



Making Decisions Under Risk

Module Name: Risk
Session Number: Session4

Outline Of This Session



- Risk analysis
- Downside risk
- Making decisions under risk

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Risk Analysis



- Analysis where one or more variables is not known
- Several types of analysis can be done within a spreadsheet
- Most popular forms are
 - Best case - worst case
 - “What if”
 - Sensitivity
 - Simulation

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Wheat Budget Example



Wheat Budget Example					
Income					
	Yield				45
	Price				\$6.00
	Gov Pmt				\$17.00
	Returns Per Acre				\$287.00
Costs					
	Seed				\$14.00
	Herbicide				\$6.40
	Fungicide				\$11.80
	Fertilizer				\$85.00
	Misc				\$7.60
	Machinery Costs				\$85.00
	Non Mach Labor				\$9.00
	Land Rent				\$50.00
	Interest on 1/2 non land costs		8%		\$8.75
	Total Costs				\$277.55
	Net Returns				\$9.45

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Best Case - Worst Case

- The value of the bottom line is re-calculated using the most optimistic (best case) and the least optimistic (worst case) values for uncertain variables
 - E.g., Best case = 60 bu/ac, \$8.50/bu
 - Worst case = 25 bu/ac, \$4.50/bu

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Best Case

Wheat Budget Example			
Income			
Yield		60	← INSERT 60
Price		\$8.50	← INSERT \$8.50
Gov Pmt		\$17.00	
Returns Per Acre		\$527.00	
Costs			
Seed		\$14.00	
Herbicide		\$6.40	
Fungicide		\$11.80	
Fertilizer		\$85.00	
Misc		\$7.60	
Machinery Costs		\$85.00	
Non Mach Labor		\$9.00	
Land Rent		\$50.00	
Interest on 1/2 non land costs	8%	\$8.75	
Total Costs		\$277.55	
Net Returns		\$249.45	

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Worst Case



Wheat Budget Example							
Income							
	Yield				25	←	INSERT 25
	Price				\$4.50	←	INSERT \$4.50
	Gov Pmt				\$17.00		
	Returns Per Acre				\$129.50		
Costs							
	Seed				\$14.00		
	Herbicide				\$6.40		
	Fungicide				\$11.80		
	Fertilizer				\$85.00		
	Misc				\$7.60		
	Machinery Costs				\$85.00		
	Non Mach Labor				\$9.00		
	Land Rent				\$50.00		
	Interest on 1/2 non land costs	8%			\$8.75		
	Total Costs				\$277.55		
	Net Returns				\$148.05		

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“What if” Analysis



- Simply change the uncertain input variables one at a time to determine what happens to the bottom line
- Through a series of these changes, insight is gained into how sensitive the bottom line is to each input variable

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What If Yield Increases?



Wheat Budget Example				
Income				
Yield				50
Price				\$6.00
Gov Pmt				\$17.00
Returns Per Acre				\$317.00
Costs				
Seed				\$14.00
Herbicide				\$6.40
Fungicide				\$11.80
Fertilizer				\$85.00
Misc				\$7.60
Machinery Costs				\$85.00
Non Mach Labor				\$9.00
Land Rent				\$50.00
Interest on 1/2 non land costs	8%			\$8.75
Total Costs				\$277.55
Net Returns				\$39.45

A 5 bushel increase in yield increases net returns from \$9.45 to \$39.45

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What If Interest Rates Rise?



Wheat Budget Example				
Income				
Yield				45
Price				\$6.00
Gov Pmt				\$17.00
Returns Per Acre				\$287.00
Costs				
Seed				\$14.00
Herbicide				\$6.40
Fungicide				\$11.80
Fertilizer				\$85.00
Misc				\$7.60
Machinery Costs				\$85.00
Non Mach Labor				\$9.00
Land Rent				\$50.00
Interest on 1/2 non land costs	11%			\$12.03
Total Costs				\$280.83
Net Returns				\$6.17

A 3 point rise in interest rate decreases net returns from \$9.45 to \$6.17

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Sensitivity Analysis



- Key input variables are changed to determine the sensitivity of the bottom line to changes in those variables
 - A one way table reports the results for a series of values for one variable input
 - A two way table reports the results for a series of values for two variable inputs

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One – Way Table



Input	Output
20	-\$140.55
30	-\$80.55
40	-\$20.55
50	\$39.45
60	\$99.45

Use The Data Tab,
Click on What If Analysis
The Data Table

In older version of Excel
It is the data-table command

Two – Way Table



The screenshot shows a Microsoft Excel spreadsheet titled 'Wheat Budget Example'. The spreadsheet is organized into sections: Income (rows 4-9) and Costs (rows 12-24). A 'Data Table' dialog box is open, showing the 'Row input cell' as \$G\$5 and the 'Column input cell' as \$G\$4. The data table in the spreadsheet shows the following values for 'Returns Per Acre':

