, 2016, 2017, and 2018. Average profit-

<table>
<thead>
<tr>
<th>Measure</th>
<th>Definition</th>
<th>Safety threshold</th>
<th>Performance threshold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equity-to-asset ratio</td>
<td>Total farm net worth/total farm assets</td>
<td>&lt;0.5</td>
<td>Weak: &lt;0.50 Stable: 0.50–0.70 Strong: &gt;0.7</td>
</tr>
<tr>
<td>Current ratio</td>
<td>Current farm assets/current farm liabilities</td>
<td>&lt;1.0</td>
<td>Weak: &lt;1.5 Stable: 1.5–2.5 Strong: &gt;2.5</td>
</tr>
<tr>
<td>Debt coverage ratio</td>
<td>Capital debt repayment capacity/planned principal and interest payments</td>
<td>&lt;1.15</td>
<td>Weak: &lt;1.3 Stable: 1.3–2.0 Strong: &gt;2.0</td>
</tr>
<tr>
<td>Operating expense ratio</td>
<td>(Total operating expense – interest – depreciation)/gross income</td>
<td>&gt;0.85</td>
<td>Weak: &gt;0.85 Stable: 0.75–0.85 Strong: &lt;0.75</td>
</tr>
<tr>
<td>Net farm income ratio</td>
<td>Net farm income/gross revenue</td>
<td>&lt;0.05</td>
<td>Weak: &lt;0.10 Stable: 0.10–0.15 Strong: &gt;0.15</td>
</tr>
</tbody>
</table>

1Safety thresholds based on lender triggers for loan risk.
2Performance thresholds based on 10-yr distributions, 2010 through 2019, of New York farms from the Cornell University Dairy Farm Business Summary.
3Market valuation of assets used in calculation.
ability years were 2010, 2012, 2013, and 2019. Averaged across these years, the good years averaged ROA of 11.7%, average years 5.4%, and poor years only 0.5%. These categories are used to assess the changes in financial performance measures in strong and poor years as well as examine how many farms cross the respective thresholds. Average annual ROA values are also displayed in Figure 1, which illustrates the variation in systemic profitability over the time period considered as well as the 10-yr average and high and low thresholds.

For EA, CR, and DCR, higher values indicate less financial risk and the mean values are correlated across years. The year 2014 was, on average, the most profitable year during this period by a large margin with an average ROA of 12.68% (Table 2). Similarly, EA peaked at 0.72, while the CR and DCR both peaked at 3.3. 2011 was also a very profitable, solvent, and liquid year for these farms on average. In contrast, 2015 through 2018 were very unprofitable and solvency (EA) and liquidity (CR) declined as well. Debt repayment

![Figure 1. Average rate of return on assets for New York dairy farms from 2010 through 2019.](image)

### Table 2. Summary means or medians by year, New York Dairy Farms

<table>
<thead>
<tr>
<th>Year</th>
<th>ROA (%)</th>
<th>EA ratio</th>
<th>CR ratio</th>
<th>DCR ratio</th>
<th>OER ratio</th>
<th>NFIR ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>6.66</td>
<td>0.65</td>
<td>2.34</td>
<td>2.05</td>
<td>0.76</td>
<td>0.15</td>
</tr>
<tr>
<td>2011</td>
<td>10.73</td>
<td>0.70</td>
<td>2.67</td>
<td>2.59</td>
<td>0.72</td>
<td>0.20</td>
</tr>
<tr>
<td>2012</td>
<td>4.82</td>
<td>0.69</td>
<td>2.58</td>
<td>1.65</td>
<td>0.80</td>
<td>0.11</td>
</tr>
<tr>
<td>2013</td>
<td>6.53</td>
<td>0.70</td>
<td>2.64</td>
<td>1.87</td>
<td>0.77</td>
<td>0.14</td>
</tr>
<tr>
<td>2014</td>
<td>12.68</td>
<td>0.72</td>
<td>3.26</td>
<td>3.34</td>
<td>0.69</td>
<td>0.23</td>
</tr>
<tr>
<td>2015</td>
<td>0.57</td>
<td>0.70</td>
<td>2.82</td>
<td>0.85</td>
<td>0.85</td>
<td>0.04</td>
</tr>
<tr>
<td>2016</td>
<td>0.13</td>
<td>0.68</td>
<td>2.33</td>
<td>0.94</td>
<td>0.85</td>
<td>0.03</td>
</tr>
<tr>
<td>2017</td>
<td>2.20</td>
<td>0.68</td>
<td>2.39</td>
<td>1.29</td>
<td>0.81</td>
<td>0.07</td>
</tr>
<tr>
<td>2018</td>
<td>−0.72</td>
<td>0.65</td>
<td>2.05</td>
<td>0.79</td>
<td>0.87</td>
<td>−0.006</td>
</tr>
<tr>
<td>2019</td>
<td>3.52</td>
<td>0.67</td>
<td>2.48</td>
<td>1.44</td>
<td>0.79</td>
<td>0.09</td>
</tr>
<tr>
<td>All years</td>
<td>4.71</td>
<td>0.68</td>
<td>2.56</td>
<td>1.62</td>
<td>0.79</td>
<td>0.10</td>
</tr>
</tbody>
</table>

