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Financial Ratio Analysis using ARMS Data

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Financial Ratio Analysis using ARMS Data

Abstract

Purpose – The purpose of this research is to evaluate the financial performance measures calculated and reported by Economic Resource Service (ERS) from ARMS data. The evaluation includes the calculation method and the underlying assumptions used in obtaining the reported values. Recommendations for improving the information reported are proposed to ERS.

Methodology/approach – The financial measures calculated and reported are compared with those recommended by the Farm Financial Standards Council (FFSC). The underlying assumptions are identified by analyzing the software code used in calculating the values reported. The values reported by ERS are duplicated and alternative methods for calculating the financial performance measures are considered. The values obtained from the various calculation methods are compared and contrasted.

Findings – Recommendations for ERS include: 1) calculate and report the financial measures recommended by FFSC, 2) note values that are imputed, 3) periodically update and validate assumptions used in calculating imputed values, 4) review its policy for flagging estimates as statistically unreliable, 5) report medians, and 6) consider reporting the percent of farm businesses that have values within critical zones.

Originality/value – Four methods for calculating financial performance measures are compared and contrasted. These are the aggregate mean, sample mean, sample median, and percent of farm businesses with values in critical zones.

Keywords – Financial ratio, performance measure, farm business, imputation, ARMS.

QEL codes – Q14.

Financial Ratio Analysis using ARMS Data

The Agricultural Resource Management Survey (ARMS) dataset is the most comprehensive dataset available on U.S. farm operators, households, and businesses. ARMS is conducted annually and is jointly sponsored by the USDA's National Agricultural Statistics Service (NASS) and Economic Research Service (ERS). ARMS provides detailed financial statement information that may be used to construct financial performance measures of the farm business. It is important to have these financial performance measures to assess and analyze the financial standing and progress of the business. In particular, these financial performance measures are characterized by liquidity, solvency, profitability, repayment capacity, and financial efficiency (Barry and Ellinger, 2012). Although absolute measures of these financial characteristics are useful in analyzing business performance over time, ratios are more appropriate in comparing one business relative to others since absolute measures are likely to differ by business size. Ratios, in addition to assisting farm managers to measure business performance, are used by lenders to evaluate loan applications and to monitor loan performance. For example, lenders assign loans to various loan classifications based on values of farm business financial ratios that are within certain critical zones (Kohl and Wilson, 1997).

Estimates of financial ratios from ARMS data are calculated and reported by ERS. However, the ratios are not necessarily the same as those recommended by the Farm Financial Standards Council (FFSC) and, in some instances, the ratio definitions differ. Moreover, the method used by ERS in calculating the ratios is different from the method normally expected.

First we identify several recent studies that have used ARMS data and financial ratios to analyze financial performance. Then we explore the similarities and differences in the financial ratios recommended by FFSC and reported by ERS. Next we investigate the method ERS uses to calculate the ratios, including several underlying assumptions that are made. Then we use three alternate methods to calculate the ratios and compare the results.

Recent Studies

A number of recent studies have relied on ARMS data to analyze farm financial performance. Ahrendsen *et al.* (2007) used ARMS data at the farm business level to test if there are significant differences in the financial characteristics, as measured by balance sheet, income statement and

financial ratio values, among groups of U.S. farmers that are likely eligible to receive USDA Farm Service Agency (FSA) direct farm loans. They found beginning farmers had weaker financial characteristics than non-beginning farmers. However, the same result was not found when they compared socially disadvantaged farmers with non-socially disadvantaged farmers, since there were few significant differences in financial characteristics and any differences that were found were mixed. They concluded FSA direct farm loan borrowers had weaker financial characteristics than eligible, non-FSA direct farm loan borrowers, implying FSA was meeting its objective to serve farm businesses likely to be denied credit by commercial creditors.

Chavez *et al.* (2009) analyzed the mean financial characteristics of 18 different types of U.S. crop and livestock farms sampled in the 2005 ARMS. They found significant, two-way statistical differences in mean current ratio, debt-to-asset ratio, operating expense ratio, and asset turnover ratio between various pairs of farm types. Their results provide a general indication of the comparative liquidity, solvency, profitability, and financial efficiency of different types of U.S. crop and livestock farms.

