Why to use models? Why not?

- To understand better the behaviour of a system
- To predict the future development of a system
- To manipulate the system in order to achieve a desired result
- Models are usually cheaper and faster than conventional experiments
- Sometimes the only way to find a solution is through modeling

– Models can be too complicated or too restricted

The steps of classical modeling

1. Define your objectives

2. Hypothesis: intuition, expertise

3. Mathematical formulation: experience

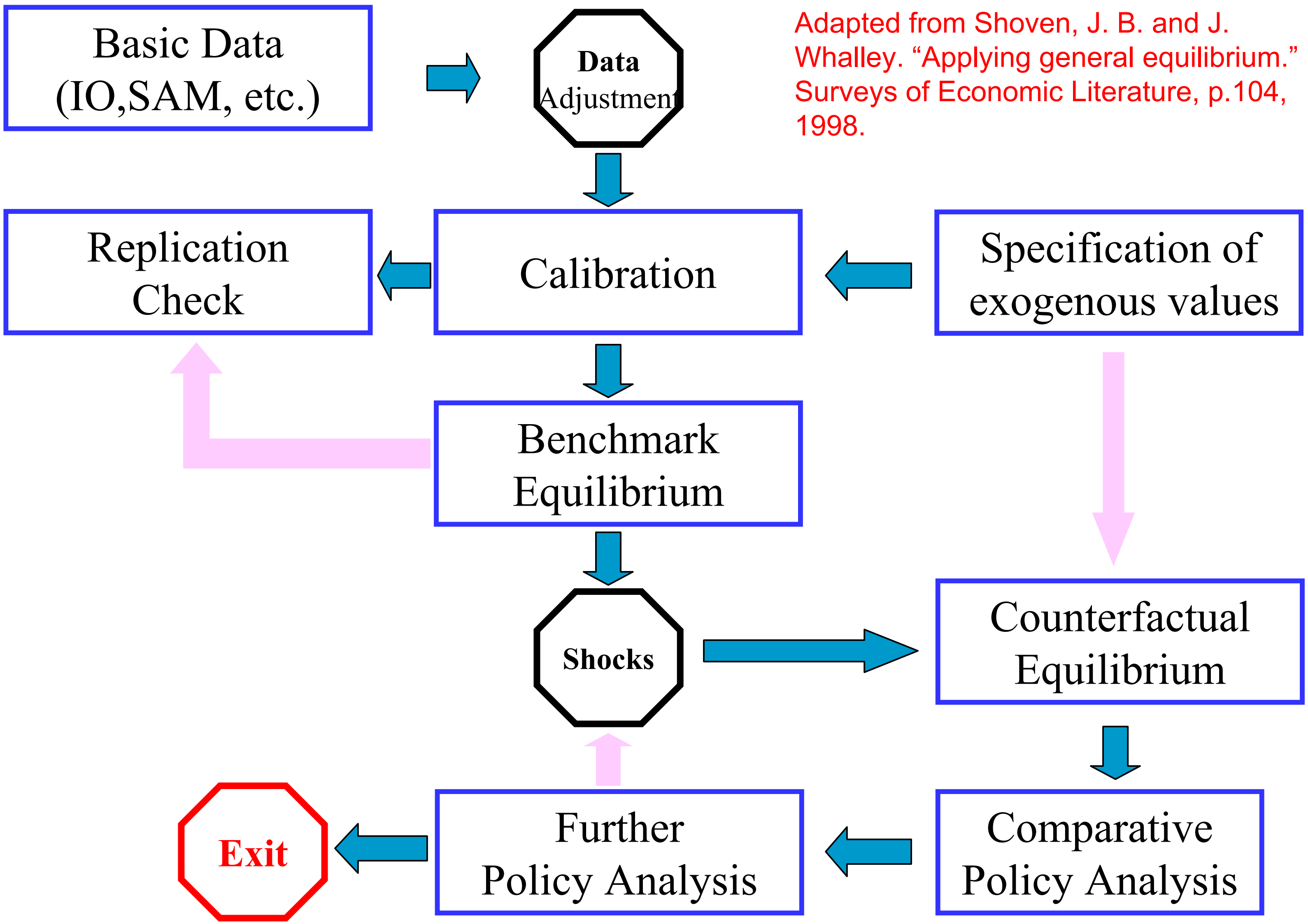
4. Verification: hard work, testing over and over again

5. Calibration: estimation, comparison

6. Analysis and evaluation: varies from mechanical work to very abstract proofs

CGE Overview -- Steps in CGE Modeling

Adapted from Shoven, J. B. and J. Whalley. “Applying general equilibrium.” Surveys of Economic Literature, p.104, 1998.