1Rate of return on assets (ROA), equity-to-asset ratio (EA), operating expense ratio (OER), and net farm income ratio (NFIR) summarized by mean values. Current ratio (CR) and debt coverage ratio (DCR) summarized by median values.
ratio (DCR) declined sharply from 2014 to 2015 but recovered a bit on average in 2017.

With respect to the financial efficiency measures, lower values indicate better performance for OER while NFIR are the opposite (higher values are better). Similar to the solvency, liquidity, and repayment capacity measures, 2014 was the best year for OER (0.69) and NFIR (0.23) (Table 2). The worst year for OER and NFIR was 2018, which was the fourth consecutive year of poor performance.

Table 3 displays the deciles across these risk measures for 105 New York dairy farms from 2010 through 2019, with each column sorted independently from strongest to weakest. Each of the measures are arranged so that the 90th percentile is the top performance in terms of that measure with respect to financial risk (i.e., the least financial risk).

These distributions span good, bad, and average profit years. The implication is that, for example, NFIR above 0.24 or OER below 0.67 were extraordinary. The deciles reflect long-run performance of the farms and performance will cluster closer to the top deciles in good years and near the bottom in poor years. However, it is useful to consider the long-run performance of these farms relative to the thresholds discussed above. Across these years, the bottom 30 to 40% of observations were in the concern area for liquidity, debt coverage, and financial efficiency. Solvency was less of a concern relative to safety thresholds.

An accurate assessment of the financial risk position involves all aspects of the financial measures discussed. No farms are likely to be in the top deciles of all measures. Individual farm and market situations including recent expansions that increase debt may change ratios for better or worse. These deciles can help locate farm performance, and this chart can be used by noting where a farm’s value was within the range. Being in the lower percentiles across these measures indicates challenges and increased risk related to financial performance. As thresholds are approached in repayment capacity, liquidity, solvency, and earnings, it is increasingly important that financial drivers such as milk and feed price risk be offset. For example, as repayment capacity approaches 1.15—that is, as repayment capacity threatens to be less than $1 available to service $1 in debt—then it is imperative that the likelihood of milk price falling below the threshold necessary to protect repayment capacity be minimized. However, if the business has a strong working capital position or high percent equity, the farm business may have the ability to absorb the impact internally or through the use of borrowed capital and spend less effort utilizing various risk tools. In this way, examining financial risk helps determine whether risk management is needed but, importantly, does not tell a manager what they should do. There are several milk price risk management tools available and the

### Table 3. New York dairy farm financial measure deciles\(^1\) from 2010 through 2019

<table>
<thead>
<tr>
<th>Percentile</th>
<th>ROA(^2) (%)</th>
<th>EA(^2) ratio</th>
<th>CR(^3) ratio</th>
<th>DCR(^3) ratio</th>
<th>OER(^2) ratio</th>
<th>NFIR(^2) ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>90</td>
<td>13.84</td>
<td>0.94</td>
<td>10.74</td>
<td>6.06</td>
<td>0.67</td>
<td>0.24</td>
</tr>
<tr>
<td>80</td>
<td>9.87</td>
<td>0.84</td>
<td>5.77</td>
<td>3.40</td>
<td>0.71</td>
<td>0.20</td>
</tr>
<tr>
<td>70</td>
<td>7.62</td>
<td>0.77</td>
<td>3.96</td>
<td>2.62</td>
<td>0.74</td>
<td>0.17</td>
</tr>
<tr>
<td>60</td>
<td>5.56</td>
<td>0.72</td>
<td>3.14</td>
<td>2.05</td>
<td>0.76</td>
<td>0.14</td>
</tr>
<tr>
<td>50</td>
<td>4.02</td>
<td>0.67</td>
<td>2.56</td>
<td>1.62</td>
<td>0.78</td>
<td>0.11</td>
</tr>
<tr>
<td>40</td>
<td>2.66</td>
<td>0.62</td>
<td>2.13</td>
<td>1.27</td>
<td>0.81</td>
<td>0.08</td>
</tr>
<tr>
<td>30</td>
<td>1.05</td>
<td>0.59</td>
<td>1.77</td>
<td>0.99</td>
<td>0.83</td>
<td>0.05</td>
</tr>
<tr>
<td>20</td>
<td>−0.37</td>
<td>0.55</td>
<td>1.41</td>
<td>0.64</td>
<td>0.86</td>
<td>0.02</td>
</tr>
<tr>
<td>10</td>
<td>−2.70</td>
<td>0.48</td>
<td>1.08</td>
<td>0.13</td>
<td>0.91</td>
<td>−0.03</td>
</tr>
</tbody>
</table>

