

Risk Management

Terry L. Kastens
Kevin C. Dhuyvetter

Department Agricultural Economics
Kansas State University

MAST Program

tkastens@ksu.edu --- 785-626-9000
kcd@ksu.edu --- 785-532-3527

www.agmanager.info



Module: Risk Management

Session: Financial Risk: Risk with Leverage

Purpose

- Extend the student's understanding of leverage risk
- Help the student understand the difference between return on assets and return on equity

3

Return on Equity -- a measure of *financial* profitability

$$\text{ROE} = \frac{\text{ending NW} - \text{beginning NW}}{\text{beginning NW}}$$

$$\text{ROE} = \frac{\text{NFI} - \text{unpaid labor} + \text{capital gains}}{\text{beginning NW}}$$

- return on investment
- can compare with return on other investments

4

Return on Assets -- a measure of *business (farm) profitability*

$$\text{ROA} = \frac{\text{end NW} - \text{begin NW} + \text{interest paid}}{\text{beginning Assets}}$$

$$\text{ROA} = \frac{\text{NFI} - \text{unpd lab} + \text{cap gains} + \text{int}}{\text{beginning Assets}}$$

- independent of leverage: can compare farms leveraged differently

5

A Mathematical Relationship . . .

$$\text{ROE} = \frac{\text{ROA} - I}{1 - D/A} + I$$

where, I = int rate, D = debt, and A = assets

- $\text{ROA} \uparrow$ implies $\text{ROE} \uparrow$
- $I \uparrow$ implies $\text{ROE} \downarrow$
- $D/A \uparrow$ implies $\text{ROE} \uparrow$
 - If and only if $\text{ROA} > I$

6

- The leverage decision depends on **EXPECTED (future) return on assets and expected interest rates.**
- Leverage increases profit IF and **ONLY IF** return on assets is expected to be greater than interest rates.
- From a profitability standpoint, the decision rule is to either borrow an infinite amount or not to borrow at all.

7

Measures of Risk (variability)

$$s^2 = \text{variance} = \frac{\sum (x_i - \bar{x})^2}{n}$$

$$s = \text{standard deviation} = \sqrt{s^2}$$

- **2 in 3 chance of an outcome falling between the mean + 1 std and the mean - 1 std**
- **managers are ultimately interested in the variability of return on equity -- determines probability of severe losses or bankruptcy**

8

Risk Relationships . . .

Using L to represent Leverage or D/A:

$$\text{var}(\text{ROE}) = \left(\frac{1}{1-L} \right)^2 * \left[\text{var}(\text{ROA}) + L^2 * \text{var}(\text{I}) - 2 * L * \text{cov}(\text{ROA}, \text{I}) \right]$$

If $\text{var}(\text{I}) = 0$ and $\text{cov}(\text{ROA}, \text{I}) = 0$:

$$\text{std}(\text{ROE}) = \frac{\text{std}(\text{ROA})}{1-L}$$

- increase in variability of ROA increases variability in ROE (probability of loss)
- same story for variability in interest rates
- leverage increases probability of loss
...at an increasing rate -- because of $1/(1-L)$

9

Kansas Farm Management Association 2000 to 2700 farms 1973-1998

- average ROA was 5.09%
- average interest rate was 10.9%
- std. dev. of the interest rate was 2.86%
- Correlation between ROA & int was -0.3

- a KFMA subsample: the most profitable half of the largest third (about 350-400 farms)
 - average ROA was 13.52%
 - std. dev. of ROA was 8.66%

10

Risk and profit with leverage

Debt-to Asset Ratio	Average Return on Equity						
Base Case:		ROA = 13.52% std = 8.66% interest = 10.9%					
0%	13.52%						
20%	14.18%						
40%	15.27%						
60%	17.45%						
80%	24.00%						

$$ROE = \frac{ROA - I}{1 - D/A} + I$$

11

Risk and profit with leverage

Debt-to Asset Ratio	Average Return on Equity	Standard Deviation of ROE					
Base Case:		ROA = 13.52% std = 8.66% interest = 10.9%					
0%	13.52%	8.66%					
20%	14.18%	11.06%					
40%	15.27%	15.12%					
60%	17.45%	23.30%					
80%	24.00%	47.99%					

$$std(ROE) = \sqrt{var(ROE)}$$

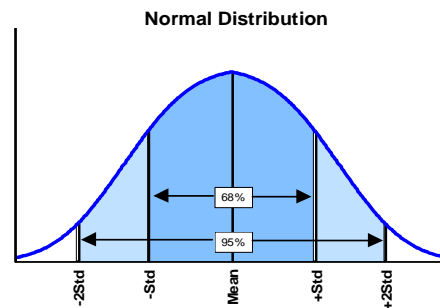
$$var(ROE) = \left(\frac{1}{1-L} \right)^2 * \left[var(ROA) + L^2 * var(I) - 2 * L * cov(ROA, I) \right]$$

12

Risk and profit with leverage

Debt-to Asset Ratio	Average Return on Equity	Standard Deviation of ROE	Probability of a Return on Equity Below			
			0%	-5%	-10%	-25%
Base Case:			ROA = 13.52% std = 8.66% interest = 10.9%			
0%	13.5%	8.7%	5.92%	1.62%	0.33%	0.00%
20%	14.2%	11.1%	10.00%	4.15%	1.44%	0.02%
40%	15.3%	15.1%	15.62%	9.00%	4.73%	0.39%
60%	17.5%	23.3%	22.69%	16.76%	11.94%	3.42%
80%	24.0%	48.0%	30.85%	27.28%	23.93%	15.36%

Given a mean and standard deviation, and assuming a normal distribution, we can assign probabilities to various levels of return.