Building the Basic Data – things to do

4. Decide on functional forms e.g. Cobb-Douglas, CES, Leontief, LES, etc.

   e.g. Cobb-Douglas => the benchmark data is sufficient to determine behavior parameter values

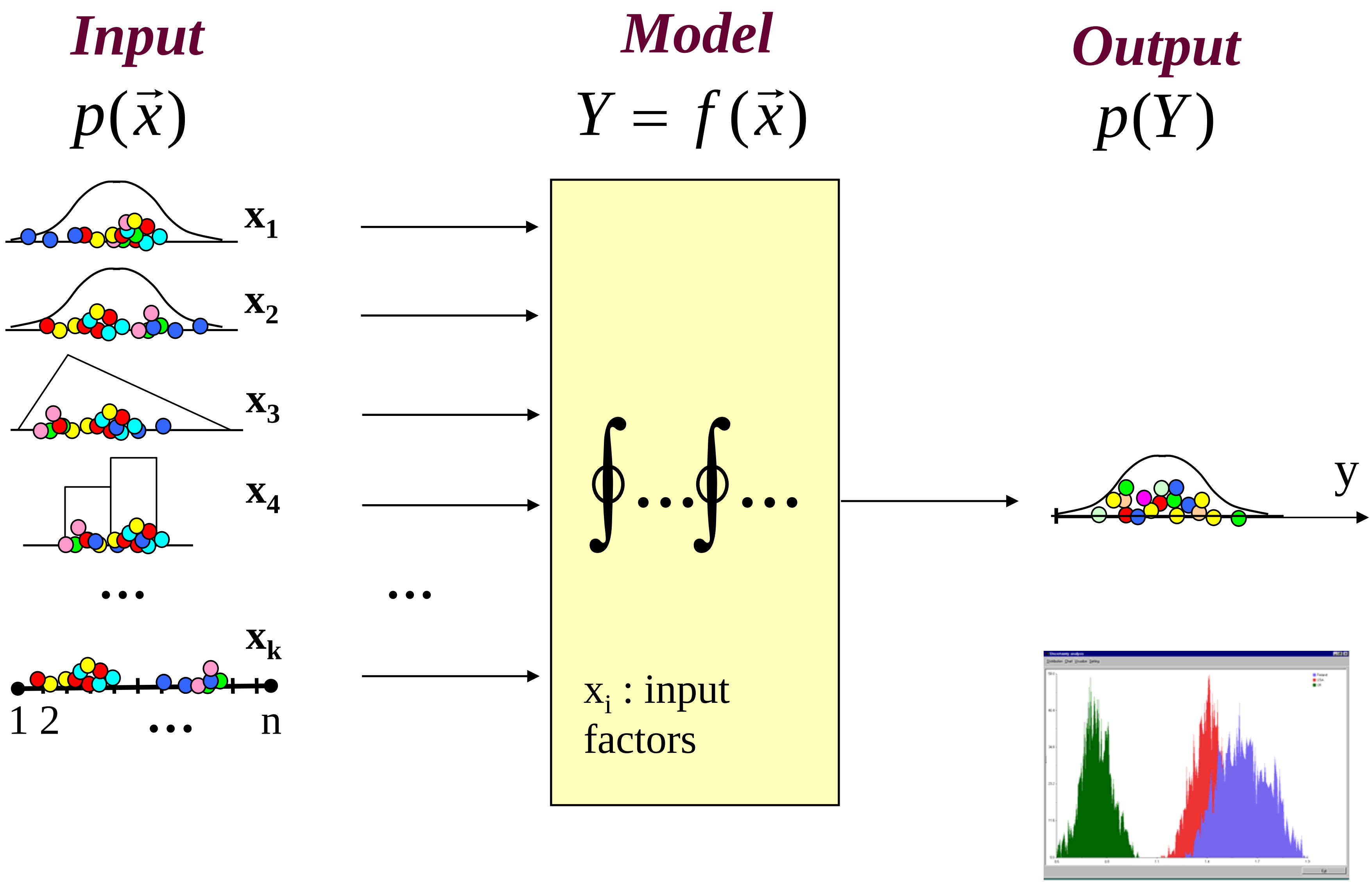
   e.g. CES or LES => exogenous elasticity values are required

