FINANCIAL RATIOS AS INDICATORS OF ECONOMIC SUSTAINABILITY: SYNERGIES AND TRADE-OFFS FOR SWISS DAIRY FARMS

Subtheme: Knowledge & Information

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Abstract

The presented analysis of synergies and trade-offs between indicators of economic sustainability used a large sample of panel data of Swiss dairy farms ranging from the years 2003 to 2014. Using these data, six common financial ratios are used to calculate economic indicators representing profitability, liquidity and stability. The correlation analysis shows a strong positive correlation (i.e. synergy) between the two financial ratios for profitability. Between the financial ratios for liquidity and stability, synergies and trade-offs exist to various extents. The financial ratios are then normalized and harmonized to get an overall coherent picture and to construct an aggregate indicator of economic performance. The results are a promising starting point for analysing additional factors that should be considered in quantitative sustainability assessments.

Keywords: *sustainability, indicator, financial ratio, farm management, assessment criteria*

1 Introduction

Sustainability assessments of farms are of growing concern in agricultural sciences (Buckwell et al. 2014), and a rising number of sustainability measurements are available comprising environmental, social and economic indicators (Breitschuh et al. 2008, Schultheiß et al. 2008). In sustainability assessments, the economic dimension is typically depicted by financial ratios dealing with profitability, liquidity and stability (Breitschuh et al. 2008, Latruffe et al. 2016, Grenz 2017). These three items are used as economic indicators and either presented individually or combined towards an aggregate. For the latter, the single ratios or indicators are typically weighted and summed up. Partially, also other indicators representing for example productivity, autonomy and resilience are used to describe economic sustainability (Lebacq et al. 2013, Diazabakana et al. 2014).

The financial ratios representing profitability, liquidity and stability are not exclusively used for the assessment of sustainability. They are also applied in the analysis of accountancies (e.g. Wheeling 2008, Mußhoff and Hirschauer 2011). In addition, in Switzerland they play a key role in the assessment of investment projects.

For an integrated assessment of the economic sustainability of farms, the relation between the economic indicators is of interest, in particular with regard to trade-offs and synergies. For example, van der Veen and Venugopal (2014) analysed the synergy or trade-off between the social and environmental performance of an organization and its profitability, and Annim (2012) analysed whether there is a trade-off between social and financial performance in microfinance institutions. A synergy, i.e. a positive correlation between indicators, would enable us to focus on a few or even one single indicator. Conversely, trade-offs between economic indicators require an indicator framework which allows compensating low scores for one indicator with high scores for another.

The aim of this paper is threefold. Based on a literature review, we select in a first step financial ratios to measure economic sustainability. Secondly, we analyse the relationships, i.e. synergies and trade-offs, between these financial ratios empirically for Swiss dairy farms using data from the Farm Accountancy Data Network (FADN). Finally, we aggregate the financial ratios into a single performance indicator.

The paper is organized as follows. Section 2 describes the method of selecting the economic indicators, the data used and the statistical analysis. Section 3 presents the results, sections 4 the discussion and 5 the conclusions.

2 Methods

2.1 Selection of financial ratios

In a review of sustainability assessments, Buckwell et al. (2014) identify 95 indicators of economic sustainability. In view of a broad practical application of economic sustainability indicators, Zorn et al. (2017) carry out a literature review (Breitschuh et al. 2008, Latruffe et al. 2016, Grenz 2017) and contact experts. Their goal is to reduce the number of indicators to a minimum while keeping all relevant aspects of economic sustainability. Furthermore, focusing on Swiss agriculture, they consider currently applied (and thus readily available) financial ratios (Obi et al. 2011, Schweizerischer Bundesrat 2013). As a result, Zorn et al. (2017) propose six financial ratios in a context of farm accounting data; the resulting three indicators represent profitability, liquidity and stability, consist of two financial ratios each and build together the basis for assessing the economic sustainability of farms (Figure 1).