Kropp and Katchova (2011) examined the effect of direct payments on the liquidity and repayment capacity of beginning farmers relative to established farmers. Their results indicated direct payments have the potential to impact the liquidity and repayment capacity of payment recipients, particularly for experienced farmers. They suggest direct payments have the potential to alter farm business access to credit and may alter current production decisions.

Other recent studies have relied on ARMS data to analyze farm financial performance criteria as measured by financial ratios. The criteria have included solvency (debt-to-asset ratio) and/or profitability (net farm income, rate of return on assets) (D'Antoni *et al.*, 2009; Adhikari *et al.*, 2009; and Mishra *et al.*, 2009). Katchova (2010) used 2005-2008 ARMS data to estimate the likelihood of farm businesses experiencing financial stress. She considers farm businesses to have financial stress if measures of liquidity (current ratio), solvency (debt-to-asset ratio), profitability (rate of return on assets and operating profit margin ratio), repayment capacity (term debt coverage ratio), or efficiency (operating expense ratio) are in their respective critical zones.

Defining Farm Financial Ratios

This section outlines the farm financial ratios that are recommended by FFSC and the ratios that are calculated and reported by the USDA-ERS. We explore the similarities and differences in

these financial ratios, in terms of which financial ratios are calculated and in terms of the formula definitions used to calculate these financial ratios.

The FFSC is a non-profit organization consisting of professionals representing various groups and experts involved with agricultural production and finance. FFSC provides a national forum for developing standards and implementing guidelines that promote uniformity and integrity in financial analysis and reporting for agricultural producers. FFSC has published two reports: Financial Guidelines for Agricultural Producers and Management Accounting Guidelines for Agricultural Producers. The Financial Guidelines have included 16 financial ratios for nearly 20 years. In 2010, five additional ratios were included in the Guidelines. The current set of 21 financial ratios (FFSC, 2011), called “Legal 21,” is intended to measure financial viability of farm and ranch operations in a uniform and standardized way in the agricultural sector.

Financial ratios represent five financial characteristics: liquidity, solvency, profitability, repayment capacity and financial efficiency that are associated with the financial performance of farm businesses. FFSC provides definitions for each of these financial characteristics. Liquidity is the farm business’ ability to meet financial obligations as they become due. Solvency is the farm’s ability to pay all its debt if the farm were to be sold and all assets used to cover debt. Profitability is the difference between the value of goods produced and the cost of the resources used in their production. Repayment capacity is the borrower’s ability to repay term debt on time. Financial efficiency shows how effectively the farm business uses assets to generate income. These five broad categories are intended to be used jointly to explain the financial performance and viability of farm businesses.

Each of the five financial characteristics is represented by several specific financial ratios that measure the particular type of financial performance. Table 1 presents the FFSC recommendations for financial ratios as well as the ERS-calculated financial ratios using the ARMS data. Several financial ratios that ERS calculates are the same as the ratios suggested by the FFSC: current ratio, debt-to-asset ratio, rate of return on assets, rate of return on equity, operating profit margin, term debt coverage ratio, asset turnover ratio, and operating expense ratio. Some financial ratios and indicators measured in absolute levels are recommended by the FFSC but currently are not calculated and reported by ERS: working capital, working capital-to-gross revenues ratio, equity-to-asset ratio, debt-to-equity ratio, EBITDA, capital debt repayment

capacity and margin, replacement margin, replacement margin coverage ratio, depreciation expense ratio, interest expense ratio, and net farm income ratio. Finally, some financial ratios are reported only by ERS: working capital-to-expense ratio, debt repayment capacity utilization, and economic cost-to-output ratio.

We recommend that ERS explores ways of creating a higher consistency of reported financial ratios and indicators with the FFSC recommendations. We recommend that ERS add the financial ratios and indicators recommended by the FFSC to the list of values calculated and reported.

Table 2 provides more detailed definitions about how financial ratios are calculated by the FFSC and USDA-ERS. Overall, there is a significant consistency in the financial ratio definitions between FFSC and USDA but there are several exceptions. FFSC defines the denominator for the rate of return on assets as the average of the total assets from the previous and current year. However, USDA uses the total assets in the current end-of-year as a denominator because it is a cross-sectional survey which only includes a limited amount of financial statement information from the previous year. The same arguments apply for the rate of return on equity with a denominator of average equity versus equity and the asset turnover ratio with a denominator of average total assets versus total assets. Since USDA does not collect detailed information on previous year financial statements, we believe it is acceptable to use the current year assets or equity instead of the average values over the current and previous year. We also notice that farm debt repayment capacity is calculated differently, where FFSC subtracts family living expenses and income taxes but the USDA does not. The different formulas result in higher debt repayment capacity measured by the USDA-calculated ratios.

