International Institute for Applied Systems Analysis
IIASA www.iiasa.ac.at

A National Scenario for a Regional Model

Grassini, M.

IIASA Working Paper

WP-82-131

November 1982

A NATIONAL SCENARIO FOR A REGIONAL MODEL

Maurizio Grassini

November 1982
WP-82-131

INTERNATIONAL INSTITUTE FOR APPLIED SYSTEMS ANALYSIS
A-2361 Laxenburg, Austria

PREFACE

In the standard literature on regional and multiregional modeling one can find a dichotomy with regard to approaches suggested. When a top-down strategy is contemplated, a break-down method is applied to a national model. The bottom-up approach instead implies that national scenarios are obtained through summing-up the regional components.

The Tuscany Case Study has been carried out in such a way that it does not properly fit into the framework mentioned above. Both from a theoretical and pragmatic point of view strong arguments can often be given for continuing a top-down and bottom-up approach. In this way certain consistency checks can be made. In the case of the Tuscany Case Study the national model had to be used as a means to feed the regionalized model with the outcome of actions related to agents which are recognizable only at the national level.

Laxenburg, November 1982

Börje Johansson
Acting Leader
REGIONAL DEVELOPMENT GROUP

CONTENTS

1.	THE NEED OF A NATIONAL SCENARIO FOR REGIONAL MODELS	1
2.	THE NATIONAL SCENARIO IN THE TUSCANY CASE STUDY	2
3.	THE REAL SIDE OF THE NATIONAL MODEL	6
4.	THE OUTCOME OF THE NATIONAL MODEL	13
References		14

A NATIONAL SCENARIO FOR A REGIONAL MODEL

Maurizio Grassini

1. THE NEED OF A NATIONAL SCENARIO FOR REGIONAL MODELS

The Tuscany Case Study (TCS) as a biregional model distinguishing Tuscany from the Rest of Italy properly covers the whole national economy. But, TCS is not a national model; Tuscany, as a functional region, is a small open economy and economic processes located in closer areas strongly interacting with Tuscany have to be taken into account. This has been accomplished by defining the Rest of Italy as a working surrounding area, and because of the dimension of the biregional model, the evaluation of the impact of the national economic activities over Tuscany has been made possible.

Efforts on selecting specific data have been made mainly for Tuscany. Consequently, the Rest of Italy statistical data have been derived as differences fron national figures. This is the first connection one can find with the national dimension of the biregional model. Furthermore, however short the horizon, the use of the model for forecasting requires assumptions concerning both regions. The attempt to model regional economic processes and to give evidence of local agents' actions is not equally accomplished in Tuscany and in the Rest of Italy, neither can one assume that the sum of regional agents is equal to the national decision-makers set. Macroeconomic policies such as monetary and fiscal policies have a strong impact on disposable income, rates of interest, exchange rate, and credit: all variables affecting regional economies but completely, or least partially, determined out of the regional dimension.

Then, a regional model as a bi- or multiregional model requires a national scenario which represents the frame delimiting the feasible set of the local economic phenomena.

2. THE NATIONAL SCENARIO IN THE TUSCANY CASE STUDY

The national scenario for the TCS model is provided by INTIMO (Interindustry Italian Model). INTIMO is a modern input-output econometric type model of the Italian economy. It belongs to the INFORUM (Interindustry Forecasts project, University of Maryland), family; this project, founded and directed by Professor Clopper Almon, stimulates the construction of national models under a unifying scientific approach and through the linkage of them by means of a dynamic model of international trade. Hence, models can run together or separately, there being an updated international scenario for each member specifically supplied. INTIMO, as the TCS core model, is based upon an input-output scheme. The statistical data come from the Tavola dell'Economia Italiana (1975) and the present model retains the maximum detail, this is to say, the representation of the economy in 44 branches. The connection between INTIMO and TCS classifications is presented in Table 1.

