

Prospering in an Information Economy

1. What is an Information Economy?

Is information Scarcer or more Plentiful?

Data is Plentiful, Information is Scarce relative to need

Cost of Information

Time, Mental Energy, and other resources

2. Is information Scarcer or More Plentiful than 100 years ago?

A basic concept of economics is scarcity

There is obviously far more data available than ever before

BUT

Prospering in a global, dynamic-to-chaotic world requires decision makers to acquire the knowledge necessary for wise action in time to avert oncoming disasters and exploit transitory opportunities, then repeat the process in rapid succession.

3. Cost of Information

Paying for Data

Paying for "Data that have been processed into a format that is understandable by its intended audience." -Wiktionary "Information"

Costs of Delay while keeping options open until more is know

Scarcity of Time and Mental Energy of Decision Makers

4. "Expected" Monetary Value of a risky venture

Definition of Expected Monetary Value

EMV in Life Insurance and Casinos

Lifetime Portfolio of Unlike Ventures

Heuristics: The Main Chance

Heuristics: The Most Probable Outcome

Heuristics: Worst Case Scenarios

Heuristics: Go for Broke

5. Definition of Expected Monetary Value

Payoff Matrix:	Actions: You May Freely Choose Any One States: One is True; You Have No Control Probability of Each State
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	Hot Weather	Cold Weather
Invest in ski wear	Big Loss	Big Profit
Invest in swim wear	Moderate profit	Small Profit

If all states are equally probable:

EMV of an action is the simple average of its possible outcomes

If some states are more probable than others:

more probable states get more weight in the weighted average

Specifically, multiply each possible outcome of an action times the probability of the state in which it occurs,;

EMV is the sum of the results

6. EMV in Life Insurance and Casinos

very large numbers of identical "gambles" with customers.

Sell 1 year life insurance policies for \$101 that pay \$10,000 at death

To 100,000 people each of whom has 99% chance of living a year

Revenue = \$10,100,000

The number who die will "almost certainly" be "very close to" 1,000

Cost will "almost certainly" be "very close to" \$10,000,000

Profit will "almost certainly" be "very close to" \$100,000

Average profit will "almost certainly" be "very close to" \$1

Casinos make many many bets with more than two outcomes, they know the probabilities more precisely than life insurance companies

In each case, their average profit will "almost certainly" be "very close to" the EMV

7. Lifetime portfolio of unlike ventures

If you have many independent ventures over a lifetime or career,

In "the long run" your total payoff will "almost certainly" be higher if you always maximize EMV than if you use any other rule.

The catch: If you go bankrupt there is no "long run"

8.Heuristics: The Main Chance

Conceptualize the risky venture in terms of just two possible states with their probabilities and the payoffs of each alternative action under the two states

Chose the action with the best EMV.

Uses Real Numbers, but Fewer.

9. Heuristics: The Most Probable Outcome

Ignore all states except the most probable and choose the action with the best payoff under that state.

Uses Ordinal Information only;

which state is most probable?

which action's outcome for that state is best?

Choose that action.

10. Heuristics: Worst Case Scenarios

"Maximin"

Treat uncertainty as if it were a smart opponent out to get you.

Choose the outcome with the best guaranteed minimum payoff despite the worst that could happen if you chose it.

Avoids bankruptcy,

Uses Ordinal Information only;

no need to judge how probable any state is

which payoff for each alternative action is worst?

which of those "worsts" is best?

Choose the corresponding action.

11. Heuristics: Go for Broke

"Maximax"

Win the lottery and retire!

If you win, you don't need the "long run."

Uses Ordinal Information only;

no need to determine how probable any state is

which payoff for each alternative action is best?

which of those "bests" is best?

Choose the corresponding action.

12. Expected Utility

Risk Aversion

Utility Theory Respects Risk Attitudes

Tradeoffs Revisited

13. Risk Aversion

**A \$10,000 car is more like a \$60,000 car than it is like walking.
Canned food is more like a five-star restaurant than it is like starving.
A cheap apartment is more like a mansion than it is like homelessness.
A PC is more like a super computer than it is like a pencil and paper.**

In each case, if we take the dollar value of the three possibilities, the EMV of a 50-50 chance between the best and the worst is substantially higher than the monetary value of the middle alternative,

but nearly everyone would prefer the middle alternative to the gamble. This is called Risk Aversion.

This shows that money is not always an adequate "medium of exchange" for decision making under uncertainty.