\$9.45	\$5.00	\$6.00	\$7.00
36	-\$85.55	-\$50.55	-\$15.55
45	-\$35.55	\$9.45	\$54.45
55	\$14.45	\$69.45	\$124.45

Simulation Analysis

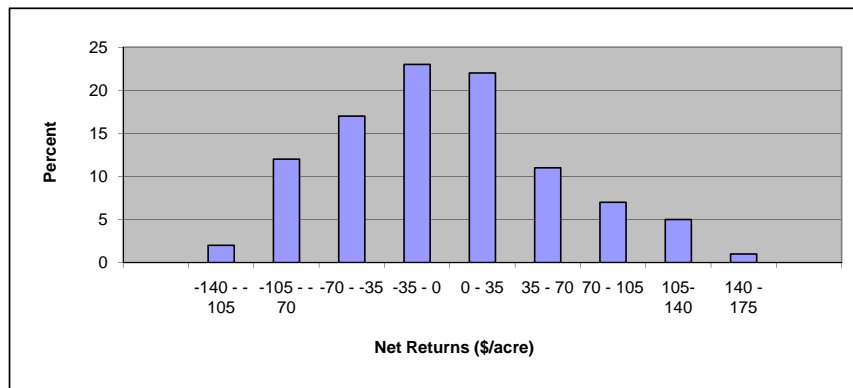


- Most sophisticated and informative of the four methods
- Similar to playing out multiple “what ifs”
- Randomly generate variables for uncertain inputs and estimate the corresponding values of the bottom line

100 Iteration Simulation Yields the Following Net Return Distribution



Mean = \$16.32, SD = \$71.41



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Further Explore Downside Risk In Agriculture



- Downside Risk
 - Focuses on low outcomes rather than variability.
 - Example Measures:
 - Number of years for which enterprise return to labor and management is negative.
 - Number of years in which return on equity is negative over a ten year period.

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Further Explore Downside Risk In Agriculture



- Some surveys have indicated that downside risk is more relevant to producers than absolute variability
- Research looked at the magnitude of influence of various factors on downside risk
- Downside risk defined as % of years with negative ROE

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Downside Risk



- Downside Risk Study
 - KFMA data for 1991-2000 period (923 farms).
 - Downside risk measure used was the number of years in which return on equity was negative over study period.

Source: Langemeier and Jones, 2001

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Downside Risk



- Debt /Asset , Total Expense Ratio, Age of Operator, % of income from Livestock
 - All positively related to downside risk
- Gross Farm Income
 - Gross Farm Income (farm size) is negatively related to downside risk

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Downside Risk



- Return on Equity and Downside Risk
 - Top (450 farms)
 - Return on equity (9.79%)
 - Downside risk (1.82 years)
 - Bottom (349 farms)
 - Return on equity (-6.75%)
 - Downside risk (6.97 years)

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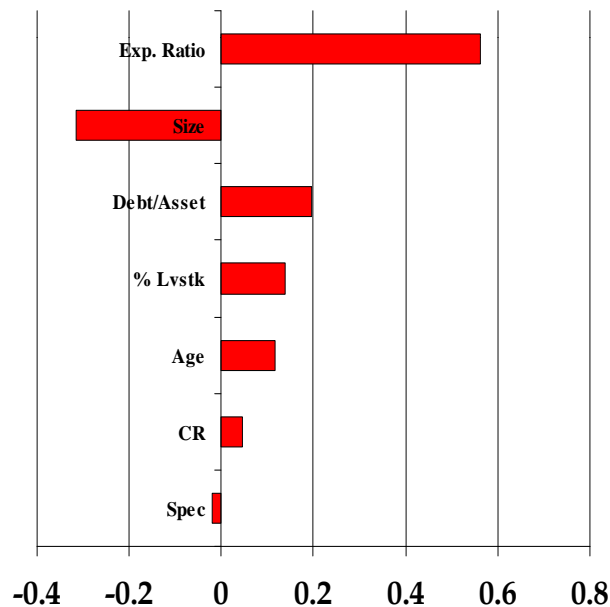
Factors Significantly Impacting Downside Profit Risk



- Expense Ratio (+)
- Farm Size (-)
- Debt/Asset (+)
- % Livestock (+)
- Age (+)

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Relative Impact Of Factors On Downside Profit Risk



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Making Decisions Under Risk



- Actions, choices, alternatives (A1, A2, etc.)
 - We control these
- Events, conditions, weather, etc.
 - We can't control these
- Probabilities
 - We may be able to formulate
- Payoffs, returns, regrets
 - We calculate these
- Criteria for choosing
 - Depends on individual

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Quantifying Risks, Averages VS Expected Values



Rainfall	Probability	Expectation
1 inch	40%	.4
2 inch	30%	.6
3 inch	20%	.6
4 inch	10%	.4