The general structure of the model is presented in Figure 1. It is easy to recognize the input-output framework starting from the intermediate consumptions box. At its right and bottom final demand and value added components are respectively listed. The variables considered in the model and their connections shown by the arrows give evidence of the integration between real and price sides. A specific link running from value added to final demand components goes through an income distribution process where institutional rules and public policy-makers affect i.e., the family disposable income and the propensity to consume. These

Table 1. Comparative Scheme of the 44 Industries and the 31 Industries Classification.

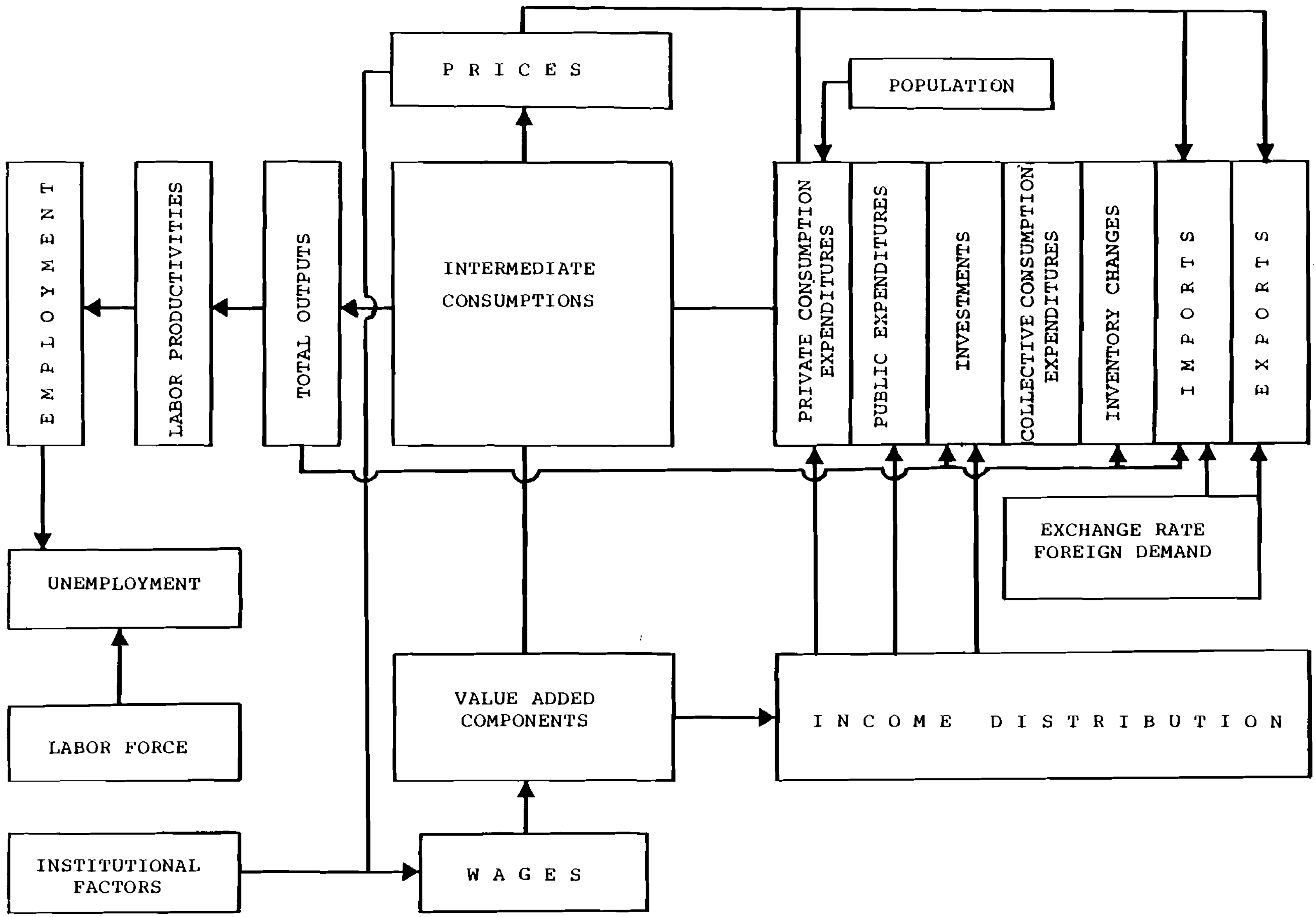
INTIMO	INDUSTRIES	TCS
1	Agricultural, forestry and fishery	1
2	Coal mining	
3	Coke	2
4	Crude petroleum, natural gas, oil refining	
5	Electric, gas and water services	3
6	Nuclear fuel	
7	Iron and non-ferrous metal ores mining	4
8	Stone and clay products	5
9	Chemical and pharmaceutical products	6
10	Metal products (motor vehicles and machinery excluded)	7
11	Farm and general industrial machinery and equipment	8
12	Office machines; scientific instruments	9
13	Electric lighting and wiring equipment	10
14	Motor-cars, lorries and equipment	11
15	Other transportation equipment	
16	Fresh and corned meat and other butchery products	12
17	Milk and kindred products	13
18	Other food	14
19	Alcoholic and non-alcoholic drinks	15
20	Tobacco manufactures	16
21	Fabricated textile products and apparel	17
22	Leather tanning, leather products, footwear	18
23	Lumber and wood products, furniture	19
24	Paper and allied products, printing and publishing	20
25	Rubber and miscellaneous plastic products	21
26	Miscellaneous manufacturing	22
27	New construction and public works	23
28	Scrap, used and second-hand goods; maintenance and repair services	24
29	Trade	
30	Hotels and lodging places	25
31	Land transportation	
32	Sea and air transportation	26
33	Warehousing and kindred services	
34	Communications	27
35	Finance and insurance	28
36	Business services	30
37	Real estate and rental	29
38	Marketed research and educational services	30
39	Marketed sanitary services	30
40	Marketed amusement and cultural services	30
41	Non-marketed miscellaneous services (government services)	
42	Non-marketed research and educational services (government services)	31
43	Non-marketed sanitary services (government services)	
44	Non-marketed household services	

