# CONSTRUCTION OF HYBRID INPUT-OUTPUT TABLES FOR E3 CGE MODEL CALIBRATION AND CONSEQUENCES ON ENERGY POLICY ANALYSIS


Julien Lefèvre, CIRED[1]
Phone: +33 (0) 1 43 94 73 85 ▪ E-mail: jlefevre@centre-cired.fr

Gaëlle Le Treut, CIRED[1]
Phone : + 33 (0) 1 43 94 73 67 ▪ E-mail: letreut@centre-cired.fr

Frédéric Ghersi, CIRED[1]
E-mail: ghersi@centre-cired.fr

Emmanuel Combet, CIRED[1]
Phone: + 33 (0) 1 43 94 73 82 ▪ E-mail: combet@centre-cired.fr

[1]CIRED ▪ Centre International de Recherche sur l'Environnement et le Développement,
45 bis, Avenue de la Belle Gabrielle, 94736 Nogent-sur-Marne, France.
Fax : + 33 (0) 1 43 94 73 70


## Overview


Hybrid modelling approaches are increasingly used to bridge the historical gap between the bottom-up (BU) and top-down (TD) approaches to energy/economy/environment (E3) modelling. By nature, they require a substantial effort of harmonisation between national accounts and energy balance data. For most computable general equilibrium (CGE) models defined at the scale of a given country, efforts have been made to reconcile those data. But the methods being used and their impacts on the empirical information are generally poorly documented. Models domains corresponding to multiple countries rely on hybrid datasets whose characteristics and methods of production are not explored in details. Such an exploration is required, however, because different hybridisation techniques have different impacts on key empirical features that are important for policy evaluation. After reviewing the literature on hybridisation methods, this paper proposes an innovative procedure for building hybrid Input-Output matrices at the scale of a country, and illustrates it with data for France. Compared to existing methods, this procedure includes information about energy flows, prices and quantities coming from energy statistics, without alteration on this data. All this information is then introduce within a consistent social accounting framework. The impact of this method is illustrated in a standard Capital-Labour-Energy (‘KLEM’) CGE model. The welfare costs of the same price-induced energy policy are evaluated, keeping the same behavioural structural assumptions and parameters. The model is alternatively calibrated either using our hybrid matrices or unmodified original input-output data from national accounts. This comparison shows that the model calibrated on hybridised data produce systematically lower welfare costs estimates, when targeting energy reduction alternatively on firm consumptions and household consumptions.


## Methods

Standard macroeconomic models are exclusively built on monetary data drawn from national accounts and benchmark quantities are not described in physical units. The need for physical information, such as energy consumptions, to carry out E3 analysis has led to develop hybrid accounts. They depart from the standard accounts but collect and process additional data. Based on energy volumes, and sometimes on prices of goods, they reconcile monetary flows registered in the Input Output Tables (IOT) of national accounts. All hybridisation procedures follow two basic accounting principles: (i) both the physical and money descriptions must respect conservation principles (the balances of resources and uses, respectively in quantities and values), (ii) physical and money flows are linked by a system of price. However, the method of data hybridisation is not standardized and different procedures may be proposed. We compare, at the level of the single region existing hybridisation procedures. Then, we explain the choice made in developing hybrid methods for the IMACLIM modelling framework. This method follows two main rules: (i) the total size of the economy is preserved, (ii) the data on energy quantities and prices faced by economic agents are reintroduced. The procedure involves three mains steps. First, it reorganizes the physical datasets, namely the energy balance and energy prices, into input-output formats compatible with that of national accounts. Then, it reconstitutes energy expenses multiplying energy quantities and prices. Finally, it substitutes the calculated energy expenses in the system of national accounts, adjusting other components of the accounting system without modifying the total value-added of domestic production and keeping global balance. We illustrate the method on the 2010 French economy, focusing on energy flows.

## Results

By applying hybridization procedure, the calculated energy expenses of the energy sector are cut down by 61%. We show that major determinants of policy analysis also change like the share of firm and household in total energy expenses or the relative energy purchasing prices of firms and households. We calibrate a standard 'KLEM' CGE model on 2010 France, either on hybrid accounts with agent-differentiated prices or on unmodified national accounts, to illustrate the consequences on policy analysis. To do so, we explore the welfare costs of a full range of energy reduction (5% step reduction up to 95%) induced by an excise tax on firm, household and total energy consumptions. We show that hybridised data produce systematically lower welfare cost estimates, in each case of excise tax. However, the divergence appears to be stronger in the case on an excise tax on firm consumptions with much more contrasted repercussions. If the absolute gap between welfare cost coming from hybrid data and unmodified data is small, relative gap appears to be much more contrasted. Moreover this relative gap is ever-increasing as the target's ambition decreases. For a 5% cut of firm consumptions the welfare cost estimated on unmodified data, although a small 0.21%, is over 6 times that estimated on hybridised data

## Conclusions

Firstly, the paper underlines the fact that building a hybrid social accounting matrix has a non-marginal impact on the empirical description of the initial state of an economy. Therefore, hybrid matrix also impacts the policy evaluations drawn from CGE models of this economy. Indeed, changes on empirical description occur on figures that matter for energy policy evaluation: the economic size of energy flows, the relative share of energy bills paid by productive sectors and final consumers, the relative energy prices paid by economic agents and hence the relative energy consumption volumes of economic agents. Compared with the other hybridisation techniques, the solution proposed in this paper replaces the nomenclature of energy flows in IOT by the nomenclature used in energy balances. It allows for keeping the whole size of the economy unmodified, as recorded in national accounts, while including without alteration the quantitative information about energy flows, and prices that come from specialised statistics. The "validity" of the description will therefore be based on the accuracy of those statistics and their aggregation. The solution can be extended to other material flows, or to other countries or years. Secondly, the paper shows that hybridisation techniques induce changing on the empirical description of the initial state. It shows how this initial state has impact on policy analysis, even with a small and highly aggregated "standard" neoclassical model like the one used here. Nevertheless, the magnitudes of the impacts will vary with the modelling assumptions about technical change and the macro functioning of the economy. They will also differ with the levels of aggregation of productive sectors and economic agents, as well as, with the specific data at hand. The primary motivation for elaborating hybrid social accounting matrices remains to introduce in CGE frameworks the expert information about future technical change and energy saving possibilities at different time horizons. Therefore, a natural follow up to this paper would be to diagnose how the different techniques and assumptions used to realise this dialogue between bottom-up engineering expertise and top-down macroeconomic modelling, may impact subsequent evaluation studies.

## References

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