\(^1\)Business summary of 105 New York dairy farms. Each measure is sorted so that the 90th percentile is the strongest or safest and the 10th percentile is the weakest or most risky. Each decile does not necessarily contain the same farms summarized across the table.

\(^2\)Rate of return on assets (ROA), equity-to-asset ratio (EA), operating expense ratio (OER), and net farm income ratio (NFIR).

\(^3\)Current ratio (CR) and debt coverage ratio (DCR).

### Table 4. Dairy farms at risk relative to safety thresholds by year from 2010 through 2019

<table>
<thead>
<tr>
<th>Year</th>
<th>EA &lt;0.5</th>
<th>CR &lt;1.0</th>
<th>DCR &lt;1.15</th>
<th>OER &gt;0.85</th>
<th>NFIR &lt;0.05</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>21.9</td>
<td>12.4</td>
<td>22.8</td>
<td>11.4</td>
<td>10.5</td>
</tr>
<tr>
<td>2011</td>
<td>10.5</td>
<td>4.8</td>
<td>8.6</td>
<td>1.9</td>
<td>2.9</td>
</tr>
<tr>
<td>2012</td>
<td>12.4</td>
<td>7.6</td>
<td>25.7</td>
<td>22.9</td>
<td>17.1</td>
</tr>
<tr>
<td>2013</td>
<td>6.7</td>
<td>6.7</td>
<td>25.7</td>
<td>15.2</td>
<td>12.4</td>
</tr>
<tr>
<td>2014</td>
<td>2.9</td>
<td>2.9</td>
<td>7.6</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>2015</td>
<td>7.6</td>
<td>5.7</td>
<td>63.8</td>
<td>42.9</td>
<td>52.4</td>
</tr>
<tr>
<td>2016</td>
<td>12.4</td>
<td>7.6</td>
<td>58.1</td>
<td>42.9</td>
<td>48.6</td>
</tr>
<tr>
<td>2017</td>
<td>15.2</td>
<td>11.4</td>
<td>39.0</td>
<td>25.7</td>
<td>34.3</td>
</tr>
<tr>
<td>2018</td>
<td>20.0</td>
<td>12.4</td>
<td>70.5</td>
<td>48.6</td>
<td>68.6</td>
</tr>
<tr>
<td>2019</td>
<td>16.2</td>
<td>7.6</td>
<td>37.1</td>
<td>13.3</td>
<td>23.8</td>
</tr>
</tbody>
</table>

\(^1\)Equity-to-asset ratio (EA), current ratio (CR), debt coverage ratio (DCR), operating expense ratio (OER), and net farm income ratio (NFIR).
preferred option depends on managerial preferences, cost, and market situation.

Table 4 displays the percent of farms below trigger values for each financial measure in each year. This reveals important aspects of financial risk and resiliency. Relative to the 0.5 threshold for EA, which indicates that at least half of the farm business assets are owned, about one-fifth of these operations were below in 2010 and 2018. The 2010 values reflect farms recovering from the financial crisis and resulting recession in 2008 and 2009. The high percentage below that trigger in 2018 was a consequence of 4 consecutive years of financial stress.

A CR value of below 1.0 indicates that the farm has more current liabilities than current assets. The result is that the farm may need to borrow funds or sell productive, longer-term assets to cover this difference if cannot be covered by operations. Using this threshold, more than 10 percent of the operations in this set had serious liquidity problems in 2010, 2017, and 2018, indicating high levels of financial risk (Table 4).

