

INVESTING IN HUMAN CAPITAL

ESD.71 Final Application Portfolio
Presentation
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PREAMBLE

- In a number of industries, quality of the workforce is a key factor in determining a product's position in the market
- Investing in human capital earlier in a product's lifetime may yield higher future revenues
- This effect becomes even more significant as competition for skilled workforce becomes stronger and wages increase



THE CASE OF AUTOMANUFACTURING

- The car manufacturing industry is no exception to these trends
- Seeing an increase of knowledge intensity in both product and workforce
- This poses the problem of decision-making in a context where workforce size and experience has an overall impact on product quality and thus, potential market share



DESIGN LEVERS FOR ANALYSIS

- The performance of the system analyzed can be improved by changing:
 - Number of workers hired
 - Period when they are hired
- Hiring an employee has both a one-time initial cost, and a cost per period (wages)
- In addition, initial plant size can be varied, for more or less economies of scale
- Can build more capacity than workforce can currently produce → flexibility to hire and augment production in the future



UNCERTAINTY FACTORS

- Two main sources of uncertainty:
 - Future demand for the product
 - Workers' wages
- This changes in both these parameters could occur because of technical innovation, environmental regulation, labour regulations, etc.
- The analysis presented will focus on uncertainty in future demand, but similar methods could be applied for other factors



COMPARING TWO DESIGNS

- Fixed workforce strategy:
 - Fixed number of workers, all hired at year 0
 - Plant size corresponding to production capacity of these workers
- Flexible workforce strategy
 - Fewer workers hired at year 0, with possibility to hire more later
 - Larger plant built initially to have the flexibility of increasing production later

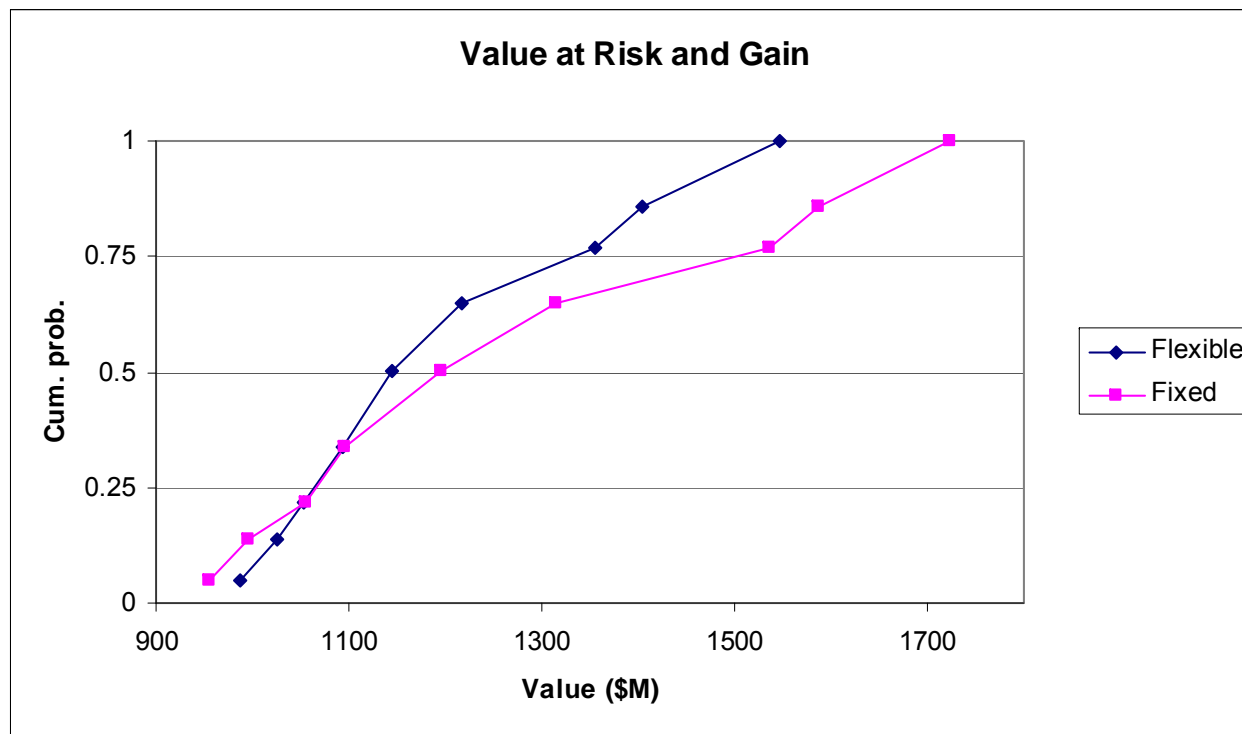


DECISION ANALYSIS: SETUP

- Two stages of five years
- At each chance node:
 - Demand assumed to follow a geometric Brownian motion with average growth rate 1.7%, volatility 2%
 - Two stages are simulated 2000 times and bucketed in “high”, “medium” or “low” outcomes
- At each decision node, there is a choice between hiring more workers or not
- Expected value is calculated after each node

DECISION ANALYSIS: RESULTS

- Value higher for the fixed plan (\$1.3G) than for the flexible plan (\$1.2G), but flexible plan better under “maximin” objective