Calculating Farm Financial Ratios

Farm financial ratios are calculated and reported by USDA-ERS staff. We have examined the 2009 Farm Business Summary Program developed by Banker *et al.* (2010) from USDA-ERS. The SAS program aggregates and calculates summary variables based on the ARMS raw data. We have only examined relevant information for calculating financial ratios but have not examined in detail how financial statement (balance sheet and income statement) items are calculated.

The Farm Business Summary Program shows how to aggregate and calculate financial

ratios and the results are reported in the ARMS webtool (USDA-ERS, 2011). The webtool reports summary values for 10 financial ratios: current ratio, working capital-to-expense ratio, debt-to-asset ratio, rate of return on assets, rate of return on equity, operating profit margin ratio, term debt coverage ratio, asset turnover ratio, operating expense ratio, and economic cost-to-output ratio.

The formulas for calculating these ratios were discussed in the previous section. Here we examine some of the assumptions used in calculating these ratios. When working with financial ratios, one of the major issues is that for some observations, the ratios are undefined (if the denominator is zero) or quite large in value because of small values for the denominator. This presents a problem if a researcher needs to use individual financial ratios calculated for each farm business.

Some financial ratios are imputed by ERS if they cannot be calculated. For example, the debt-to-asset ratio is replaced by 1.1 in case of zero total assets but positive amount of total debt. In this case the value of 1.1 is used in assigning the farm business to the category of insolvent farm businesses with debt-to-asset ratios exceeding one. When values are imputed, we recommend that they are flagged in the data set so that researchers are aware of the imputation.

Several financial ratios are based on financial terms that need to be estimated because such questions are not directly asked on the ARMS questionnaire. For example, principal payments on loans are estimated as 0.2455 times the non-current non-real estate liabilities plus 0.076 times the non-current real estate liabilities. These values are likely based on assumptions and prior estimations about the current versus non-current proportion of liabilities. We recommend that there is a process for periodic validating and updating of these assumptions.

The USDA-ERS uses the following method for calculating financial ratios which are reported on the ARMS webtool. Each financial ratio is calculated as the weighted sum of the numerators for all farm businesses divided by the weighted sum of the denominators for all farm businesses, which we refer to as “the aggregate mean” for each financial ratio. (USDA assigns weights to farms depending on the number of farms that each farm represents.) For example, the current ratio reported in the ARMS webtool is calculated as the sum of current assets for all farm businesses divided by the sum of current liabilities for all farm businesses. Financial ratios calculated using this method can be interpreted as farm operator “group-level” financial ratios, where the group is represented by all farm operators covered by ARMS, i.e., in the contiguous 48

states, and does not include landlords and others. This method of calculating financial ratios produces drastically different results when compared to using the average of the financial ratios for each farm, as we will discuss in the next section. We assume that ERS uses this method for calculating ratios because of outliers and unidentified financial ratios for individual farm businesses.

The ARMS webtool also reports the relative standard error (RSE) for each estimate. The RSE is calculated as the standard error of the estimate expressed as a percent of the estimate. Estimates with large RSE are flagged as statistically unreliable due to a combination of a low sample size and high sampling error. In the case of financial ratios, an estimate can be close to zero (especially for the profitability ratios), which leads to a high RSE. Therefore, in these legitimate cases where the estimate is close to zero, it is misleading to flag such financial ratio estimates as unreliable because they are neither due to low sample size nor high sampling error. We recommend that USDA-ERS review its policies for flagging estimates as unreliable when they are legitimately close to zero.

U.S. Farm Business Financial Ratios

As we have seen there is a variety of ways to define and measure farm business financial characteristics of liquidity, solvency, profitability, repayment capacity, and financial efficiency. Even after financial ratios are defined, a variety of methods may be used to calculate the financial ratios as indicators of farm business financial characteristics. In this section we compare several different methods to calculate each of the 10 financial ratios reported in the USDA-ERS webtool.