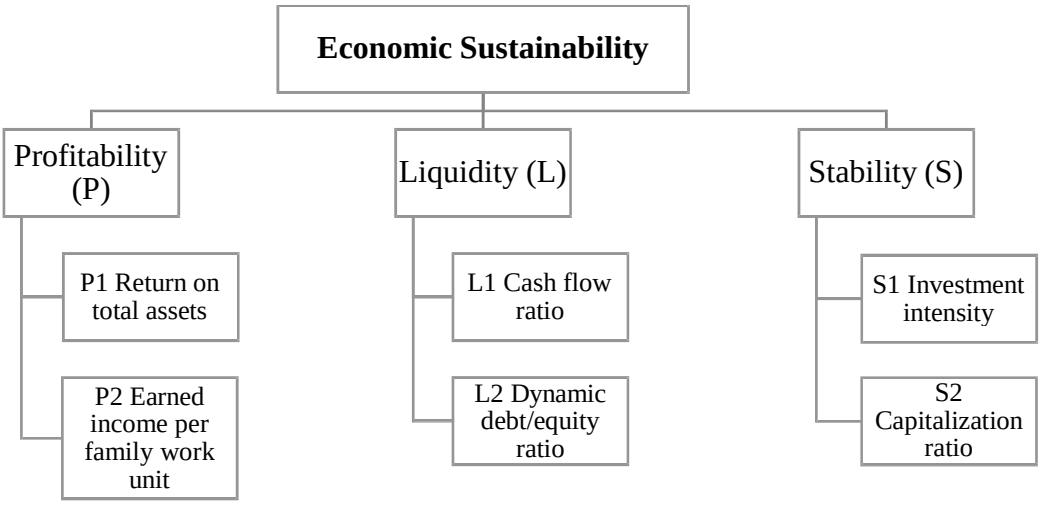

Figure 1: Framework of economic sustainability indicators

2.2 Description of the six financial ratios

In the following, we describe the six financial ratios suggested as economic indicators by Zorn et al. (2017).

Profitability

Profitability commonly deals with return on assets: Aupperle et al. (1985), studying the relationship between corporate social responsibility and profitability, use return on assets as profitability indicator. So do Narver and Slater (1990), examining the effect of market orientation on business profitability. In Swiss agriculture, **return on (total) assets** (P1) is used as a financial ratio to characterize profitability. Initially, to compute P1, net income is calculated by summing the debt interest, the other financial income (or subtracting the financial expenses), the interest claim and the profit (or subtracting the loss) (Equation 1):

$$\begin{aligned} net income = {} & + debt interest \\ & + (-)\, other financial income\ (expenses) \\ & + interest claim \\ & + (-)\, profit\ (loss) \end{aligned} \qquad (1)$$

The profit (or the loss) is calculated by deducting the external costs, the interest claim of equity and the wage entitlement of family workforce from the total output (Equation 2). For wage entitlement of family workforce, the regional comparable income is used as opportunity cost (Agroscope 2004-2015):

$$\begin{aligned} profit\,(loss) = &+ total\,output \\ &- external\,costs \\ &- interest\,claim\,of\,equity \\ &- wage\,entitlement\,of\,family\,workforce\,(opportunity\,cost\,of\,the\,region) \end{aligned}$$

(2)

P1 is then calculated by dividing the net income by the assets of the farm (Equation 3):

$$P1 = \frac{net\,income}{farm\ assets}$$

(3)

Under current interest rates, the remuneration of own work is more important (around 15 times) than own capital (Lips and Gazzarin 2016). Therefore, **annual income per family work unit** (FWU; P2) is also an appropriate financial ratio which describes profitability. Income per FWU is derived from the agricultural income covering the remuneration of family own labour and capital. To determine the opportunity cost of own capital, it is charged with the interest rate of federal bonds. Deducting remuneration of own capital yields the earned income of all FWUs. The latter is subsequently divided by the number of FWUs. Therefore, the family earned income per FWU (P2; Equation 4) is:

$$P2 = \frac{earned\ income\ of\ all\ FWUs\ (in\ CHF)}{number\,of\,FWUs} = \frac{agricultural\,income - return\,on\,equity}{number\,of\,FWUs}$$

(4)

Liquidity

On the basis of the analyses of Breitschuh et al. (2008), Latruffe et al. (2016) and Grenz (2017), liquidity is represented by the **cash flow ratio** (L1) and the **dynamic debt/equity ratio** (L2). The cash flow is calculated as follows: the sum of the harmonized outcome from

agriculture (adjusted for the occupation of the spouse and for the provision after retirement) and the depreciations results in the agricultural cash flow (Equation 5); to the latter is added the additional income of the farm and from it is subtracted the private expenditure in order to obtain the business and private cash flow (Equation 6):

$$\begin{aligned} agricultural\ cash\ flow = {} & + harmonized\ outcome\ from\ agriculture \\ & + depreciations \end{aligned} \tag{5}$$

$$\begin{aligned} business\ and\ private\ cash\ flow = {} & + agricultural\ cash\ flow \\ & + additional\ income \\ & - private\ expenditure \end{aligned} \tag{6}$$