Investing in Human Capital

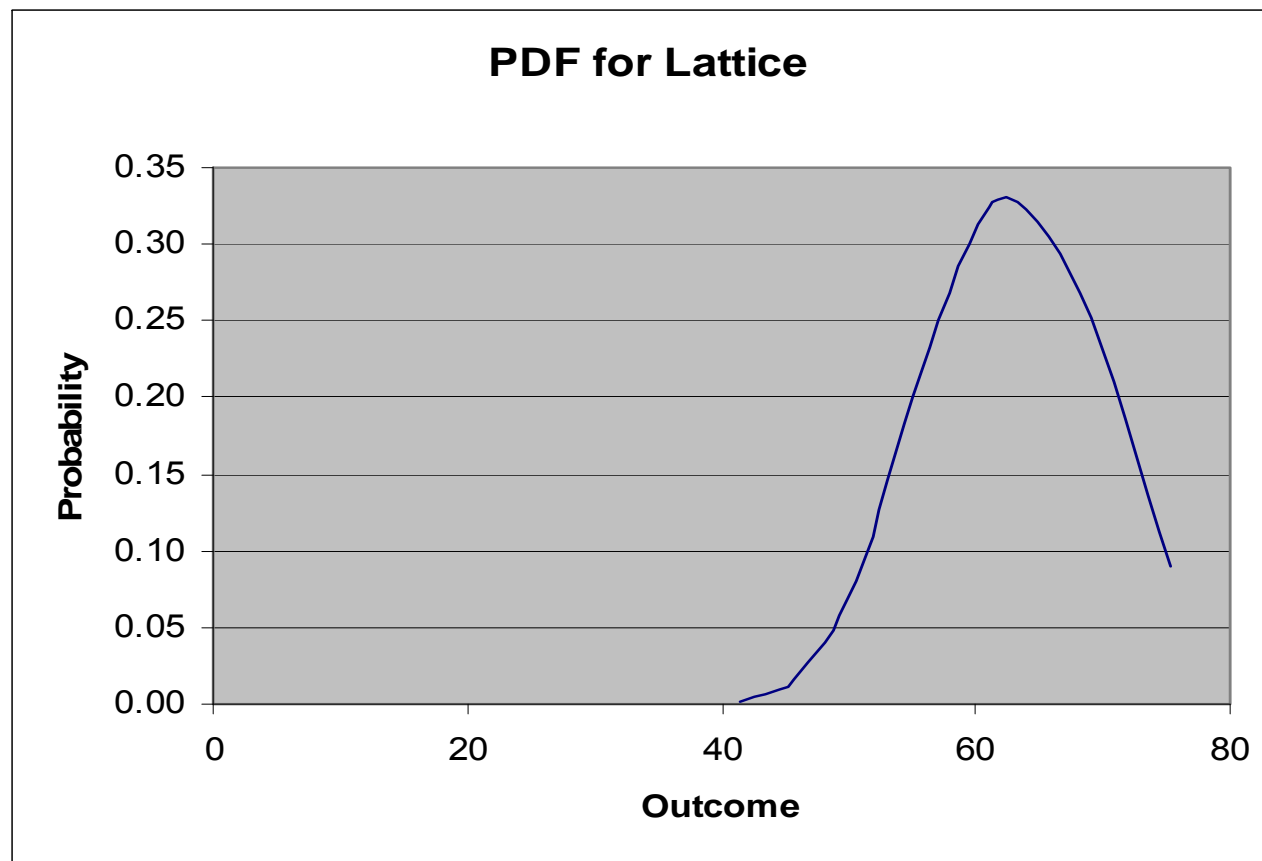
BINOMIAL LATTICE ANALYSIS: SETUP

- Demand has average growth rate 1.7%, volatility 5%, over 6 years
- Lattice parameters:
 - $u=1.0512711$
 - $d=0.9512294$
 - $p=0.67$

Year	0	1	2	3	4	5	6
Outcomes:	1860.00	1955.36	2055.62	2161.01	2271.81	2388.29	2510.74
		1769.29	1860.00	1955.36	2055.62	2161.01	2271.81
			1683.00	1769.29	1860.00	1955.36	2055.62
				1600.92	1683.00	1769.29	1860.00
					1522.84	1600.92	1683.00
						1448.57	1522.84
							1377.92

BINOMIAL LATTICE ANALYSIS: RESULTS

- Probability distribution function:



BINOMIAL LATTICE ANALYSIS: RESULTS

- Decision to exercise flexibility:

Year	0	1	2	3	4	5	6
		YES	YES	YES	YES	YES	YES
		NO	NO	YES	YES	YES	YES
			NO	NO	YES	YES	YES
				NO	NO	YES	YES
					NO	YES	YES
						NO	YES
							NO

- Expected present value of flexible design (\$2.18G) is higher than for fixed design (\$1.99G)
- Value of flexibility is \$192M



DISCUSSION

- Value of flexibility depends on a number of analysis parameters: method, objective, definition of uncertainty, discount rate, project lifetime
- Decision analysis may be more appropriate for options on building a plant, and lattice for options on hiring workforce
- Problem can scale rapidly with added uncertainty factors