The different methods we compare are the aggregate mean reported by USDA-ERS, the sample mean, and the sample median (Table 3). The values obtained by the different methods differ tremendously. For example, the aggregate mean for the current ratio is 3.15, whereas the mean and median are 61.42 and 4.30. While the aggregate mean may be a good measure of group-level farm business liquidity, it understates farm business liquidity at the individual farm level. More than half of farm businesses have a current ratio greater than the aggregate mean of 3.15. However, using current ratio at the farm-level as a measure of liquidity is problematic since the values are highly skewed to the right. This occurs even though farm businesses reporting zero current liabilities are excluded from the mean and median calculations since their current ratios

are undefined, whereas these same farm businesses are included when calculating the aggregate mean current ratio. Another ratio used as an indicator of liquidity that is far less likely to have a denominator with a value of zero is the working capital-to-expense ratio. Yet, it appears this ratio still has the problem of relatively small values for the denominator since the mean of the working capital-to-expense ratio is 223%. This far exceeds 56% and 29% for the aggregate mean and median. Unlike when the current ratio is used to measure liquidity, less than half of farm businesses have as much liquidity as the group when the working capital-to-expense ratio is used.

The relative solvency of farm businesses at the group-level and farm-level as measured by the debt-to-asset ratio is similar since the aggregate mean (9%) and sample mean (8%) are nearly the same value. However, simply using these measures greatly understate the relative solvency of farm businesses since the debt to asset ratio is highly skewed to the right with more than 75 percent of farm businesses having debt to asset ratios less than the aggregate mean and mean.

The USDA-ERS webtool reports three ratios that may be used to indicate farm business profitability: rate of return on assets, rate of return on equity and operating profit margin. Again the values for these measures vary tremendously depending on the method used in calculating them. Using the aggregate mean greatly overstates the profitability of most farm businesses since the sample median (and sample mean) is less than the aggregate mean for all three measures of profitability.

The term debt coverage ratio may be used as an indicator of debt repayment capacity. An aggregate mean of 3.82 indicates that farm businesses at the group-level have nearly four times as much income available to service term debt as is required. However, the sample median of 0.85 indicates more than half of farm businesses do not have enough income available to service term debt, which leads to quite a different conclusion regarding repayment capacity that should be investigated further.

Three ratios reported by the USDA-ERS webtool may be used as indicators of financial efficiency. As is the case for profitability, financial efficiency at the group-level appears to be better than at the farm-level. The aggregate mean indicates greater efficiency at utilizing assets to generate farm production value (higher asset turnover ratio), controlling operating expenses in creating gross cash farm income (lower operating expense ratio) and economically producing gross farm income (lower economic cost-to-output ratio) than does the sample median.

Kohl and Wilson (1997) argued that whether or not a farm business is in the critical zone for financial ratios is more indicative of difficulties than using the absolute value for each financial ratio and have specified cut-off values for the critical zones. Katchova (2010) used this approach in analyzing the characteristics of U.S. farm businesses with financial ratios falling into critical zones. A report including the percentages of farm businesses in critical zones for liquidity, solvency, profitability, repayment capacity, and financial efficiency may serve as a better indicator of potential farm business difficulties than a report including aggregate means, means, and medians (Table 3). Farm businesses with current ratios less than one are usually considered to be relatively illiquid, thus defining a critical zone for liquidity. For 2009, nearly 30% of farm businesses reporting at least some amount of current liabilities are considered to be illiquid. Farm businesses with debt-to-asset ratios greater than 55% may be considered to be in a critical zone for financial risk (high leverage or relatively low solvency). However, less than four percent of farm businesses reporting positive asset values have critical debt-to-asset ratios. Farm businesses with a rate of return on assets less than 1% or an operating profit margin less than 10% may be considered to have critically low profitability. The majority of farm businesses have critically low profitability with 75% and 71% of farm businesses falling below the critical thresholds for rate of return on assets and operating profit margin. Over half (55%) of farm businesses may be considered to have critically low repayment capacity since they have a term debt coverage ratio less than 1.1. These farm businesses are estimated to have either inadequate funds available to service term debt or less than 10 percent of a cushion in funds available to service term debt. Finally, 65% of farm businesses are considered to be at critically low levels of efficiency in controlling operating expenses relative to generating gross cash farm income.