↓ **influences**

Behavior Parameters → **CALIBRATION** → **Results**

↑

sensitivity analysis on parameter values



Input
$p(\vec{x})$
Model
$Y = f(\vec{x})$
Output
$p(Y)$
x_1
x_2
x_3
x_4
…
x_k
1 2 … n
…
$\oint \dots \oint \dots$
x_i : input factors
y

Functional Forms

Leontief (L)

zero elasticity of substitution;
own-price elasticities are less than one;
cross-price elasticities are negative;
homothetic.

Easy to parameterize but the implicit zero elasticity of substitution is unrealistically low in most situations.

Functional Forms

Cobb-Douglas (CD)

unitary elasticity of substitution;
own-price elasticities are equal to one;
cross-price elasticities are zero;
homothetic.

Like Leontief, easy to parameterize. When used as a utility function, imposes unitary income elasticities.

Functional Forms

Constant Elasticity of Substitution (CES)

relaxes the imposed substitution elasticities in the Leontief and Cobb-Douglas; however, still homothetic.

Functional Forms

Linear Expenditure System (LES)

Does not impose homotheticity.
Can be derived from the Stone-Geary utility function.
Straightforward to estimate.

Functional Forms

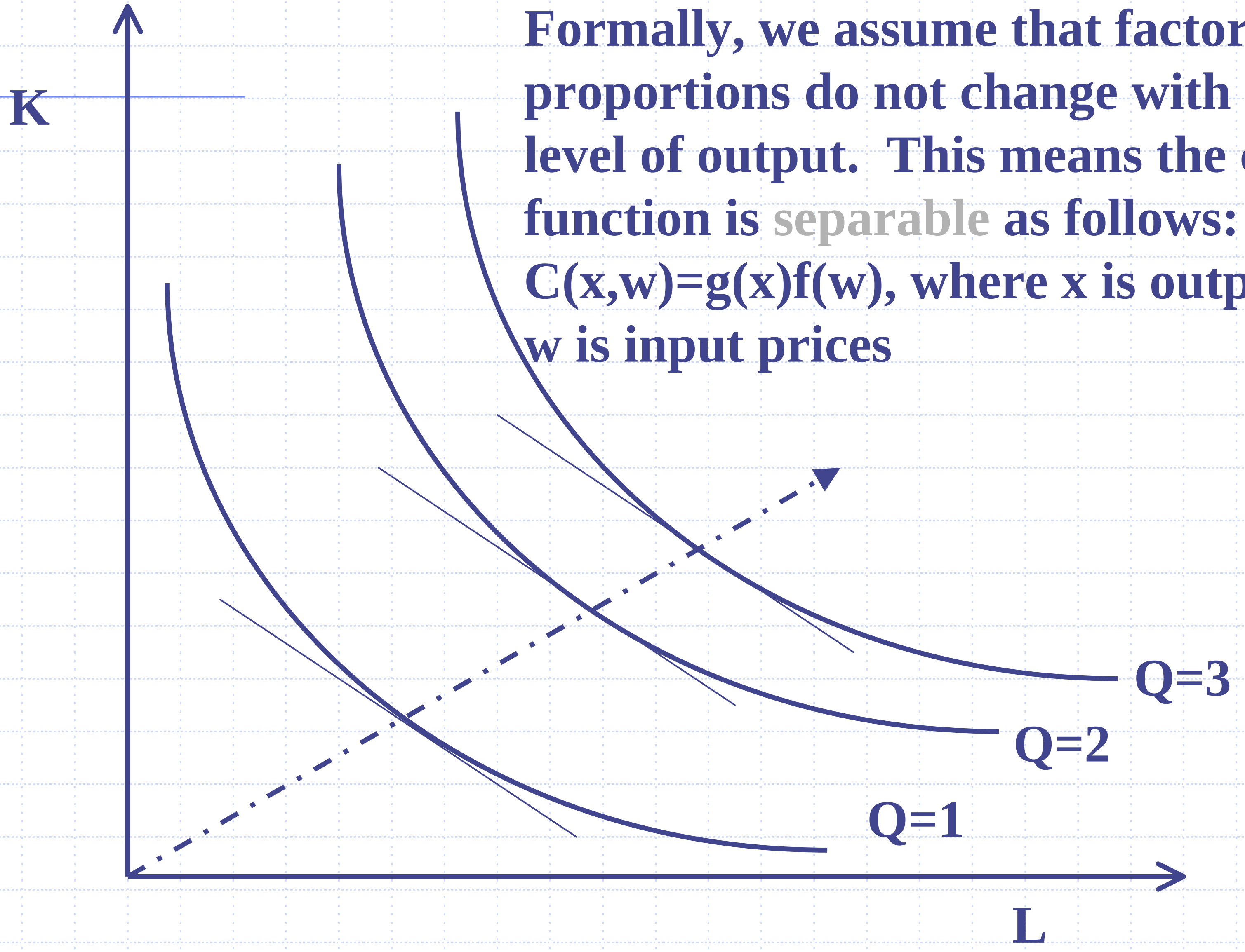
Translog (TL)