To compute the cash flow ratio (L1), we divide the business and private cash flow by the turnover (operating profit) of the farm (Equation 7):

$$L1 = \frac{business\ and\ private\ cash\ flow}{operating\ \ profit} \tag{7}$$

The dynamic debt/equity ratio (L2) describes the necessary number of years to repay the debt capital by means of the cash flow. To compute L2, we first calculate net liabilities by deducting the liquid assets and receivables from borrowed capital (Equation 8):

$$\begin{aligned} net\ liabilities = {} & + borrowed\ capital \\ & - (liquid\ assets + receivables) \end{aligned} \tag{8}$$

Subsequently, we divide the net liabilities by the business and private cash flow in order to obtain the dynamic debt/equity ratio (L2; Equation 9):

$$L2 = \frac{net\ liabilities}{business\ and\ private\ cash\ flow} \quad (9)$$

Stability

Following Breitschuh et al. (2008), Latruffe et al. (2016) and Grenz (2017), stability is captured by the **investment intensity** (S1) and the **capitalization ratio** (S2). For S1, we divide the fixed assets including machinery and buildings but not livestock by the total assets (Equation 10). The ratio shows the share of assets which is bound for a medium or long term.

$$S1 = \frac{fixed\ assets}{total assets} \quad (10)$$

The capitalization ratio (S2) represents the relation of own capital and the fixed assets (Equation 11). S2 refers to the golden rule for balance sheets, i.e. to cover long-term assets by long-term credits or own capital.

$$S2 = \frac{own\ capital}{fixed\ assets} \quad (11)$$

2.3 Empirical analysis

For the empirical analysis, all six financial ratios are depicted for the most common farm type in Switzerland, i.e. dairy farming. The analysis is based on accountancy panel data (from the Swiss Farm Accountancy Data Network) of Swiss dairy farms from the years 2003 to 2014 (Agroscope 2004-2015). The sample consists of 14,058 observations from 2,404 farms. Farms remain on average six years in the sample. The financial ratios are calculated for each year in which the farm is represented in the database. The dairy farms are located in three regions: plain, hill and mountain.

The empirical analysis includes three steps: descriptive statistics, correlation analysis and the calculation of an aggregate performance indicator. Because the financial ratios are not

normally distributed, the correlation analysis to investigate whether there are synergies or trade-offs is based on the non-parametric Spearman's rank correlation coefficient.

Aggregate performance indicator

For the aggregate performance indicator, all six financial ratios are aggregated into a single performance indicator *Y* by taking the mean values of a farm in a year. *Y* approximates the economic sustainability and allows us to explore how the economically sustainable farms are financially structured and how these structural attributes affect performance. In accordance with sustainability assessment (e.g. Breitschuh et al. 2008, Grenz 2017), we weight the three economic indicators equally (Equation 12):

$$Y = \frac{1}{3} Profitability + \frac{1}{3} Liquidity + \frac{1}{3} Stability \quad (12)$$

Giving all six financial ratios the same weight, *Y* can be formulated as follows (Equation 13):

$$Y = \frac{P1 + P2 + L1 + L2 + S1 + S2}{6} \quad (13)$$

Considering the different value ranges of the six financial ratios, we apply a score so that all of the financial ratios are in a range between 0 and 100. Due to the extreme values of the outliers, score 0 is assigned to all the values of the 1st percentile and below, and score 100 is assigned to the values of the 99th percentile and above. This normalization is realized in a proportional way. Dynamic debt/equity ratio (L2) and investment intensity (S1) indicate a better performance when they have smaller values. Consequently, to have an ascending progression of all six financial ratios, L2 and S1 are inverted by subtracting the calculated percentile from 100[5].

The aggregate performance indicator *Y* is calculated for each farm and every year, and in a subsequent step, the mean value over all years of observation is built. In addition, we distinguish four performance groups, each consisting of 25% of the total sample according to the mean overall score, which is generated by the mean of the score of the six financial ratios. Afterwards, we divide the sample by four groups containing the same number of dairy farms

[5] For example, the inversion of the value 0 results in the value 100 (100 − 0 = 100).

to allow the following rating of financial performance: the first quarter represents the group of low performing farms and the fourth quarter represents the group of well performing farms.

3 Results

3.1 Descriptive statistics

The descriptive analysis in Table 1 is based on 14,058 observations from 2,404 dairy farms. The distribution of the financial ratios is illustrated by five percentiles (5th, 25th, 50th = median, 75th and 95th percentiles).