variables have their main impact on private consumption. Here, processes leading to the determination of interest rate and user costs of capital should find their settlement once sectoral data are available.

A closer look at the model can begin by considering the top-right side of Figure 1 where one finds the final demand (vector) variables. Among them are imports; in an accounting scheme they are usually jointly listed with outputs with which they sum up to total resources. Here, imports are included among private consumption, investment, exports, public expenditure and inventory change because in the logic of the model they are provided by behavioral equations and, as can be made clear later on, they are considered as explanatory variables in the identity equation which gives outputs as equal to intermediate consumption plus final demand components minus imports. All these variables are disaggregated for branches, so is the productivity of labor situated on the left of total output. For each sector, this variable measures the amount of labor per unit output as a function of the activity level; according to the parametric structure of these functions detected from historical data, once the sectoral output is computed, the employment is derived. The total employment is subsequently confronted with the total labor force and the amount of unemployment is estimated.

Starting from the price (vector) block, passing through the intermediate consumptions down to the value added block, we can isolate the price side. Here, we find wages, social contributions, other incomes, replacements, taxes and contributions to the production, all measured at sectoral level. The econometric functions concern some value added components (wages, salaries), others being specific policy instruments. The price equation can be considered as an account identity giving a rationale for price indexes or, as long as the theory can be suitable in the case at hand, a mark-up approach for price determination. Here, the Leontieffian matrix must be split for home and import intermediate consumption to distinguish national and foreign components of the price dynamic. Furthermore, it is worthwhile to notice that some important exogenous inputs reach the core of the model through wage equations.

Figure 1. General Features of INTIMO



Those equations measure the evolution of the wage indexes with respect to a given base year and, being tailored to match long-term movements, they are considered the place where it can be suitable to incorporate institutional factors such as peculiarities of industrial relations and even long-term money supply effects. These wage equations give evidence of a way to introduce the effect of strategic variables not included into the general input-output accounting scheme.

The real and price sides of INTIMO, as in any other model of the INFORUM family, can be solved simultaneously or separately; considering the model as a tool for providing the TCS of a national scenario, here the attention is mainly focused on the real side outcomes.