Does not impose homotheticity.
Flexible but more difficult to parameterize.
Large number of parameters makes it difficult to estimate on short datasets.

Also requires that the curvature restrictions in the integrability conditions be checked by hand after estimation.

Homothetic cost functions

Formally, we assume that factor proportions do not change with the level of output. This means the cost function is separable as follows: C(x,w)=g(x)f(w), where x is output and w is input prices

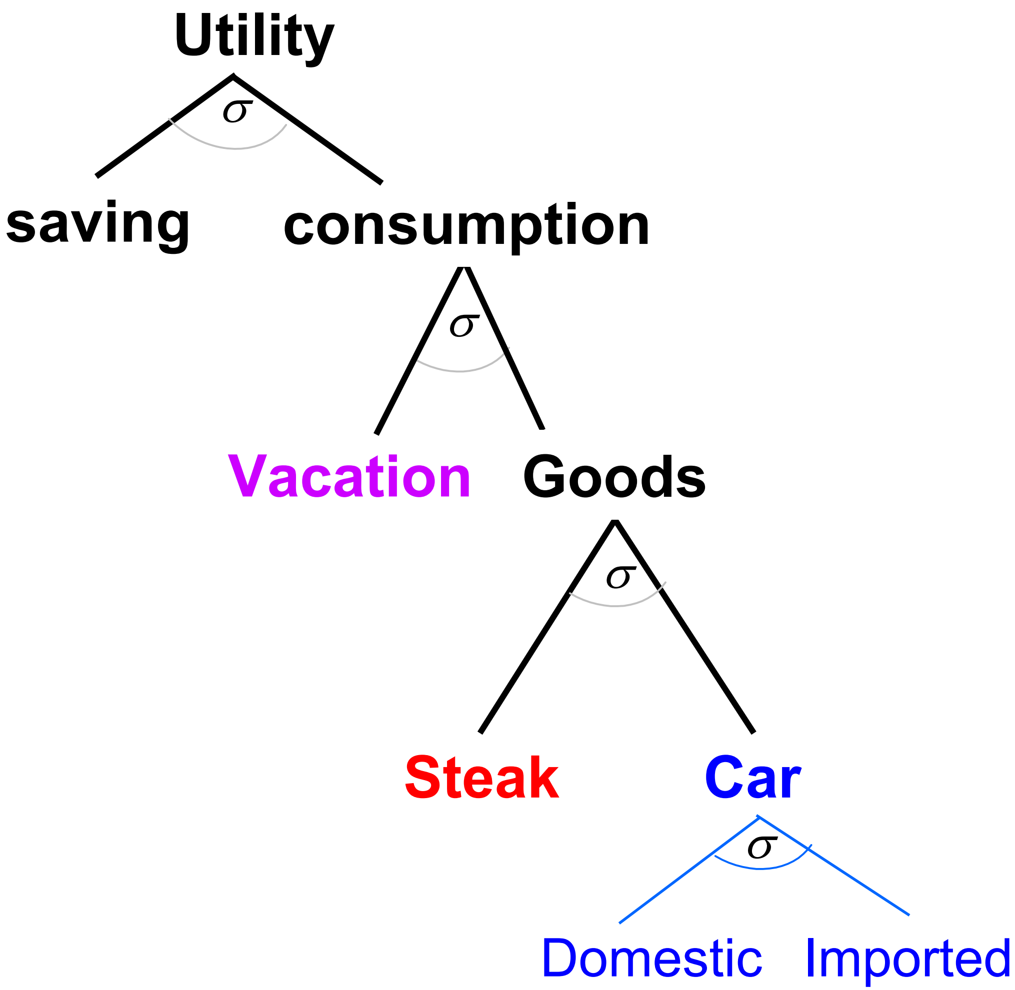


Functional Forms

Note that homotheticity (L, CD and CES) is highly undesirable in a utility function. It implies that expenditure shares do not vary with income, which has been consistently rejected in the empirical literature on demand.