Table 1: Descriptive statistics of the six financial ratios

Ratio	Unit	N	Mean	Coefficient of variation	Percentile				
					5%	25%	50%	75%	95%
Return on total assets P1	%	14,058	**−4.94%**	1.76	−20.82	−7.79	**−3.28**	0.10	4.58
Income per family work unit (FWU) P2	CHF/FWU	14,058	**38,450**	0.83	684	20,892	**35,081**	52,384	89,399
Cash flow ratio L1	none	14,058	**0.20**	0.84	0.01	0.13	**0.21**	0.30	0.45
Dynamic debt/equity ratio L2	none	14,058	**6.52**	37.31	−5.07	1.40	**5.41**	11.29	33.34
Investment intensity S1	none	14,058	**0.72**	0.22	0.37	0.67	**0.77**	0.83	0.89
Capitalization ratio S2	none	14,058	**1.12**	15.39	0.16	0.48	**0.74**	1.08	2.15

Source: Swiss FADN data from the period 2003–2014 from 2,404 dairy farms.

The mean values of income per FWU (P2), dynamic debt/equity ratio (L2) and capitalization ratio (S2) are larger than the median (50th percentile), indicating a right skewed distribution. On the other hand, return on total assets (P1), cash flow ratio (L1) and investment intensity (S1) show a smaller mean than the median, revealing a left skewed distribution. Furthermore, dynamic debt/equity ratio (L2) and capitalization ratio (S2) show high coefficients of variation (37.31 and 15.39, respectively).

664 out of 14,058 dairy farm observations (4.7%) show a negative value for P2, which clearly indicates low incomes per FWU and consequently economic viability problems. 2,438 out of 14,058 (17.3%) dairy farm observations have a negative value for the dynamic debt/equity ratio (L2), a result that is unexpected. Looking at Equation 8, the most plausible explanation is that the value of net liabilities is negative, which signifies that the business is 'net cash' positive: in our case, it means that liquid assets and receivables are larger than borrowed capital.

3.2 Relationships between the financial ratios

Table 2 reports the Spearman's rank correlations between the six financial ratios. The two ratios representing the profitability indicator, i.e. return on total assets (P1) and income per FWU (P2), show a strong synergy, with a coefficient of 0.83.

Table 2: Spearman's rank correlations between the six financial ratios

Ratio		P1	P2	L1	L2	S1
Return on total assets	**P1**	1				
Income per family work unit	**P2**	0.83	1			
Cash flow ratio	**L1**	0.31	0.24	1		
Dynamic debt/equity ratio	**L2**	0.01	−0.09	−0.34	1	
Investment intensity	**S1**	0.16	−0.07	−0.03	0.47	1
Capitalization ratio	**S2**	−0.08	0.00	0.21	−0.72	−0.58

Source: Swiss FADN data from the period 2003–2014 from 2,404 dairy farms (unbalanced panel with 14,058 farm observations).

The financial ratios on profitability show no correlation with the dynamic debt/equity ratio (L2) or the financial ratios on stability. A weak synergy exists between the cash flow ratio (L1) and both return on total assets (P1; correlation coefficient = 0.31) and income per FWU (P2; correlation coefficient = 0.24). A moderate synergy (0.47) exists between L2 and the investment intensity (S1). A weak trade-off (−0.34) is found between the two financial ratios on liquidity, a moderate trade-off (−0.58) between the financial ratios on stability, and a relatively strong trade-off (−0.72) between L2 and S2.

3.3 Aggregate performance indicator

The analysis of the aggregate performance indicator *Y* shows that farms with the highest overall mean score (4th quarter, well performing farms) have high scores across the six financial ratios (Table 3). The difference between the scores of the 4th quarter and the 1st

quarter (low performing farms) reflects the results from the correlation analysis, considering that L2 and S1 have been inverted. P2, L1 and S1 have the largest range between 1st and 4th quarter.

Table 3: Average scores of performance groups (grouped according to mean overall score) determined for six financial ratios

Performance group	*Mean score*	Score P1 Return on total assets	Score P2 Income per family work unit	Score L1 Cash flow ratio	Score L2 Dynamic debt/equity ratio	Score S1 Investment intensity	Score S2 Capitalization ratio
1st quarter (low performing farms)	*32.7*	56.0	26.9	28.2	54.2	17.2	13.6
2nd quarter	*40.2*	68.5	37.0	39.7	60.5	19.4	16.3
3rd quarter	*45.6*	74.2	45.2	47.6	62.1	24.5	19.7
4th quarter (well performing farms)	*55.7*	79.0	56.8	56.4	63.7	44.9	33.2
Range between 1st and 4th quarter	*23.0*	*23.0*	*29.9*	*28.2*	*9.5*	*27.7*	*19.6*

Source: Swiss FADN data from the period 2003–2014 from 2,404 dairy farms. The score for each financial ratio ranges between 0 (poor result) and 100 (good result).

