Handout 12

Strategies for Risk/Uncertainty in Policy/Project Analysis

Realistically, when performing either policy analysis of nonstructural things or project analysis of structural things – both called policy analysis henceforth here – we are anticipating events before they occur. Virtually all the prices, quantities, preferences, technologies, etc. being exercised in policy analysis are actually risky (with objective or subjective probabilities) or uncertain (without assignable probability).

The only sound way to regard all policy analysis methods, at least those we have developed thus far, in light of the permeating r/u that truly exists is to imagine that we have been applying <u>expected values</u> for all our data and functions and computing <u>expected welfare measures</u>. That's the most direct and simple path for interpreting our work thus far. Yet, this is theoretically unacceptable unless risk neutral preferences prevail at the social/community level.

<u>Doing better with/than expected welfare measures</u> (Boardman et al. 2011)

1. *Sensitivity analysis* – treat the expected value assumptions as the *base case* and then do:
   a. *Partial sensitivity analysis* – recompute monetary measures (NBs, NPV) for alternative assumptions of key r/u parameters. Discover the extent to which r/u matters, particularly for the sign of the end result.

   or

   b. *Worst- and best-case analysis* – pose combinations of r/u parameters that combine to yield low or high measures of the end result. Disclose these findings.

   The above two approaches are quite feasible, but they do not generate any likelihood or variance type information about the range of projected monetary measures.

2. *Monte Carlo analysis* (perhaps a style of sensitivity analysis) – using probability information for risky (not uncertain) parameters, conduct many random draws among the parameters and compute results. Results can be displayed probabilistically. Variance and confidence interval type information can be obtained for the results. Because this approach relies on computer-generated repetitions, the analysis can be quite thorough in considering many risky parameters.

3. *Functional analysis* (my questionable label) – if a closed form function exists stating how results (like NBs or its component surplus measures) depend on risky parameters and if the variance of parameters is known (perhaps from statistical estimation work of S/D), then techniques such as Taylor series expansions can yield estimated variances of results. This was shown in a prior course handout (#7).

The Monte Carlo method is more widely applicable than the Functional one. Indeed, it can be applied so readily that it is a good idea for many analyses.

None of the above methods employ any social preference information about risk nor do they directly modify any decision-making criteria (is NB>0?, is NPV>0?).

<u>Welfare measurement under risk aversion</u> (Boardman et al. 2011 & Freeman et al. 2014)

Expected values of measures like ΔR, ΔS, ΔG, CV, CS, EV, and ES are not theoretically appropriate unless the agent is risk neutral. The normally emphasized correct welfare measure stems from a willingness to pay ex ante question, and *WTP ex ante* is a widely used term in the literature. The general question used to define it is: "In advance of knowing what will occur (i.e. what the state of nature will be), what maximum amount would you be willing to pay for X?" The answer is also called *option price*, though it's a total amount (and the normally correct welfare measure) rather than a per unit price. Option price (OP) differs from expected surplus by a corrective amount called option value (OV). If a policy action reduces risk and the agent is risk averse, expected surplus value (ESV, my term) normally is biased in understating OP by the amount OV. OV is not always positive, and its sign is difficult to anticipate. OV cannot be determined independently of determining OP. Observe that the WTP ex ante question appears to be the risky incarnation of the Kaldor test. [I have not investigated whether a Hicks test version of OP has been explored in the literature.]

OP is a theoretically correct measure to employ for all risky policy impacts on agents, and, frankly, all policy impacts are either risky or uncertain. Yet, analysts rarely seek OP. About the only time OP is sought is when there is a central single policy effect being investigated by an academician. Otherwise, we simply compute expected surpluses and hope that we are not too wrong.

Conditions when we are not as wrong (Boardman et al. 2011 & Freeman et al. 2014)

1. If *actuarially fair insurance* is available to risk averse agents, which of course can only be imperfectly true, then the correct welfare measure is max[ESV, OP].
2. For social welfare analysis, we are combining the risk preferences of many agents into an aggregate, and it is possible that the aggregate has softer sensitivity to risk. The outcome here depends on whether risk is experienced individually as different experiences or collectively as a shared experience. When individually, like traffic accidents, max[ESV, OP] is the ideal measure. When collectively, like regional weather, *aggregate OP* (AOP) is desired.
   a. Aggregation gets quite messy in theory, and the peculiar, demanding requirements are roundly ignored in applied work. In addition to AOP, there is a recommended welfare measure called *aggregate fair bet*.

Changes to $\text{NPV} \overset{?}{>} 0$ when information (more certainty) may be forthcoming (Traeger 2014)

The merging concepts of quasi-option value (QOV) and real options value (ROV) from the environmental economics and finance arenas, respectively, raise questions about the too-simple NPV test in cases where an irreversibility is present. [See the 2016 edition of my water textbook.] For example, a policy might cause an environmental harm that cannot be undone if it is later revealed to be quite valuable. Similarly, a capital investment cannot be reversed once completed. The common NPV test poses only 2 alternatives, "do now" or "don't do now," thereby falsely capturing the decision environment which should include "maybe do later." Waiting has value in these irreversible circumstances because the uncertainty might be partially resolved as time and states of nature unfold – what is called "learning" in this literature.

Either the QOV or ROV can be used in a revised test (Traeger 2014). Using both is redundant.

The decision outcomes are do, reject, or wait. QOV is used with NPV as a $\text{NPV} \overset{?}{>} \text{QOV}$ test.

ROV is used instead of NPV: $\text{ROV} \overset{?}{>} 0$.

Great References

Boardman, Anthony E., David H. Greenberg, Aidan R. Vining, and David L. Weimer. *Cost-Benefit Analysis: Concepts and Practice*. Chapters 7-8. 4th ed. Boston: Prentice Hall, 2011.

Freeman, A. Myrick, III, Joseph A. Herriges, and Catherine L. Kling. *The Measurement of Environmental and Resource Values*. Chapter 5. Third ed. New York: RFF Press, 2014.

Traeger, Christian P. "On Option Values in Environmental and Resource Economics." *Resource and Energy Economics* 37 (August 2014): 242-52.