Hierarchical (nested) functions - consumption

- **Nested utility function**



Substitution between saving and consumption goods

Substitution between leisure and goods

Substitution between steak and car

Substitution between domestic and imported car

Why use Hierarchical (nested) Functions?

Why use hierarchical (nested) functions?

: Allows different elasticity of substitution among factors and/or among intermediate inputs in the production

: Allows different elasticity of substitution among goods in the consumption

: Expands the number of elasticity parameters used in a calibration

Parameter Estimation

- CGE model has mostly two kinds of parameters to be estimated:
  - Share parameters, which can be estimated from SAM data.
  - Elasticity parameters describing curvature of various structural functions. These cannot be estimated from the SAM.

Parameter Estimation

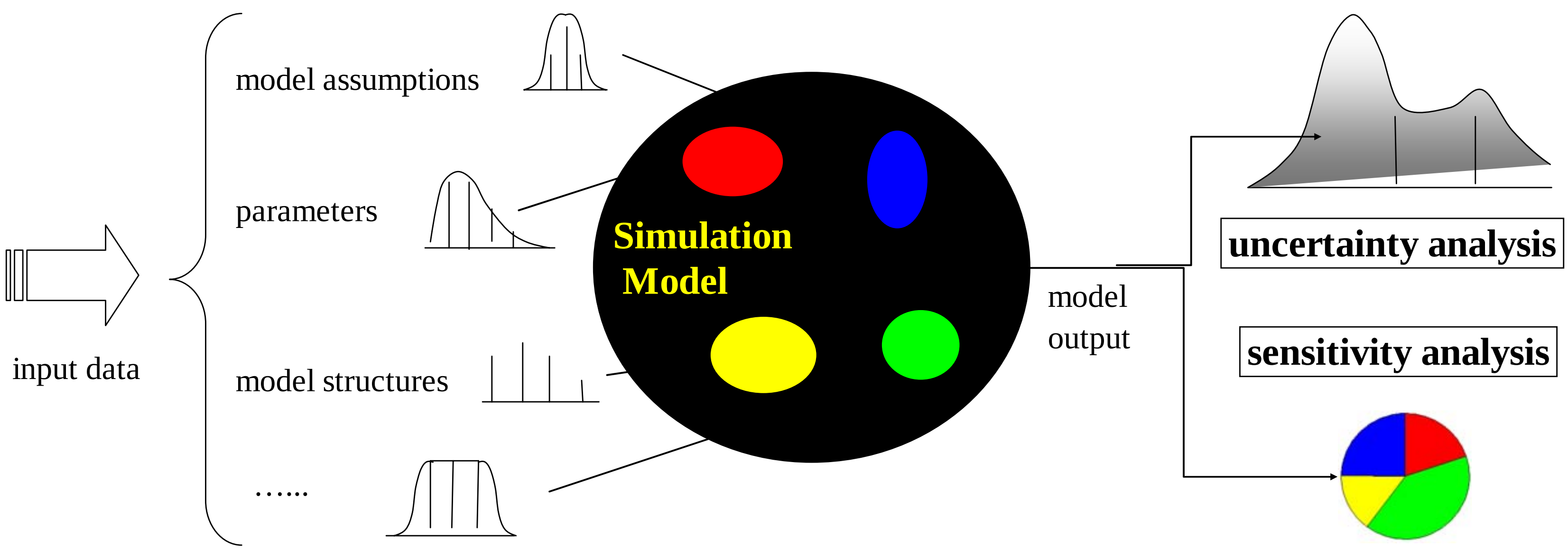
- “Benchmark” estimation. Model parameters are estimated so that the base data are an exact solution to the CGE model.
  - Assumption of base equilibrium imposes much prior knowledge on estimation.
  - Elasticities, however, are not constrained by assumption of base equilibrium.