With the DCR threshold at 1.15, the percent of operations in the danger zone varied from 7.6% to more than 70% over the 10 yr examined (Table 4). This measure was very volatile, recovering in good years and declining just as quickly in poor years. The poor dairy farm profit period from 2015 to 2018 resulted in more than half of these operations experiencing stress measured by DCR in each year.

With respect to financial efficiency, when OER was above 0.85, there was concern about cost. The percent of farms above this threshold varied from 1% to 49% (Table 4). Similarly, when NFIR was below 0.05, meaning net farm income was less than 5% of revenues, this is a concerning level. The percent of farms below 0.05 for NFIR ranged from about 1% in 2014 to 68.6% in 2018.

Table 5 displays the change for that year for each measure compared with the previous year on average across farms. These changes reveal magnitudes for financial resiliency. A more resilient operation will see financial reserves (solvency, liquidity, and repayment capacity) decline less than the average operation in relative terms during the poor years (2015, 2016, 2017, 2018) and recover more quickly than the average operations in good years (2011 and 2014). Equity to asset ratio, which was largely determined by long-term asset and equity values including appreciation, was less volatile across years than the liquidity and repayment capacity measures.

The volatility present in the milk and feed prices in recent years has resulted in large amounts of financial risk for US dairy farms (Wolf and Widmar, 2014). Depending on life-cycle effects and specific farm situation, dairy farmers often respond to profit by expanding production through investment in new facilities and cows. The measures discussed here do not inform dairy farm managers which tools should be used or to what extent.
extent. What the financial risk and resilience measures do reveal, however, is which farms have relatively less financial buffer. That is, farms that are nearing important financial thresholds should be paying more attention to avoiding the potential effects of low milk prices and high feed costs among other key risks.

In recent years, the literature on stress tests for banks and other institutions has proliferated in large part because of the financial crisis of 2008. While that crisis originated in the banking sector and resulted in major changes in the structure and regulation of US financial institutions, those events were also very consequential for dairy farms and were part of the volatility that has set the stage for modern dairy farm risk management. Although not identical, similar concepts to bank stress tests can be useful in examining the resiliency to downturns in margins.

To perform stress tests, farm managers should calculate financial measures such as EA and CR. With their farm values, they can then consider how much loss in terms of solvency and liquidity (either through asset value loss or increased debt levels) the business can withstand. This will answer the amount of loss that the farm business can afford before they are viewed as having excessively high levels of financial risk.

Comparing farm solvency and liquidity levels to the key thresholds can be facilitated by calculating how much these financial measures have suffered during poor profit years such as what these dairy farms experienced in 2015 through 2018. The farm manager can then consider how they would respond to these potential losses in terms of determining available credit, annual cash carryover, and asset management (Schwab et al., 1989). Where required capital to cover losses come from? Note that this may involve more debt. As the farm approaches key financial risk thresholds, the use of risk management tools including forward, futures, and options contracts for milk and feed price may be advisable. Additionally, farms can consider available government (i.e., Dairy Margin Coverage Program) and crop insurance products including Dairy Revenue Protection. Evaluating farm financial risk measures relative to safety thresholds reveals whether a farm would benefit from utilizing risk management tools such as crop insurance. However, which tools and to what extent depend on the farm specifics including risk preferences.

As a simple example of how these concepts and measures might be used, consider a dairy farm business that concluded a given year with EA of 0.52. The farm has total farm assets valued at $2 million and total farm debt of $960,000. To remain above a EA threshold of 0.50, assuming that any shortfall would be additional debt and holding asset values constant, this operation could afford to add less than $40,000 to their total farm debt. The data show that New York dairy farms lost EA of more than 2% for 3 of the years in the decade examined. A loss of this magnitude would be sufficient to push the farm solvency position into a range where borrowed capital might become more expensive or difficult to acquire. As such, the farm may want to consider protecting their financial position with available tools and strategies.

**Conclusions**

To measure financial risk and resilience, this research used farm data from 105 New York dairy farms from 2010 through 2019. The data revealed a boom or bust cycle in dairy farm financial performance over the decade considered. Solvency positions were relatively stable being based on long-term asset and liability values. During poor years, the percent of farms below danger thresholds for liquidity and debt repayment capacity spiked. Distributions of the farm financial risk measures over time can assist managers to assess their business performance as well as be a guide to the magnitude of changes that might occur in good or poor years. Stress testing farm financial risk measures relative to safety thresholds reveals whether a farm should be considering or utilizing risk management tools.

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**References**


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