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Profiting from Uncertainty:

The Value of Information and Options

GW Business

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The Value of Information

"… forecasts have no intrinsic value. They acquire value through their ability to influence the decisions made by users of the forecasts."

Allan H. Murphy, 1993
"What is a Good Forecast? An Essay on the Nature of Goodness in Weather Forecasting"

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The Value of Information: Basic ideas

- The Value of Information is measured as the ***difference in Expected Value*** between having and not having the information
- Information can have value only if it is liable to ***influence a decision***
- Value of Information determines an ***optimal information search***, rather than a perpetual plea that "more research is needed"
- Real information is often ***incomplete***, ***unreliable***
  Perfect Information provides an upper bound on information value
- ***Real Options*** share close similitude with Perfect Information:
  both derive their value from ***avoiding the downside***,
  or ***profiting from the upside***, of a risk

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Information: Imperfect, and Perfect

- ***Information defined:*** Information = Any piece of knowledge or observation liable to alter your beliefs about the uncertainties you are facing

  E.g.: Econometric forecasts; Experts' opinions; Intelligence reports; Results of experiments, surveys, polls, market studies, medical tests, ...

- ***Reliability of Information***

  - Real information is less than perfectly reliable:
    Prob[*X happens* given *Information predicts so*] < 100%

    Forecasts contain error; Test results inaccurate; Experts fallible; …

  - The reliability of information is often unknown, hard to measure

  - Thus, it's useful to introduce the concept of "Perfect" information

- ***Perfect Information***

  - Predicts outcomes with 100% reliability

  - The value of perfect information will provide an upper bound on the value of any real information, … and it's easy to calculate

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Decision with Information Acquisition: Example – Marketing Strategy

The management of a motion picture studio has determined the following payoff table for marketing choices for a new film (the amounts are in millions of dollars):

Box Office Result	Distribute as 'A' Feature	Distribute as 'B' Feature	Sell to TV network
Success	25	15	5
Failure	-10	-5	5

The probability that this new production will be a hit has been judged initially at 30%. The studio is considering a pre-release forecast (e.g., based on sneak previews, or opinion markets, such as Hollywood Stock Exchange, www.hsx.com) before deciding how to market the new film. Historical data on films subjected to such market studies shows that 70% of successful films had received favorable forecasts, while 80% of the box office failures had obtained unfavorable forecasts.

a) Build a decision tree model to analyze this problem.
b) What probabilities should be assigned to box office success, if the sneak preview is favorable? If the sneak preview is unfavorable?
c) If a sneak preview results in a net cost of $500,000, would you recommend it be taken? (Assume decisions are made on the basis of expected monetary value.)

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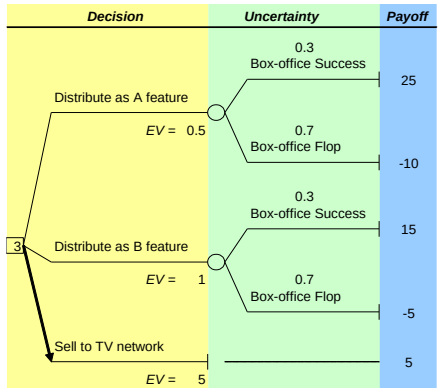
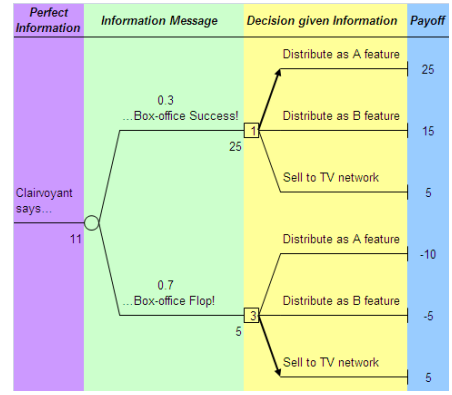
Value of Perfect Information

*Decision **without information***



*Decision **with Perfect Information***

Suppose a "Clairvoyant" could foretell the outcome with 100% reliability…



EV without information = \$5m ≤ EV with perfect information = \$11m

Expected Value of Perfect Information (EVPI) = ΔEV = 11 – 5 = \$6m

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Calculating the Expected Value of Perfect Information (EVPI)

1. Draw the tree of acquiring Perfect Information signals + the subsequent decision(s)/event(s) following each information signal
2. Calculate EV of the tree from (1) above: that's EV with Perfect Information
3. Calculate increase in EV due to perfect information:

EVPI = EV with (costless) Perfect Info – best EV without info

Perfect Information is, by definition, the highest quality information, therefore EVPI provides an upper limit on the value of any information about the uncertainty at hand.

