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 **(1883–1931), 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 **(1854–1900), 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, “The Democratic Difference” (1990).**

de·ci·sion (d¹-s¹zh“…n) *n.* 1. The passing of judgment on an issue under consideration. 2. The act of reaching a conclusion or making up one's mind. 3. A conclusion or judgment reached or pronounced; a verdict. 4. Firmness of character or action; determination. [Middle English *decisioun*, from Old French *decision*, from Latin *d¶cºsi½*, d¶cºsi½n-, curtailment, settlement, from *d¶cºdere*, to cut off, decide. See DECIDE.] --de·ci“sion·al *adj.*

SYNONYMS: decision, conclusion, determination. The central meaning shared by these nouns is “a position, an opinion, or a judgment reached after consideration”: *a decision unfavorable to the opposition; came to the conclusion not to proceed; satisfied with the panel's determination.*

a·nal·y·sis (…-n²l“¹-s¹s) *n.*, *pl.* a·nal·y·ses (-s¶z”). *Abbr.* anal. 1. The separation of an intellectual or substantial whole into its constituent parts for individual study. 2. *Chemistry.* a. The separation of a substance into its constituent elements to determine either their nature (qualitative analysis) or their proportions (quantitative analysis). b. The stated findings of such a separation or determination. [Medieval Latin, from Greek *analusis*, a dissolving, from *analuein*, to undo : *ana-*, throughout; see ANA- + *luein*, to loosen.]

Two Kinds of "Easy" Decisions

Certainty: **When we make a decision under the assumption of certainty, we only consider one state of nature to be possible; the payoff matrix has only one column of payoffs, and the best decision is the one with the best payoff. Linear programming is an example of a technique for making decisions under the assumption of certainty.**

Stochastic Dominance: **If action A has a better payoff than action B under each individual state of nature, then we say that action B is *stochastically dominated* by action A. If the payoff matrix truly represents everything the decision maker hopes (or fears) to receive from the decision in question, then no rational decision maker will ever choose to perform action B.**

Expected Monetary Value

When the payoff is money, the most widely used decision rule is "Expected Monetary Value." The Expected Monetary Value, or EMV, of an alternative action is found by multiplying the payoff for that action under each possible state of nature times the probability that that state of nature will be the actual one, and adding the results. If all states of nature are equally probable, the EMV is the same as the simple average.

IMPORTANT: **The fact the EMV is called the "expected" value does NOT mean that the decision maker can "expect" to really receive that value as his or her payoff. In the Roget Pinky example, if Mr. Pinky chooses the MARTA contract but not the Busch race, his payoff might be a $225,000 loss, a $534,000 loss, a $457,000 gain, or a $1,969,000 gain, depending on the weather. He can confidently "expect" that his payoff, whatever it may be, will NOT be a $522,000 gain.**

Expected Value Under Perfect Information

The unknown state of nature determines a best possible payoff; this is the payoff you would achieve if you knew in advance what the state of nature actually was.

> ***In the Roget Pinky example, the best possible payoff is a $215,000 loss if the weather is cold & wet, a $213,000 loss if the weather is cold & dry, a $549 gain if the weather is warm & Wet, and a $2,375,000 gain if the weather is warm & dry***

If we have a probability distribution over states of nature, we can take a statistical expectation of the best possible payoff for the "average" state of nature.

> ***In the Roget Pinky example, the statistical expectation of the best possible payoff for the "average" state of nature." equals*** *-.1*215K -.15*215K + .4*549K + .35*2375K =* ***$996,000***

Expected Value Under Perfect Information (cont'd)

The best possible payoff for the "average" state of nature is the average of all the various payoffs you would receive in the long run if you faced a population of decision situations in which

1. each decision situation has a payoff matrix identical to the payoff matrix in the actual decision,
2. the frequency distribution of states of nature equals your probability distribution,
3. you could choose your action in each decision situation separately, based on perfectly reliable information about which state of nature applied to that particular decision situation.

The best possible payoff for the "average" state of nature is

known as the "Expected Value Under Perfect Information" or EVUPI"

Cost of Uncertainty (Regret)
For a (State -- Action) Pair

The actual payoff you get as a result of a decision under uncertainty is less than the maximum unless you guess right about the state of nature. The difference between the best possible payoff for a given state of nature and the payoff you get under that state of nature for a given action is the cost of your uncertainty. Like the payoff itself, the cost of uncertainty (or ignorance) depends in part on the action you choose to perform and the uncontrollable state of nature. The cost of uncertainty is also known as "regret" or "opportunity loss."

Expected Regret for an Action

Since the cost of uncertainty depends on what the unknown state of nature actually is, it is itself uncertain. The "Expected Regret" or "Expected Opportunity Loss (EOL)" is the statistical expectation of the possible regrets for a particular alternative action, found by multiplying the regret for that action under each possible state of nature times the probability that that state of nature will be the actual one, and adding the results.

In the Roget Pinky example, the expected regret for no Busch, no MARTA is $299,000. The expected regret for Busch but no MARTA is $259,000, The expected regret for MARTA but no Busch is $227,000, and the expected regret for Busch and MARTA together is $73,000.

EMV + EOL = EV<u>U</u>PI

The Expected Monetary Value for any action plus the Expected Regret for that same action equals the Expected Value <u>Under</u> Perfect Information.

In the Roget Pinky example these equations are

697 + 299 = 996 ***for no Busch, no MARTA***
737 + 259 = 996 ***for MARTA but no Busch***
769 + 227 = 996 ***for MARTA but no Busch***
923 + 73 = 996 ***for Busch and MARTA together***

Expected Value Of Perfect Information

If Mr. Pinky makes his decision using the EMV criterion on the basis of the information available to him, he will choose Busch and MARTA for an Expected Monetary Value of $923,000. If he faced a population of race days with a frequency distribution identical to his probability distribution of weather, and he had to choose each one with no additional knowledge, he would choose Busch and MARTA every time. In the long run, his various gains and losses would average out to $923,000 gain per race.

On the other hand, if he could make a decision about each of these hypothetical races separately, based on perfectly reliable information about which state of nature applied to that particular decision situation, his long-run average gain would be $996,000 per race.

Since the perfect information improves his long-run average gain by $73,000, we refer to this quantity as the Expected Value Of Perfect Information. **EVPI = Expected Regret of the Best Bet**