Average = 2.5 inch

Expected Value = 2 inch

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Organizing the Information



- Payoff and Regret matrices
 - Summarizes the expected net returns from the various choices (A1, A2, etc.), for a range of possible scenarios or conditions
- Decision trees
 - Illustrate the possible outcomes

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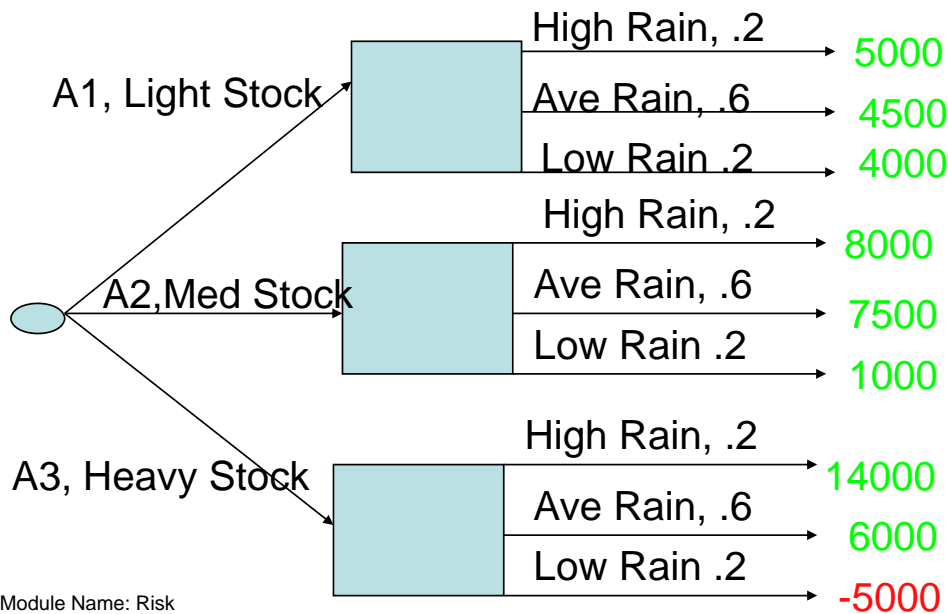
Summer Stocker Enterprise Payoff Matrix



		A1	A2	A3
Actual Rainfall	Prob	Light Stocking	Medium Stocking	Heavy Stocking
High	.2	5000	8000	14000
Average	.6	4500	7500	6000
Low	.2	4000	1000	-5000

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Decision Tree Representation



So, Which Strategy Is Best (A1, A2, or A3)?



- It depends on your ability to bear risk
- It depends on your attitude toward risk
 - These two will dictate your selection criterion

A1 A2 A3

Actual Rainfall	Prob	Light Stocking	Medium Stocking	Heavy Stocking
High	.2	5000	8000	14000
Average	.6	4500	7500	6000
Low	.2	4000	1000	-5000

Decision Rule	A1	A2	A3
Maximize the minimum Possible outcome	<u>4000</u>	1000	-5000

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A1 A2 A3

Actual Rainfall	Prob	Light Stocking	Medium Stocking	Heavy Stocking
High	.2	5000	8000	14000
Average	.6	4500	7500	6000
Low	.2	4000	1000	-5000

Decision Rule	A1	A2	A3
Maximize the maximum Possible outcome	5000	8000	<u>14000</u>

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A1 A2 A3

Actual Rainfall	Prob	Light Stocking	Medium Stocking	Heavy Stocking
High	.2	5000	8000	14000
Average	.6	4500	7500	6000
Low	.2	4000	1000	-5000

Decision Rule	A1	A2	A3
Minimize the maximum Possible regret	-9000	<u>-6000</u>	-9000

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A1 A2 A3

Actual Rainfall	Prob	Light Stocking	Medium Stocking	Heavy Stocking
High	.2	5000	8000	14000
Average	.6	4500	7500	6000
Low	.2	4000	1000	-5000

Decision Rule	A1	A2	A3
Maximize the outcome of equally likely states	4500	<u>5500</u>	5000

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A1 A2 A3

Actual Rainfall	Prob	Light Stocking	Medium Stocking	Heavy Stocking
High	.2	5000	8000	14000
Average	.6	4500	7500	6000
Low	.2	4000	1000	-5000

Decision Rule	A1	A2	A3
Maximum most likely state	4500	<u>7500</u>	6000

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A1 A2 A3

Actual Rainfall	Prob	Light Stocking	Medium Stocking	Heavy Stocking
High	.2	5000	8000	14000
Average	.6	4500	7500	6000
Low	.2	4000	1000	-5000

Decision Rule	A1	A2	A3
Maximum Expected Return	4500	<u>6300</u>	5400

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Summary



- Risk analysis
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