3. THE REAL SIDE OF THE NATIONAL MODEL

The analytical structure of the model can be conveniently presented starting from the Leontieff equation

$$Ax + f = x \qquad (1)$$

where x is a vector of sectoral total outputs, f is a vector of sectoral final demand components and A is the intermediate consumption matrix per unit output. This equation states that the total (sectoral) output is equal to all the final uses plus goods and services consumed in the production process in a given time span. Here, the time span is equal to one year and the final uses are distinguished into private consumption expenditure, three government sectors (general administration, health and education services), collective private consumption expenditure, investment, inventory change, exports, and imports (with a negative sign).

In general, we can state that the final demand vector is equal to the sum of r final demand components

$$f = f_1 + f_2 + f_3 + \ldots\ldots + f_r \qquad (2)$$

Some components, let us say $k \leq r$, are explained by means of econometric equations. These components and the total output are the set of the endogenous variables of the (real side) model. Once an econometric estimate of a set of variables is required, the statistical data available can impose classifications conceptually different from the ones in the basic accounting scheme. We find this kind of discrepancy for private consumption expenditure and private investment. The estimation of a demand equations system is carried out relying on time series data available, that in the National Account (NA) scheme refer to an hypothetical consumer's basket which, of course, has a structure different from that of an I-O branches classification. In modeling investment functions, time series data must refer to investing sectors while in an I-O table final demand for investment is related to producing sectors. In these cases, one needs a code for transforming into I-O final demand vectors the estimates obtained by using NA data; every Central Statistical Bureau producing NA and I-O statistics supplies such kinds of codes which connect the two accounting schemes. These codes are known as bridge matrices having rows and columns relating to the two classifications. In general, we can assume that such a bridge between NA and I-O statistics must be accomplished for each final demand vector, so that calling B_i the bridge matrix for the i-th final demand vector, and F_i the NA item classification of vector f_i, we have

$$f_i = B_i F_i \qquad (3)$$

When classification discrepancies are not met, matrix B_i will be equal to an identity matrix (as is the case for import and export vectors specifically produced from OECD data matching directly the used I-O classification); then we can redefine

$$Ax + B_1F_1 + B_2F_2 + \ldots\ldots B_rF_r = x \qquad (4)$$

As previsouly stated, $k \leq r$ final demand components are explained by behavioral equations econometrically estimated. Each final demand component is then considered at its own level of disaggregation according to NA time series available with its specific bridge matrix. Then for each vector F_i we have a set of n_i equations

$$
\begin{aligned}
F_{i1} &= F_{i1}\ (\cdot) \\
F_{i2} &= F_{i2}\ (\cdot) \\
&\vdots \\
F_{ij} &= F_{ij}\ (\cdot) \\
&\vdots \\
F_{in_i} &= F_{in_i}(\cdot)
\end{aligned}
\qquad (5)
$$

Among the explanatory variables in $(\cdot)$ one can find variables which are expected to be solved simultaneously in the system; variables which are endogenous in the price side of the model; and variables which are purely exogenous.

The endogenous variables in the real side of the model can be gathered into a vector

$$
\begin{bmatrix} F_1 \\ F_2 \\ \vdots \\ F_i \\ \vdots \\ F_r \\ x \end{bmatrix} = \begin{bmatrix} F \\ x \end{bmatrix} \qquad (6)
$$

where F is a subvector collecting all the final demand components.

A general view of the model can be given assuming, for easy notation, that all the functional forms in the system be linear; in fact, some of them are strictly non-linear, but we resort to a linear approximation to make it possible at a glance to detect the interdependencies present in the structural equations. Then, the model can be presented as follows

$$\begin{bmatrix} F \\ x \end{bmatrix} = \begin{bmatrix} D & C \\ B & A \end{bmatrix} \begin{bmatrix} F \\ x \end{bmatrix} + G \qquad (7)$$

