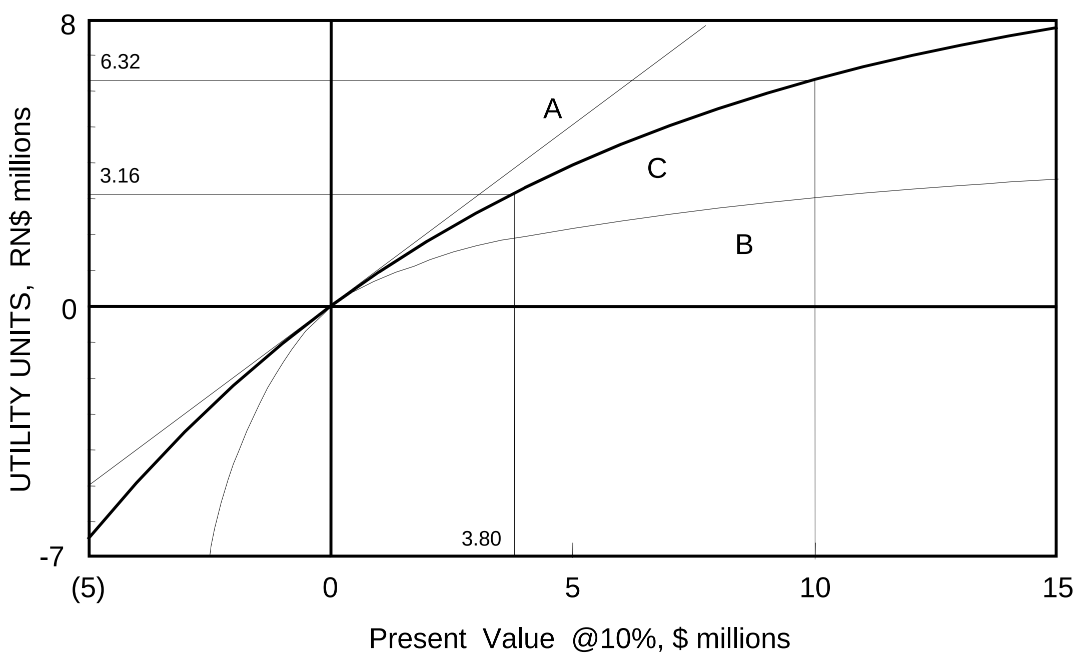
10. RISK POLICY

Few people are objective (or neutral) about risk. Risk-averse people—most of us—have a heightened sensitivity to downside results. We also have a diminishing value for additional improvements on the upside. That is, risk-averse decision-makers seek disproportionately greater returns for higher levels of risk.

Decision theory has been expanded to accommodate attitudes about risk. A new measure has been devised to translate dollar values into preference or utility units. Converting from an actual, objective outcome measure into units of perceived value is by use of a ***utility function***. The utility units are arbitrary and are used solely to compare alternatives.

An organization or decision-maker's risk attitude can be represented by the utility function. Everyone has one, and perhaps everyone’s curve is unique. This is often called a risk profile curve. The figure shows three example risk profile curves:



EV converts a distribution into a single best value.

The utility function modifies this single value into one incorporating risk preference.

A risk neutral decision-maker has a linear risk preference function, such as curve A, a straight line. Doubling PV doubles the utility value.

Risk-averse persons, such as persons represented by B and C, have concave downward curves. A typical risk-averse person, perhaps uninitiated to decision analysis concepts, is shown as curve B. This person has a sharp “knee” near the origin, showing a dramatic change in preference. A risk-seeking person would have a curve that is concave upward (not shown).

The shape of a person's risk profile curve is usually obtained through an interview process with a decision analyst. The curve is developed from answers to a series of hypothetical investments. For example, the decision-maker might be asked what certain amount would be equally attractive to an investment (called a lottery) with a 50% chance of gaining $9 million and 50% chance of losing $2 million. The answer is his or her certain equivalent for this lottery and establishes another point on the curve.

From actual decision data or from limited interviews, many people exhibit risk-seeking and risk-averse behavior in different sections of their curves or for different risk structures.[1]

The smooth exponential utility function, such as curve C shown in the graph, has a formula such as:[2]

$$\text{Utility}(x) = r(1 - e^{-x/r})$$

risk tolerance coefficient

where x is the present value outcome value in dollars

r is the *risk tolerance coefficient*, $10 million for this decision-maker

A certain equivalent (or *certainty equivalent*) is the risk-free amount a decision-maker would be *just willing to exchange* for a chance lottery. There are several acceptable forms for the exponential utility function. All forms operate the same in obtaining the same certain equivalent.

While there is no one "correct" or "right" curve, an exponential preference function has several attractive properties:

- It is simple to calculate conversions, both ways.
- U($0) = RN$0 (RN$ = risk-neutral dollars)
- The utility measure is not entirely arbitrary. The risk-neutral $ measure means that if U(x)=Y, that outcome RN$x is Y times better than a $1 outcome.
- Buy and sell values are the same.
- The delta property: adding $Z NPV to every outcome increases the CE by $Z.

The risk-neutral, straight-line utility function is a special case where r is infinity. EMV thus equals CE, and the EMV decision policy has the features above.

To use the utility curve, first convert outcome NPVs into utility units. Then the expected values of chance and decision nodes, now called ***expected utilities*** (EUs), are calculated in the usual way. The preferred decision alternative is the one with the highest expected utility.

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[1] I have yet to find a person who is truly risk-seeking. Not included are people finding entertainment value in gambling and those persons who believe they can somehow beat the odds. Risk-seeking persons can be turned into “money pumps.”

[2] There are variations. This is the formula I like because the *risk neutral dollars* measure has some meaning. RN$100,000 is 100,000 times better than $1.

The utility function converts PV into utility. It also can be used for the inverse transform, converting EU into CE.

The dollar amount corresponding to expected utility is the certain equivalent. The utility function graph works for this purpose. In the case of the previous exponential utility equation, a more convenient and accurate certain equivalent is obtained by using the inverse transform equation:

$$CE(\text{in }\$) = -r \ln(1 - \frac{EU}{r})$$

where r is the *risk tolerance coefficient*

EU is expected utility

Here is a simple example showing how this works: Consider a situation where the outcome is either +$10 million or $0. Each outcome has a .5 probability. The EMV is $5 million. What is the value to a conservative decision-maker? Let's assume a risk tolerance coefficient, $r = 10^6$.

The $10 million outcome has a RN$6.32 million utility value (risk-neutral dollars). This can be read from the graph (curve C) or computed with the formula. The utility of $0 is RN$0. The expected utility is therefore:

EU = 0.5(6.32) + 0.5(0) = RN$3.16 million.

If comparing to other uncertain alternatives, we simply choose the highest expected utility. However, to appraise value or to compare with an unrisked dollar amount, we must convert expected utility into dollars.

The Reading from the C curve (or using the formula), a $3.16 EU (y-axis) corresponds to a CE = $3.80 million (x-axis, labeled Present Value). Thus, a decision-maker with this risk preference function would be indifferent between having $3.8 million cash in hand or a 50% chance of gaining $10 million.

Each individual has a unique risk profile curve, based upon beliefs, values, and attitudes about risk. Without deliberate design, an organization often has as many risk policies as it has decision-makers. This causes inconsistency and, probably, loss of value. The decision process can be greatly improved by using a single risk policy throughout the organization. The risk profile curve is a complete and succinct way to state and apply corporate risk policy.