A report on the percentage of farms in a critical zone does not suffer from the problem of extreme ratio values for sample means. Also, the use of critical zones would allow the inclusion of farm businesses with undefined ratio values as long as certain assumptions are made, e.g., farm businesses with positive current assets and zero current liabilities are assumed to have large current ratios, i.e., are liquid.

Summary and Recommendations

The ERS calculates and reports farm business financial ratios based on ARMS data. The ratios are valuable in understanding financial performance at the group-level for farm operators. The

method used in calculating the ratios does not suffer from the problems of undefined, outlier, or extreme value ratios that frequently occur when ratios are calculated at the individual farm level. However, when doing farm-level financial performance analysis, it is important to calculate ratios at the farm level.

In summary, our recommendations for ERS are:

- Compute and report the financial ratios and indicators recommended by the FFSC, i.e., the legal 21.
- Formulas used for computing the values should be consistent with those recommended by FFSC to the extent possible. We realize this may not be possible in all instances, e.g., using end-of-year assets instead of average of beginning-of-year and end-of-year assets.
- When values are imputed they should be flagged in the dataset so that researchers are aware of the imputation.
- If values are imputed based on assumptions and prior estimates, e.g., current versus non-current portions of liabilities, these assumptions and estimates should be periodically validated and updated.
- Review its policies for flagging estimates as statistically unreliable. Consider only reporting values as statistically unreliable if they have a small sample size. A large relative standard error (RSE) does not necessarily imply an unreliable estimate if the estimate is close to zero. Consider reporting the standard error in addition to RSE.
- Consider reporting medians and a few selected percentiles in addition to aggregate means.
- Consider reporting the percent of farm businesses that have values within critical zones.

We realize some of these recommendations may take time to implement and may need to be adjusted over time, such as reporting the percent of farm businesses in critical zones and determining the appropriate critical zones. However, other recommendations, such as flagging imputed values, may be implemented quickly and relatively easily.

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Table 1. FFSC financial ratio recommendations and ARMS webtool reports

Financial Characteristic	FFSC	ARMS
<i>Liquidity</i>	Current ratio	Current ratio
	Working capital	
	Working capital-to-gross revenues	Working capital-to-expense ratio
<i>Solvency</i>	Farm debt-to-asset ratio	Debt-to-asset ratio
	Farm equity-to-asset ratio	
	Farm debt-to-equity ratio	
<i>Profitability</i>	Net farm income	
	Rate of return on farm assets	Rate of return on assets
	Rate of return on farm equity	Rate of return on equity
	Operating profit margin	Operating profit margin
	Earnings before interest, taxes, depreciation, and amortization (EBITDA)	
<i>Repayment Capacity</i>	Capital debt repayment capacity	
	Capital debt repayment margin	
	Replacement margin	
	Term-debt coverage ratio	Term debt coverage ratio
	Replacement margin coverage ratio	
<i>Financial Efficiency</i>		Debt repayment capacity utilization
	Asset turnover rate	Asset turnover ratio
	Operating expense ratio	Operating expense ratio
	Depreciation expense ratio	
	Interest expense ratio	
	Net farm income ratio	Economic cost-to-output ratio

Table 2. FFSC and ARMS webtool report financial ratio definitions

Financial Characteristic	FFSC	ARMS
<i>Liquidity</i>		
Current ratio	Total current farm assets /Total current farm liabilities	Same
Working capital	Total current farm assets - Total current farm liabilities	Not reported
Working capital-to-gross revenues	Working capital /Gross farm income	Not reported
Working capital-to-expense	Not recommended	Working capital /Total cash expenses
<i>Solvency</i>		
Debt-to-asset ratio	Total farm liabilities /Total farm assets	Total farm debt /Total farm assets
Equity-to-asset ratio	Total farm net worth /Total farm assets	Not reported
Debt-to-equity ratio	Total farm liabilities /Total farm equity	Not reported
<i>Profitability</i>		
Net farm income	Gross cash farm income -Total cash farm expenses +/-Inventory changes -Depreciation	Not reported
Rate of return on assets	Net farm income +Farm interest -Value of operator labor & mgt =Return on farm assets /Average farm assets	(Net farm income +Interest expenses -Estimated charges for operator labor and management) /Total assets
Rate of return on equity	Net farm income -Value of operator labor & mgt = Return on farm equity /Average farm net worth	(Net farm income -Estimated charges for operator labor and management) /Net worth
Operating profit margin	Return on farm assets /Value of farm production Where Value of farm production = Gross cash farm income +/- Inventory changes -Feeder livestock purchased -Purchased feed	Net farm income /Value of farm production
Earnings before interest, taxes depreciation, and amortization (EBITDA)	Net farm income +Interest expense +Depreciation & amortization	Not reported

