

Sensitivity Analysis

- **What is it?** – The answer to the questions:
 - “How would our design decision (or recommendation) change if some of the numbers we used changed?”
 - “What are the most important inputs to our process?”
 - “What variable(s) drive the decision?”

Why is it important?

Much of what we use in modeling is subjectively derived

Many of the numbers we use are subject to measurement error or other sources of uncertainty

It will help us understand the model better

It will help us understand the decision problem better

Sensitivity Analysis

(continued)

- **How do we do it?**
 - Important part of the modeling effort
 - No structured procedure for doing it
 - Requires common sense
 - Requires creativity
 - Can consider various aspects of the problem:
 - Problem structure
 - Data
 - Probabilities (or distributions)
- **Simply Put:** Vary elements of the problem and see how it changes the output

Problem Identification and Structure

- **Check for correct specification of the problem**
 - **Rule: The first articulation of the problem is wrong**
 - **Problem definition is iterative**
 - **Stay in touch with decision maker to stay on track**
- **Structure of Model (both value model and analytic model)**
 - **We have seen that different people can structure a problem differently**
 - **Different value structure**
 - **Different measures**
 - **Different algorithms**
 - **Try the problem in multiple ways**

One-Way Sensitivity Analysis

- **Only one factor is varied at a time**
- **All others are held at the nominal (base) values**
- **Need to establish the range over which the variable will vary**
 - **Maybe there is a known range**
 - **Vary by percentage (e.g. +/- 30%)**
- **Bottom Line: Does a change in the variable affect the output – and therefore, the decision**
- **Also Important: If not, we don't have to worry about the variable**

Tornado Diagram

- **Used to compare one-way sensitivity analyses for all relevant variables**
- **Free software available at**
<http://www.tushar-mehta.com/excel/software/tornado/>
- **Example: Soft Pretzel Problem**

Variable	Base Value	Lower	Higher
Unit Price	\$0.40	\$0.20	\$0.90
Market Proportion	22.00%	16.00%	28.00%
Market Size	\$120,000.00	\$90,000.00	\$15,000.00
Fixed Cost	\$8,000.00	\$6,500.00	\$9,500.00
Variable Cost	\$0.06	\$0.05	\$0.07
Profit/Loss	\$976.00		

Sensitivity Analysis on Weights

- **The most subjective and controversial part of a decision analysis is the weights**
- **Good idea to check sensitivity of the recommendation to the weights**
- **Method:**
 - **Choose one attribute to vary, say attribute i**
 - **Rescale others so weights still sum to one**

$$w_j = (1 - w_i) \left(\frac{w_j^o}{\sum_{k \neq i} w_k^o} \right), \forall j \neq i$$