Global sensitivity analysis

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Motivation

(i) What is the stability and determinacy domain?

(ii) Which parameters mostly drive the fit of, e.g., GDP and which the fit of inflation? Is there any conflict?

(iii) Which is the ‘shape’ the relationship between structural parameters and the reduced form of a rational expectations model?
• A Definition

[Global*] sensitivity analysis: “The study of how the uncertainty in the output of a model (numerical or otherwise) can be apportioned to different sources of uncertainty in the model input”

*Global could be an unnecessary specification, were it not for the fact that most analysis met in the literature are local or one-factor-at-a-time
One factor at a time methods are those whereby each input variable is varied or perturbed in turn and the effect on the output measured.
OAT methods - derivatives

\[ S_1 = \frac{\partial y}{\partial x_j} \]  
\[ S_2 = \frac{\partial y}{\partial x_j} \frac{x_j^0}{y^0} \]  
\[ S_3 = \frac{\partial y}{\partial x_j} \frac{\text{std}(x_j)}{\text{std}(Y)} \]

Effect on \( Y \) of perturbing \( x_j \) around its nominal value \( x_j^0 \)

Relative effect on \( Y \) of perturbing \( x_j \) by a fixed fraction of its nominal value \( x_j^0 \)

Relative effect on \( Y \) of perturbing \( x_j \) by a fixed fraction of its standard deviation
While derivatives are valuable for an array of estimation, calibration, inverse problem solving, and related settings, their use in sensitivity analysis can be modest in the presence of finite factors uncertainty and non-linear models.
Among practitioners of sensitivity analysis this is a known problem – non OAT approaches are considered too complex to be implemented by the majority of investigators.

Among the global methods:

• various types of Monte Carlo filtering.
• ‘meta-modelling’ (smoothing methods or kriging) and variance based methods,
Sensitivity analysis vs. mapping

Both aim at quantifying as much as possible the relationships between $X_i$ and $Y$.

This course deals mainly with the mapping aspects, pointing to the dual sensitivity issues when applicable.
Further, sensitivity analysis can:

- surprise the analyst, find technical errors,
- gauge model relevance,
- identify critical regions in the space of the inputs, e.g. instabilities of a dynamical model
- help in estimation/calibration
- establish priorities for research, simplify models,
- anticipate (prepare against) falsifications of the analysis
- ...