14. Utility Theory Respects Risk Attitudes

Consider a lottery: if you win you get the best possible outcome in the real venture under consideration, but if you lose you get the worst possible outcome in that real venture.

What probability of winning this lottery is subjectively neither better nor worse than receiving each possible outcome of the real venture? This probability is a measure of the "utility" of that outcome.

It can be proved mathematically that whatever your risk attitude, you should use the expected return (be "risk neutral") in a venture whose payoffs are chances in a reference lottery.

To make a decision that respects risk attitudes, convert the real payoffs into equivalent chances in the reference lottery and maximize expected value.

15. Tradeoffs Revisited

What probability in a gamble where you get a \$60,000 car if you win but have to walk everywhere if you lose is neither better nor worse than a \$10,000 car?

What probability in a gamble where you always eat in a five-star restaurant if you win but starve if you lose is neither better nor worse than eating canned food for certain?

What probability in a gamble where you live in a mansion if you win but become homeless if you lose is neither better nor worse than living in a cheap apartment?

What probability in a gamble where you get a supercomputer if you win but have to use pencil and paper if you lose is neither better nor worse than getting a PC for certain?

16. Subjective Probability

Three Sources of Probability

Ultimately they are All Subjective

Rules for Subjective Probability?

Dutch Book Exercise

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17. Three Sources of Probability

Historical Data (Relative Frequency)

(e.g Insurance)

Cause and Effect Models (Classical Probability)

(e.g. casinos, weather forecasting)

Subjective Probability

Creedal Probability: Disciplined Personal Opinion

Pignistic Probability: "Put your money where your mouth is"

Often, the decision maker must rely on subjective probabilities. Don't dismiss this as mere intuition. If you are familiar with the domain in which the problem arises, you can assess very useful, if imperfect, probabilities.

18. Ultimately they are All Subjective

The only absolutely "objective" probability that something will happen is 1 if it happens, or 0 if it doesn't.

Any other probability is an expression of the incomplete information possessed by a particular decision maker at a particular point in time.

Historical "Relative Frequency" probability is based on the subjective hope that the future will be like the past.

Cause and Effect "Classical" probability is based on the theory that supports the cause and effect model, and the data that drive the model

19. Rules For Subjective Probability?

Subjective Probability must obey the same mathematical laws as classical probability

$$0 \leq P(x) \leq 1 \quad \sum P(x) = 1 \quad P(x \text{ OR } y) = P(x) + P(y) - P(x \text{ AND } y)$$

$$P(x \text{ GIVEN } y) = P(x \text{ AND } y) / P(y) \quad P(x \text{ AND } y) \leq P(x)$$

Why should my personal opinion be forced to follow these rules?

Dutch Book Theorem:

20. Dutch Book Exercise

Students anonymously submit a set of probability estimates.

I will pick an example that is not consistent with statistical laws,

I will create a Dutch Book against someone firmly holding these views

21. Value of Information

Information As A Producer Good

Worthless Information

Perfect Information

Value of Imperfect Information

Bags & Chips Exercise

22. Information As A Producer Good

Education costs money, but then so does ignorance.

Sir Claus Moser (b. 1922), German-born British academic, Warden of Wadham College, Oxford. Daily Telegraph (London, 21 Aug. 1990).

A little knowledge that acts is worth infinitely more than much knowledge that is idle.

Kahlil Gibran (1883– Lebanese poet, novelist. *The Voice of the Master*, pt. 2, ch. 8 (1960; repr. in *A Second Treasury of Kahlil Gibran*, tr. by Anthony Ferris, 1962).

Private information is practically the source of every large modern fortune.

Oscar Wilde (1854– Anglo-Irish playwright, author. Sir Robert Chiltern, in *An Ideal Husband*, act 1.

Knowledge is the most democratic source of power.

Alvin Toffler (b. 1928), U.S. author. *Powershift: Knowledge, Wealth, and Violence at the Edge of the 21st Century*, pt. 1, ch. 2, “Democratic Difference” (1990).

23. Worthless Information

When you acquire information, you don't know what message you're going to get.

To decide how much the information is worth "paying" for, you need to know what messages you MIGHT get.

If you will do the same thing no matter which of the messages you MIGHT get is the one you actually DO get, the information value is ZERO as a produced good!

**Sometimes "Data" has some other value as a producer good
e.g. regulatory compliance.**

Value of Information as a Consumer Good

24. Perfect Information

If I already possess perfect information about a risky venture, it is no longer risky at all; I know what state will occur and I will act accordingly.