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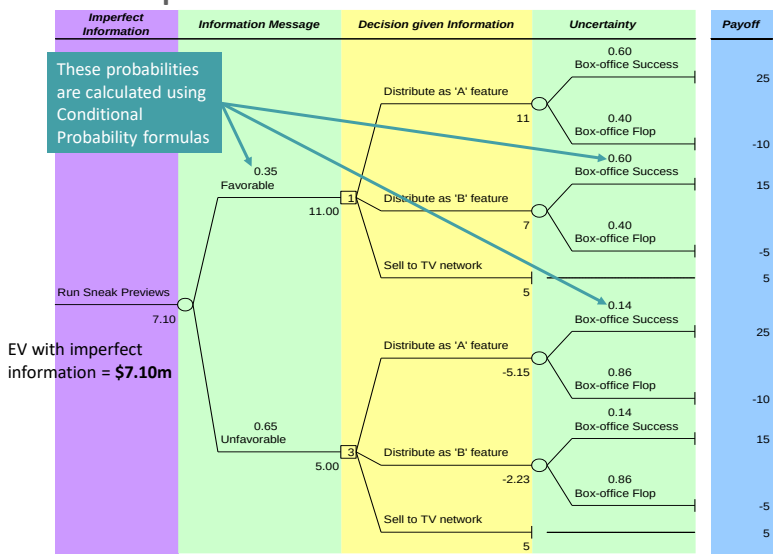
Value of Imperfect Information



Expected Value of Imperfect Information (EVII) = 7.10 – 5 = $2.10m

- $2.1m is the most we would be willing to pay for the Sneak Previews
- Note that EVII ≤ EVPI (this is always true)

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Imperfect Information: Probability Calculations

Take 30 movies that were box-office successes and 70 movies that were flops, which were all run through sneak previews. The breakdown of the 100 cases is as follows:

Box-office result	***Sneak preview result*** Favorable	Unfav.	
Success	**21**	**9**	30
Flop	**14**	**56**	70
	35	65	**100**

Prob(**Success**|**Fav** sneak preview) = 21/(21+14) = .60

Prob(**Flop** | **Unfav** sneak preview) = 56/(9+56) = .86

Prob(**Fav** sneak preview) = (21+14)/100 = .35

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Calculating the Expected Value of Imperfect Information (EVII)

- EVII defined similarly as EVPI:

  EVII = EV with (costless) Imperfect Info – best EV without the Info

- Notes:
  - The cost of information acquisition is ignored in calculating EVII (that's just by definition, and for consistency with EVPI)
  - Information is worth acquiring if its value exceeds its cost, that is, if: EVII > Cost of Information
  - EVPI ≥ EVII ≥ 0 …always!

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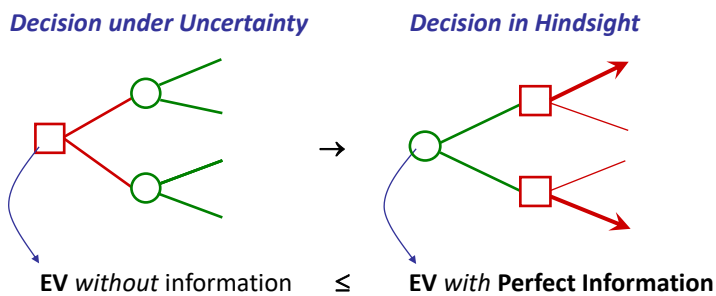
Perfect Information: the value of deciding after the fact

- How much better off would we be if we could decide with hindsight?

Invert the Decision-Chance sequence:



The increase in EV measures the value of resolving the uncertainty before deciding, it is the Expected Value of Perfect Information, **EVPI**:

EVPI = EV with (costless) Perfect Info – EV without info

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Practical interest of EVPI

- Provides an easy-to-estimate upper bound on the value of any real information that could be obtained.
- EVPI can always be calculated just from the existing decision tree data.
- EVPI may help prioritize which uncertainties should be subjected to further information gathering.

Exploit EVPI to:

- Price the cost of uncertainty
- Prioritize: further research / front-loading activities / information gathering

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Summary on Value of Information

- Information and Forecasts are a key ingredient of decision making under uncertainty. More or better information can improve decision-making.
- Forecasts are not perfect. *Yes, we already know that!* … ok but assume that they are even *less* reliable than you think.
- Information that will have no chance of changing your decision is worthless (value = 0). No need to know it if it will not influence the decision.
- Information could be too expensive: if the cost of obtaining a forecast is more than the value created by the forecast, it's not worth acquiring.
- Perfect information can provide an upper limit on how much you should be willing to pay for better forecasts / more information.

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"Let's hold off making a decision until we have even more information we don't really need."

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