Matrix C contains parameters relating to those components of total output, x, which appear as explanatory variables in the final components equations; matrix B is a collection, $[B_1, B_2, \ldots]$, of bridge matrices which convert into the I-O classification the econometric estimates of variables defined according to the other accounting scheme; A is the intermediate consumption matrix; D contains parameters whereby interactions among final demand components are considered. G is a vector collecting the contributions of predetermined variables. Vector G can split into two components; one considering the impact of lagged endogenous variables, and the other, what is due to purely exogenous factors. For easy notation, once more, let us consider no more than one lag in endogenous variables; then,

$$G = G_1 + G_2 = \begin{bmatrix} W_1 & W_2 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} F \\ x \end{bmatrix}_{-1} + \begin{bmatrix} P_1 \\ P_2 \end{bmatrix} z \qquad (8)$$

where we can recognize the vector of endogenous variables lagged one period. Vector z summarizes all the purely exogenous variables. Matrices W_1, W_2 and P_1 contain parameters relative to predetermined variables involved in final demand structural equations; P_2 is formed to select those final demand components considered exogenous. Now, (7) and (8) can be conveniently presented as two sets of equations; the first is

$$F = DF + Cx + W_1F_{-1} + W_2x_{-1} + P_1z \qquad (9)$$

defining the general structure of the final demand components structural equations; the second is

$$x = BF + Ax + P_2z \tag{10}$$

This set reproduces the Leontieff equation, where

$$BF = B_1F + B_2F_2 \dots + B_kF_k = f_1 + f_2 + \dots + f_k \tag{11}$$

and

$$P_2z = f_{k+1} + f_{k+2} + \dots + f_r \tag{12}$$

Hence, if we move to final demand component from vector F to vector P_2z, namely, decide not to give any econometric explanation of these endogenous variables, we are led to the fundamental equation (1). This gives us the meaning of the departure from the classical analytical core of input-output analysis stressing, at the same time, what is nowadays meant by modern input-output modeling.

We can now consider what is included in P_1z. Following Figure 1, we find population, labor force, prices, disposable income, foreign demand, foreign prices, and exchange rate. These variables have different degrees of exogeneity. Population and labor force are purely exogenous, there being at present no demographic submodel considered in the INFORUM type model. Prices are no longer exogenous if real and price sides are run together. Anyway, whereas they are included among explanatory variables, they appear in equations where, due to homogeneity conditions, only relative prices are considered. Since ratios of prices, in general, tend to have smooth time evolutions, for forecasting purposes trends in relative prices can adequately represent the paths for these exogenous variables. Disposable income is potentially modeled in the box concerning income distribution; here incomes coming from value added components are submitted to fiscal and transfer policies as well as to all the macroeconomic manipulations involving institutional agents. In this sector, we find many policy instruments which can be used to define the set of feasible scenarios set up by policy makers. Then, disposable income can be modeled for giving evidence of the impact on it of all these kinds of instruments; but, we can even consider the case in which disposable income is given as target value, so that it becomes an independent variable in the income distribution block and can be labeled as a policy instrument for the real side of the model. Foreign demand and foreign prices are strictly exogenous variables for a national model; for members of the INFORUM group, such variables can be considered partially endogenous as soon as models are run together through the world trade model specifically designed for the international linkage of them. Anyway, a model specific data base for foreign trade--sectoral demands and prices--is provided for each member of the INFORUM group. Exchange rate is the last predetermined variable met in the real side of the model. It is partially exogenous since its historical trend and systematic surplus or deficit of the commodities and services foreign balance constrain the feasible scenarios for the exchange rate itself.