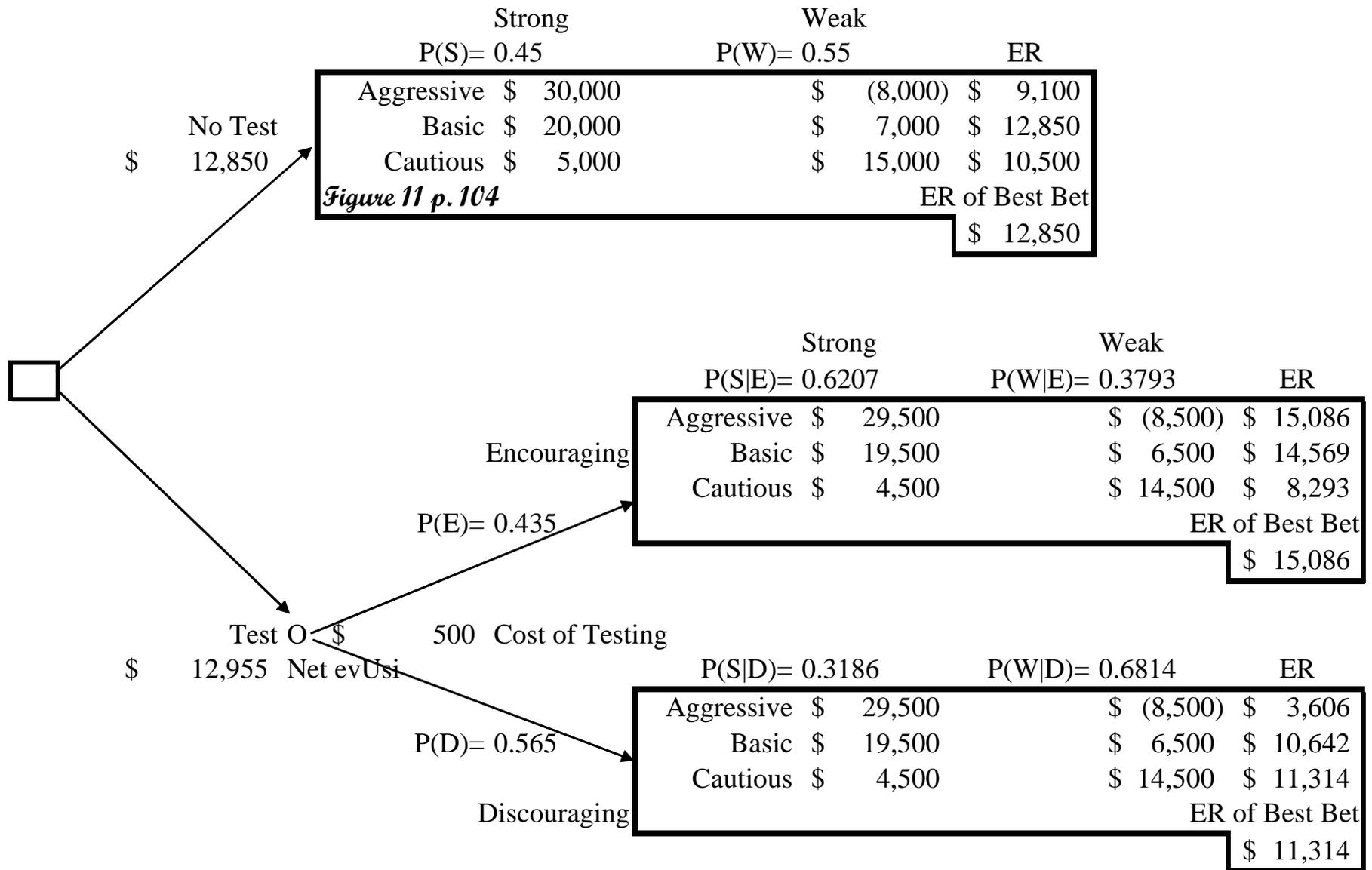
If I am about to get perfect information, I don't yet know the value of the venture;

I can find the venture's expected value under perfect information by multiplying the probability of each state times the payoff of the best action for that state.

If I have the opportunity to get perfect information at some cost, the most I should "pay" is the difference between the expected value of the venture with the information I already have and the expected value under perfect information.