Possible error sources

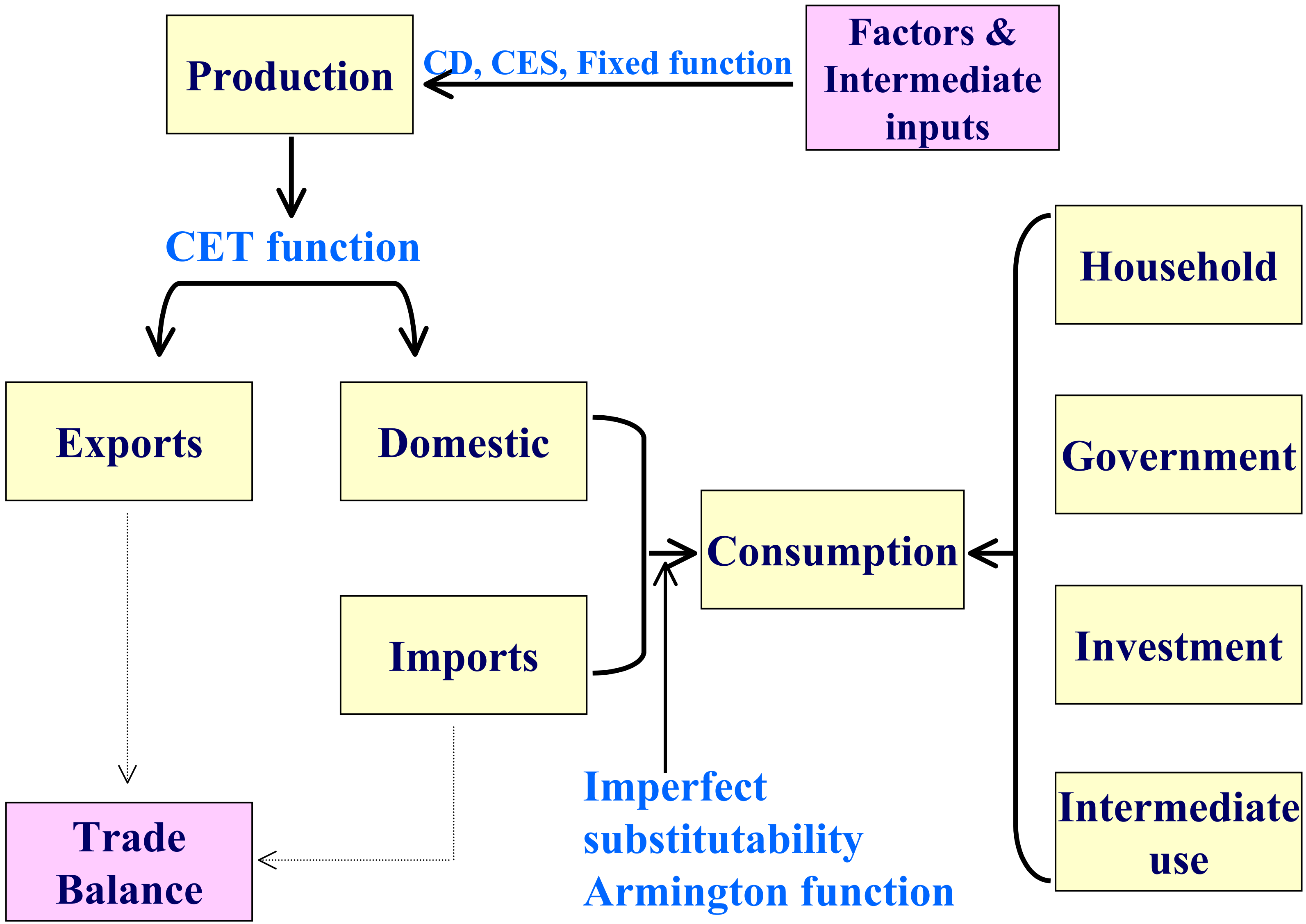
- New errors are introduced at every step of modeling
- Modeling error: the gap between the model and “reality”
- Errors due to mathematical methods used in solving the model
- Errors induced by the use of computers
- Errors in postprocessing (visualisation, data analysis)
- Wrong interpretation of the results

Screening methods

The model is a black box: information is extracted through simulation



CGE Overview -- Commodity Flow



Reference: Lofgren, H., R. L. Harris, S. Robinson, M. Thomas, and M. El-Said. "A Standard computable general equilibrium (CGE) model in GAMS, IFPRI, Washington, D.C.