The model allows for the introduction of other exogenous information, which can be labeled as structural hypotheses and can be explained considering the parametric structure in (7). First of all, we have matrix A which give the technological structure of the economy and, especially in forecasting simulation, it is hard to consider it constant over time; each element of A is expected to vary, so that the matrix should be provided with an index t defining its value of a particular point of the time axis. Matrix B is a collection of bridge matrices; some of them can be equal to the identity matrix, but others show the links between I-O and NA classifications at a given year. Behind a constant value over time of an NA figure we can find a demand to I-O branches different in composition. Then, even the bridge matrices can require an index t. Matrices D and C, as well as W_1, W_2 and P_1, due to the linear approximation of the final demand components functional forms, contain parameters that are constant and represent the structure of the behavioral or institutional estimated equations. Structural parameters indicate propensities, multipliers, elasticities and so on; these are not necessarily assumed to be constant in the long run projections and, if necessary, they can conveniently be modified. Anyway, we want to make clear that such a kind of structural change in parameter, if expected, is mainly measured on the time path of the (dependent) endogenous variable; if, for example, an income elasticity in a consumption function is expected to decrease in the future, what matters is to make sure that the specific consumption item will follow a given path. It is the same for rationing and autonomous investment done in specific sectors (i.e., constructions). Thus, it is better to consider the case of turning endogenous variables into exogenous ones if the influence of the policy maker or a priori information is strong enough to fix the outlay out of the private decision sphere, rather than managing with behavioral equation structural parameters.

Then, we have matrices A and B which can be provided with an index t, and the equation system (9) with a flexible dimension.

Confining attention to the real side of the model, once given a scenario (which determined vectors P_1z and P_2z), the model can be solved in the endogenous variables F and x. The "linearized" version of the model overrides the nonlinearities which are largely present in the final demand component equations so that the iterative procedure in solving the model risks not being appreciated. In fact, the equations for F are mainly nonlinear and the solution can conveniently be carried out as follows. First a guess on total output, x^0, is given. The first solution for the endogenous variables, F^0, is obtained and used for solving the Leontieff equation (1); the value of the total output, x^1, is then used to compute a new value for the final demand components, F^1. The procedure is repeated until the difference between output vectors in successive iterations is considered negligible.

4. THE OUTCOME OF THE NATIONAL MODEL

Given national scenarios, INTIMO provides forecasts for the Italian economy. These forecasts are composed of 40 private consumption expenditure items, 23 investment estimates for investing sectors, 26 inventory changes according to producing branches, imports and exports on commodities for 27 sectors and 9 exports and 10 imports on services.

Private collective consumption and public expenditure belong to the scenario, while sectoral total outputs are forecast components. By means of labor productivity equations, total outputs permit the estimation of sectoral employments. The comparison of total employment with the labor force (a scenario variable) gives an estimate of total unemployment.

The variable structure of the INTIMO real side model is summarized in Table 2.

Table 2. Variable Structure

Scenario	Forecasts
Population	Private Consumption Expenditures
Labor Force	Investments
World Demand	Inventory Changes
Foreign Prices	Imports
Disposable Income	Exports
Prices	Employments
Rate of Exchange	Total Outputs
Private Collective Expenditure	
Public Expenditure	

The present variable structure represents the coverage to which the biregional model, during the process of building, tends to fit.

REFERENCES

Almon, C. (1981) An International Family of Linked Input-Output Models. Paper presented at the International Conference on "Structural Economic Analysis and Planning in Time and Space", University of Umeå, Umeå, Sweden.

Almon, C., M. Buckler, L.H. Horwitz, and T.C. Reimbold, (1974), 1985: Interindustry Forecasts of the American Economy (D.C. Healt, Lexington, Mass).

Ciaschini, M. (1982) Modern Input-Output Models as Simulation Tools for Policy-Making, Collaborative Paper, CP-82-56, International Institute for Applied Systems Analysis, Laxenburg, Austria.

Ciaschini, M. and M. Grassini (1981) INTIMO: il modello italiano nel sistema INFORUM. Rapporto preliminare. Presented at the II Conferenza Italiana di Scienze Regionali. (AISRE), Napoli, Castel dell'Ovo.

Grassini, M. (1982) Un Modello Macroeconometrico di Analisi e Previsioni Intersettoriali, XXXI Riunione Scientifica della Società Italiana di Statistica (forthcoming in the Proceedings).

Nyhus, D. (1975) The Trade Model of a Dynamic World Input-Output Forecasting System. INFORUM Research Report No. 14 - INFORUM, University of Maryland.

Snickars, F. (1982) "International Linakges in Multiregional Economic Models", in Boris Issaev, et al. (ed.). Multiregional Economic Modeling: Practice and Prospect, North-Holland, Amsterdam.