Snack Vendor Spreadsheet

25. Value of Imperfect Information



26. Bags & Chips Exercise

Prior probabilities

$$P(L) = \frac{3 \text{ Light bags}}{8 \text{ Total Bags}} = 0.375$$

$$P(D) = \frac{5 \text{ Dark Bags}}{8 \text{ Total Bags}} = 0.625$$

Payoffs

	Light Bag	Dark Bag	EMV
Bet L	\$100	(\$50)	\$ 6.25
Bet D	(\$50)	\$100	\$ 43.75
Best Bet			\$ 43.75

Likelihoods

$$P(W|L) = \frac{4 \text{ White per light bag}}{5 \text{ Chips per Bag}} = 0.8000$$

$$P(W|D) = \frac{2 \text{ White per dark bag}}{5 \text{ Chips per Bag}} = 0.4000$$

$$P(B|L) = \frac{1 \text{ Blue per light bag}}{5 \text{ Chips per Bag}} = 0.2000$$

$$P(B|D) = \frac{3 \text{ Blue per dark bag}}{5 \text{ Chips per Bag}} = 0.6000$$

Joint Probabilities

$$P(W\&L) = \frac{12 \text{ White in Light bag}}{40 \text{ Total chips}} = 0.3$$

$$P(W\&D) = \frac{10 \text{ White in Dark bag}}{40 \text{ Total chips}} = 0.25$$

$$P(B\&L) = \frac{3 \text{ Blue in Light bag}}{40 \text{ Total chips}} = 0.075$$

$$P(B\&D) = \frac{15 \text{ Blue in Dark bag}}{40 \text{ Total chips}} = 0.375$$

Marginal Probabilities

$$P(W) = \frac{22 \text{ White Chips}}{40 \text{ Total chips}} = 0.55$$

$$P(B) = \frac{18 \text{ Blue Chips}}{40 \text{ Total chips}} = 0.45$$

Posterior Probabilities

$$P(L|W) = \frac{12 \text{ White in Light bag}}{22 \text{ White Chips}} = 0.545454545$$

$$P(D|W) = \frac{10 \text{ White in Dark bag}}{22 \text{ White Chips}} = 0.454545455$$

$$P(L|B) = \frac{3 \text{ Blue in Light bag}}{18 \text{ Blue Chips}} = 0.166666667$$

$$P(D|B) = \frac{15 \text{ Blue in Dark bag}}{18 \text{ Blue Chips}} = 0.833333333$$

Bet "L" Bet "D" Best Bet
\$ 31.82 \$ 18.18 \$ 31.82

Bet "L" Bet "D" Best Bet
\$(25.00) \$ 75.00 \$ 75.00

Paper Bags and Poker Chips

Gross EVUSI = \$51.25

Gross EVSI = \$7.50

An example of "Bayes Theorem"

27.Heuristics

Heuristics: One Reason Decision Making

Heuristics: Salesmen and Champions

Heuristics: Representativeness

28. Heuristics: One Reason Decision Making

When in doubt, consider one piece of "new" information and act based on it.

Often the information will "favor" one alternative action without the need to calculate numerical expected monetary value or expected utility.

Varieties:

"Take the Best" -- look for information that can make you change your mind

"Confirmation" -- look for information to confirm what you already think

"Take the Last" -- look for information in familiar places

29. Heuristics: Salesmen and Champions

Ask around: follow the advice of whoever has the best credentials, the most persuasive argument, or the glitziest advertisements

30. Heuristics: Representativeness

"If it looks like a duck and walks like a duck and quacks like a duck"

Save on the time and mental energy costs of information:

**If you can't make the decision confidently with the old information,
Get new information and decide on the basis of just that
Skip the "Bayes theorem" calculations**

31. Real Options Theory

Financial Options vs. Real Options

Real Options in the Tomato Garden

32. Financial Options vs. Real Options

Financial Option:

the right to choose next year whether or not to buy a specific stock at a price that is specified now.

(When the option is exercised you know next year's stock price.)

Real Option:

the right to choose next year which action to take in a risky venture.

(Delay as a way of acquiring information)

Financial discounts provide a weak theory of risk attitude but a strong theory of time

Utility theory in decision analysis is a strong theory of risk attitude but a weak theory of time

**Real Options Theory may provide a synthesis. **

33. Real Options in the Tomato Garden

Figure 7: A Stylized Mapping of Projects Into Call-Option Space

$$NPV_q = \frac{\text{Underlying Asset Value}}{PV(\text{Exercise Price})}$$