Continued on next page.

<i>Repayment Capacity</i>		
Capital debt repayment capacity	Net farm income + Depreciation + Net non-farm income - Family living & income taxes + Interest expense on term loans	Net farm income + Depreciation + Net non-farm income + Interest expense on term loans
Capital debt repayment margin	Capital debt repayment capacity - Scheduled principal & interest on term loans ^a	
Replacement margin	Capital debt repayment capacity - Unfunded (Cash) capital replacement allowance	
Term-debt coverage ratio	Capital debt repayment capacity / Scheduled principal and interest on term loans ^a	Capital debt repayment capacity / Scheduled principal and interest on term loans
Replacement margin coverage ratio	Capital debt repayment capacity / (Scheduled principal and interest on term loans ^a + Unfunded capital replacement allowance)	
Debt repayment capacity utilization		Total farm debt / Income for debt coverage
<i>Financial Efficiency</i>		
Asset turnover ratio	Value of farm production / Average farm assets	Farm production value / Total farm assets
Operating expense ratio	Total farm operating expenses excluding interest & depreciation / Gross farm income	Cash operating expenses / Gross cash farm income
Depreciation expense ratio	Depreciation / Gross farm income	
Interest expense ratio	Farm interest / Gross farm income	
Net farm income ratio	Net farm income / Gross farm income	
Economic cost-to-output ratio	Not recommended	(Total cash costs + Depreciation + Imputed return to management and unpaid labor) / Gross farm income

^a Includes payments on capital leases

Table 3. Farm business financial ratio means, quartiles, and critical zones using 2009 ARMS data

Ratio	Aggregate		25th		75th		Critical zone value	Percent farms in critical zone
	Mean ^a	Mean ^b	Median ^b	percentile ^b	percentile ^b			
Current ratio	3.15	61.42	4.30	0.64	24.43	< 1		29.6%
Working capital-to-expense ratio (%)	56.85	222.92	28.57	-2.88	110.78	d	d	
Debt-to-asset ratio (%)	8.79	8.33	0.21	0.07	5.84	> 55		3.5%
Rate of return on assets (%)	0.09 ^c	-8.21	-2.07	-7.31	0.92	< 1%		75.4%
Rate of return on equity (%)	-0.52	-8.44	-2.58	-8.94	0.72	d	d	
Operating profit margin (%)	0.65 ^c	-226.11	-35.53	-153.12	19.09	< 10%		71.0%
Term debt coverage ratio	3.82	68.05	0.85	-0.08	3.29	< 1.1		54.8%
Asset turnover ratio	0.14	0.21	0.05	0.02	0.10	d	d	
Operating expense ratio (%)	81.64	509.73	109.79	64.54	249.76	> 80%		65.2%
Economic cost to output ratio (%)	112.87	-290.27	254.83	119.10	716.91	d	d	

^a The aggregate mean for each ratio is calculated as the weighted sum of the numerators for all farms, divided by the weighted sum of the denominators for all farms. These numbers can be interpreted as sector-level financial ratios, where the sector is comprised of all farm businesses. These numbers are reported on the USDA-ERS (2011) webtool.

^b The mean for each ratio is calculated as the weighted mean of the ratios for all farms. The quartiles are calculated in a similar way. These numbers can be interpreted as farm-level financial ratios.

^c USDA-ERS reports the estimate is statistically unreliable due to the combination of a low sample size and high sampling error. USDA-ERS reports the Relative Standard Error (RSE), which is the standard error of the estimate expressed as a percent of the estimate. Moreover, “The larger the RSE is, less precise the estimate.”

^d Critical zone is not available for the ratio.