4 Discussion

The analysis revealed a strong synergy between the two financial ratios representing profitability (P1 and P2). Regarding profitability and other financial ratios, no notable correlations were found, except for a weak synergy with the cash flow ratio (L1). Furthermore, L1 had no or low correlations with the other financial ratios. General traditional economic literature suggests that there should be a trade-off between liquidity and profitability: if a firm is left with too much free cash flow and little debt, managers tend to act carelessly (Jensen 1986) and may invest in capital projects and acquisitions that bring little profit or provide insufficient expected returns (Lang et al. 1989). On the other hand, financial carelessness implies higher borrowing capacity that may be helpful in a risky environment. In this regard, Greenley and Oktemgil (1998) propose that free cash flow helps to counter external threats. Zhengfei and Lansink (2006), analysing the role of liquidity in the agricultural environment, observe that borrowing capacity may be important to address seasonal needs or counteract market fluctuations, which are common characteristics of the agri-business.

In the present study, the capital structure and investments were not correlated with profitability. Zhengfei and Lansink (2006), studying the Dutch agriculture, do not find any impact of the independent variables investment and debt on the dependent variable firm

performance (proxied by return on equity and productivity growth), with the exception of long-term debt on the productivity growth.

The detected trade-off between the cash flow ratio (L1) and the dynamic debt/equity ratio (L2) could be expected because L2 indicates how many years the cash flow will have to be generated in order to repay the debt. Therefore, the two financial ratios essentially go in opposite directions. Regarding the financial ratios on stability indicators, investment intensity (S1) and capitalization ratio (S2) had a positive and negative correlation with L2, respectively. As regards the synergy between debt and investment, a common relation between the financial status and the expenditure in projects or other investments has been demonstrated in corporate finance (DeAngelo and Masulis 1980, Kaplan and Zingales 1997) and in agriculture (Zhengfei and Lansink (2006). Similar to the two liquidity indicators, the two stability indicators S1 and S2 go in opposite directions, explaining the detected trade-off between S1 and S2 and consequently between S2 and L2.

The strong positive correlation between return on total assets (P1) and earned income per FWU (P2) should allow us, in a simplified approach, to use just one of these financial ratios as profitability indicator. Furthermore, dynamic debt/equity ratio (L2), investment intensity (S1) and capitalization ratio (S2) were moderately or strongly correlated suggesting that a simplified analysis could focus on L2, S1 or S2 to represent the economic sustainability of farm enterprises.

Concerning the average scores of performance groups, L1 and S1 showed larger ranges between 1st and 4th quarter of farms than L2 and S2, respectively. Furthermore, the scores for L2 and S2 varied largely. Therefore, with reference to liquidity and stability, we propose using L1 and S1 for economic sustainability analyses. Of the financial ratios on profitability, P2 had a larger range between 1st and 4th quarter of farms than P1. This result suggests using P1 as a profitability indicator. However, Lips and Gazzarin (2016) explain that under current interest rates, the remuneration of own labour (i.e. P2) is more important for the economic sustainability of a farm than own capital (i.e. P1).

Furthermore, a linear normalization approach to calculate the indicators, as suggested by Dolman et al. (2012), might help improve the scoring system.

The present study is based on yearly data. Using perennial averages for the financial ratios would be an interesting alternative. Without the variation between years, the basis for the sustainability assessment would be more stable.

5 Conclusions

Six financial ratios resulting from a literature review of economic sustainability assessments were calculated using farm observations from the Swiss FADN. The objective was to identify indicators of economic sustainability by studying the relations between these ratios.

The correlation analysis between the financial ratios does not strike critical points, because the overall picture is coherent. There is a strong synergy between the two financial ratios of profitability (i.e. return on total assets and income per FWU). Cash flow ratio is weakly positively correlated with both financial ratios of profitability, which are not correlated with other financial ratios. Dynamic debt/equity ratio, investment intensity and capitalization ratio show moderate to strong correlations; therefore, there is an interrelation between liquidity and stability to various extents.

The harmonization towards percentiles or scores allows comparing and analysing the financial ratios irrespective of challenges such as positive vs. negative values, opposite direction of action, diverse magnitudes and differing units of measurement. The results of the correlation analysis are confirmed by the score results, and it is possible to ensure consistence in the construction of an aggregate indicator of economic sustainability.

This analysis is a promising starting point for further elaboration and testing of a quantitative assessment of economic sustainability. Before implementing the presented approach, the effects of additional factors must be further analysed, and the critical boundary of economic sustainability needs to be determined.

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