MARKAL-TIMES hard-linked to the multi-regional MERGE model

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The objective

MARKAL-MACRO (M-M) and TIMES-MACRO (T-M) are general equilibrium models of a single region model. They aggregate all non energy sectors of the economy in a single sector and they represent it with a single CES production function.

Is it possible to extend the general equilibrium version of MARKAL-TIMES models to:

- *More than a single region?*
- More than a single production function?

MACRO

MACRO stand-alone defines an inter-temporal utility function of a single representative producer-consumer in each of the world region, which is maximized. The main variables of this module are the production factors capital stock, available labour and energy inputs, which together determine the total output of an economy according to a nested constant elasticity of substitution (CES) production function. The optimal quantities of the production factors are determined by their relative prices.

There are two versions of the MACRO stand-alone model developed by A. Manne; the first one corresponds to the macroeconomic module of MERGE while the second one corresponds to the M-M approach specially developed for the ETSAP tools.

MACRO in MERGE

Energy demand curves for the MACRO version of MERGE are given in two categories per sector, electric and non-electric energy. These demands are defined by quadratic functions per region and time using the engineering model's results i.e., the annual energy cost and the marginal costs of energy supply per region and time. Actual demands are determined by MACRO in a way consistent with postulated GDP adjusted to accommodate energy and environmental constraints. As there are only two demand categories per sector the demand simulation via quadratic functions is quite successful.

MACRO in MARKAL-TIMES

Similarly to MERGE the MACRO stand-alone sub-model of M-M is based on nested CES functions but demands cover the full set of energy services. One could determine again demands by quadratic cost functions but the disaggregated number of demands makes the quadratic functions less exact and successful.

Using the engineering model results to derive the quadratic demand functions for MACRO stand-alone we will iterate until the Macro's resulting energy demands and the engineering model's results are the same within a margin.

Research objectives

Activities will start with the national T-M or M-M models trying to decompose them and link them either with a stand-alone macroeconomic sub-model or with MERGE directly (each effort covering different purposes) and will continue with extensions to multi-regional global models like e.g., TIAM or GMM.

The new ETSAP tools will be completed with the active participation of the ETSAP team in charge of the GAMS codes and the users' interfaces and the procedures to be developed will be made available to the ETSAP tools licensed users.