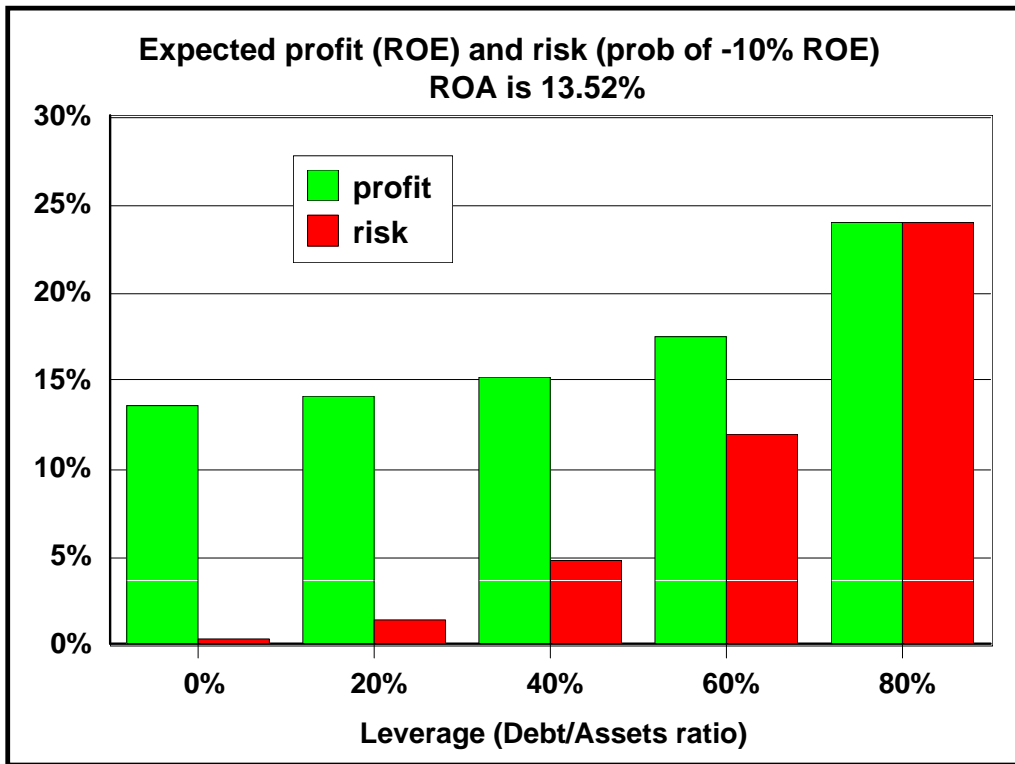


13

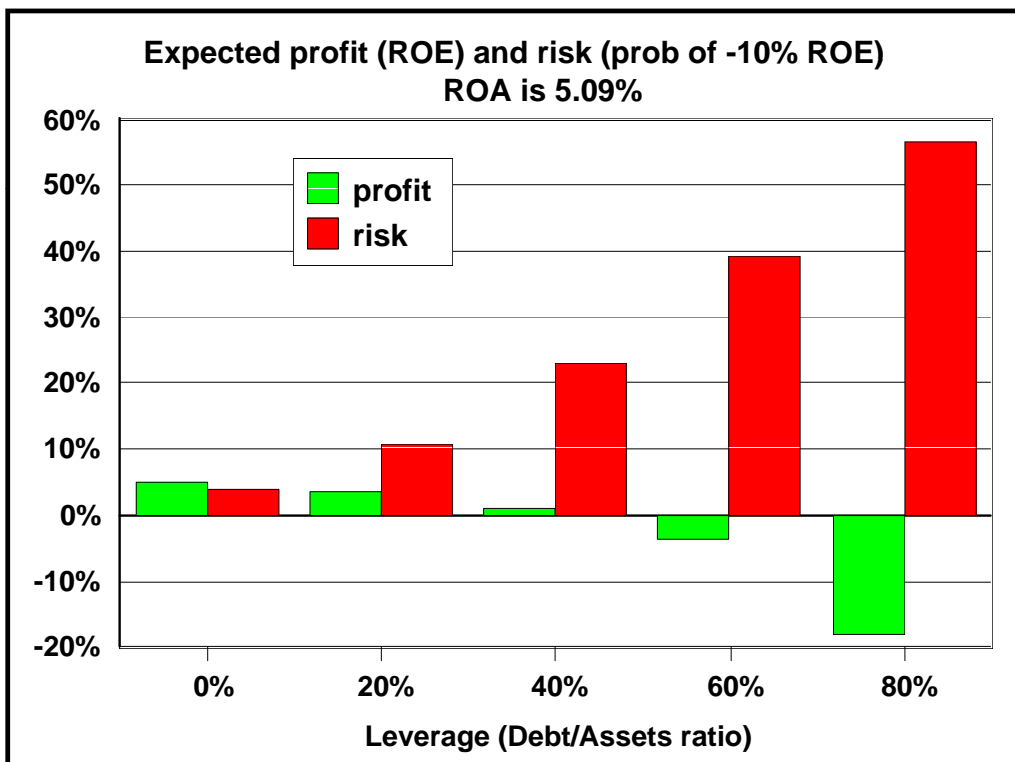
Lower profitability (ROA) . . .

Debt-to Asset Ratio	Average Return on Equity	Standard Deviation of ROE	Probability of a Return on Equity Below			
			0%	-5%	-10%	-25%
Base Case:			ROA = 13.52% std = 8.66% interest = 10.9%			
0%	13.5%	8.7%	5.92%	1.62%	0.33%	0.00%
20%	14.2%	11.1%	10.00%	4.15%	1.44%	0.02%
40%	15.3%	15.1%	15.62%	9.00%	4.73%	0.39%
60%	17.5%	23.3%	22.69%	16.76%	11.94%	3.42%
80%	24.0%	48.0%	30.85%	27.28%	23.93%	15.36%
Lower ROA:			ROA = 5.09% std = 8.66% interest = 10.9%			
0%	5.1%	8.7%	27.83%	12.20%	4.07%	0.03%
20%	3.6%	11.1%	37.11%	21.74%	10.88%	0.48%
40%	1.2%	15.1%	46.79%	34.04%	22.90%	4.14%
60%	-3.6%	23.3%	56.18%	47.65%	39.22%	17.95%
80%	-18.2%	48.0%	64.74%	60.80%	56.74%	44.32%

14



15



16

Lower interest rates . . .

Debt-to Asset Ratio	Average Return on Equity	Standard Deviation of ROE	Probability of a Return on Equity Below			
			0%	-5%	-10%	-25%
Base Case:			ROA = 13.52% std = 8.66% interest = 10.9%			
0%	13.5%	8.7%	5.92%	1.62%	0.33%	0.00%
20%	14.2%	11.1%	10.00%	4.15%	1.44%	0.02%
40%	15.3%	15.1%	15.62%	9.00%	4.73%	0.39%
60%	17.5%	23.3%	22.69%	16.76%	11.94%	3.42%
80%	24.0%	48.0%	30.85%	27.28%	23.93%	15.36%
Lower interest rates:			ROA = 13.52% std = 8.66% interest = 8.9%			
0%	13.5%	8.7%	5.92%	1.62%	0.33%	0.00%
20%	14.7%	11.1%	9.23%	3.76%	1.28%	0.02%
40%	16.6%	15.1%	13.61%	7.65%	3.92%	0.30%
60%	20.5%	23.3%	19.01%	13.73%	9.56%	2.55%
80%	32.0%	48.0%	25.24%	22.04%	19.07%	11.75%

17

Lower production risk (variability of ROA) . . .

Debt-to Asset Ratio	Average Return on Equity	Standard Deviation of ROE	Probability of a Return on Equity Below			
			0%	-5%	-10%	-25%
Base Case:			ROA = 13.52% std = 8.66% interest = 10.9%			
0%	13.5%	8.7%	5.92%	1.62%	0.33%	0.00%
20%	14.2%	11.1%	10.00%	4.15%	1.44%	0.02%
40%	15.3%	15.1%	15.62%	9.00%	4.73%	0.39%
60%	17.5%	23.3%	22.69%	16.76%	11.94%	3.42%
80%	24.0%	48.0%	30.85%	27.28%	23.93%	15.36%
Lower ROA var.:			ROA = 13.52% std = 4.33% interest = 10.9%			
0%	13.5%	4.3%	0.09%	0.00%	0.00%	0.00%
20%	14.2%	5.7%	0.62%	0.04%	0.00%	0.00%
40%	15.3%	8.0%	2.81%	0.56%	0.08%	0.00%
60%	17.5%	12.8%	8.61%	3.95%	1.59%	0.04%
80%	24.0%	27.4%	19.01%	14.45%	10.69%	3.66%

18

Leverage vs. Profit and Risk

- leverage increases profit if the return on assets is greater than the borrowing cost
- leverage increases risk at an increasing rate
- risk and profit are determined by:
 - return on assets
 - risk of farming operations
 - leverage
 - interest rates

19

Effectively using leverage is about:

- Understanding the causes of profitability
- Understanding how to reduce risk with minimal impacts on profitability, or better yet, while increasing profitability

20

End of Session:
Financial Risk: Risk with Leverage