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I. Tchijov L. Tomaszewicz (Eds.)

Input-Output Modeling

Proceedings, Warsaw, Poland, 1985

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(International Institute for Applied Systems Analysis)
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PREFACE

Input-output modeling activities have been sponsored by IIASA for many years. These activities provided a link between various research centers as well as associated research groups engaged in constructing similar systems, and also individual researchers interested in the application of input-output type models.

The aim of the sixth IIASA meeting was to demonstrate to a wide community of researchers, policy makers and their advisers the likely uses of integrated input-output models in econmic policy both at industrial and national levels. This message is well illustrated. The papers provide the users with illuminating simulation studies showing on the one hand the impact of technological structural changes in the macroaggregates and on the other hand how the changes in macrovariables influence the pattern of changes in particular industries.

This volume presents the results of the meeting organized by IIASA and IES in Warsaw.

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INTRODUCTION

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The Sixth IIASA Task Force Meeting on Input-Output Modelling took place in Warsaw (Poland) from 16 to 18 December 1985. The programme committee consisted of C. Almon (responsible for participants from the USA and oversea countries), J. Richter (responsible for the participants from Western Europe) and L. Tomaszewicz (responsible for participants from the socialist countries). The Institute of Econometrics and Statistics of the University of Lodz was the local organizer. This volume contains the proceedings of the meeting.

Among the participants there were two IIASA staff members and nineteen specialists representing economic or econometric departments of universities and research institutes from Austria, Czechoslovakia, France, the FRG, the GDR, Norway, Poland, Switzerland, the United Kingdom, the USA and the USSR. Most of them represent the INFORUM-family model builders. The main attention of the meeting was paid to the following topics: the development of input-output models of the national economies and their policy applications including the optimization, as well as the industrial use of the input-output models. Both of them have also been reflected in the research work of the IIASA "Economic Growth and Structural Change" Project, carried out in 1985.

The 16 papers presented at the meeting and the 3 papers contributed to it, have mainly an applied character. The first group of papers examines practical experience stemming from the construction and direct application of input-output models of the national economies to economic policy making. The possibilities of using the input-output approach in optimal decision making at the national level are also discussed. Naturally, international comparisons and practical problems of linkage of various national models (using foreign trade flows) are shown as well.

Papers devoted to the industrial use of input-output models are concentrated on modelling and analyzing the activities of particular branches within the framework of the input-output approach. Special attention is also paid to the problems of the efficiency of energy use.

Each of the above-mentioned areas is briefly described below.

I. INPUT-OUTPUT MODELS AND ECONOMIC POLICY APPLICATIONS

A good introduction to this group of papers is the study of C. Almon, dealing with LIFT in the INFORUM system. C. Almon -- the leader of the

INFORUM-team at the University of Maryland -- concentrates on summarizing the main principles of INFORUM model building. These models use strict input-output relations to ensure internal consistency, the modelling, carried out at a detailed level, is added up to obtain aggregated total values, and attention is paid to the long-run properties of the model. C. Almon analyzes some exceptions to these principles and indicates ways to overcome them. The second section gives an example of the application of LIFT to calculating the effects of protectionist measures applied to particular industries by establishing quotas on imports of competitive goods. The impacts of the protection of the exchange rates are also illustrated.

The next paper, written by P. Sand, is devoted to the input-output model for Norway. The central part of this model is composed of relations representing the technological and cost structure of the economy, as well as other definitional and balance equations. The quantity model and the price model are connected with submodels describing other macroeconomic categories. Apart from the direct application of this model to macroeconomic planning and elaboration of national budgets, an interesting idea of constructing and using impact tables is suggested in the paper. These tables are aimed at showing the effects of changes in exogenous variables. Examples of the application of impact tables in simulation experiments, allowing for verification of the model construction itself, as well as for analysis of different variants of the economic policy, are also given. Special attention is paid to the use of impact tables in testing the stability of input-output coefficients and in adjusting the economic plan during the planning period according to structural changes in basic categories being modelled.

The"bottlenecks" in the economy are one of the main topics in the paper presented by R. Filip-Koehn and R. Staeglin. The authors give a short description of simulation experiments with changes in raw material supply and their impact on production, employment, prices and wages. A separate section is devoted to the impact of defence spending on employment. These considerations are presented with a survey of policy applications of input-output models in the Federal Republic of Germany.

A new approach to cost structure analysis by the use of input-output methods proposed and applied to the investigation of post-war technological progress in the Japanese economy is described in I. Tchijov's and I. Sytchova's paper. The analysis is based on seven comparable input-output tables for 1951-1980. The method reveals relations between economic growth, structural changes and cost reduction, as well as dynamics and interdependencies of the three types of technological progress (labor-material-capital savings) for 18 industries and the Japanese economy as a whole.

The adaptation of a "classical", demand-oriented, INFORUM-type macromodel for the description of economic phenomena in centrally-planned economies is shown by P. Karasz on the example of Czechoslovakia. The differences lie rather in the behavioral part of the model, consisting mainly in introducing specific demand functions of personal and social consumption, and taking into account central regulations of investments and inventory changes, as well as an assumption of full employment in modelling the labour processes.

The computations of macroeconomic structural parameters are shown by J.F. Divay and F. Meunier on the example of input-output coefficients. The authors give an idea of computing these coefficients by applying a relatively simple econometric model based on Leontief's linear relations between output and production factors. The parameters of this model are estimated by applying statistical data from particular enterprises with respect to balancing constraints, heteroscedasticity corrections, a priori constraints on some coefficients, and problems of inventory changes or products in process.

II. OPTIMIZATION MODELS BASED ON THE INPUT-OUTPUT SCHEME

The authors of the next two papers introduce some optimazation techniques using as a basis the input-output systems. S. Kazantzev describes a sectoral linear optimization input-output model, maximizing the total consumption in a given structure for each time period, assuming constrained output for each sector, available stock of fixed assets and labor resources. The model allows to balance the level of output of sectors producing investment goods with the amount of financial resources available to these sectors. Theoretical analysis of the model solution is then carried out, based on shadow-prices of the right-hand side of the constraints. An example of different paths of the economic growth according to different volume of centralized investments and their sectoral structure is also given.

The paper of Cz. Lipinski is devoted to the investigation of structural disproportions in the national economy, which occur when the output capacity of particular branches is utilized at different degrees. Contrary to the typical econometric methods, based on production functions, the method of computing the capacity utilization indices is based on a simple linear optimization model with maximizing the volume of consumption as an objective function. Leontief's system of input-output relations is used as restriction. Simulation experiments with changes in values of most important input-output coefficients allow to compute the impact of structural changes in production technologies on the capacity utilization. Some empirical results obtained for the Polish economy are shown.

III. LINKAGE OF INPUT-OUTPUT MODELS AND RELATED PROBLEMS

Efforts to develop the system of national input-output models have been completed successfully for the INFORUM-type models of seven developed countries. D. Nyhus used the INFORUM-ERI International System of Macroeconomic Input-Output Models of the USA, Canada, Japan, West Germany, France, Italy and Belgium to determine the implications of fixed exchange rates on output, employment and prices as well. His paper exemplifies the results for Japan and West Germany.

The INFORUM-type input-output models for socialist countries have not yet been integrated into the system, mainly because of empirical difficulties due to constraints in official statistics. The important step towards the construction of the system of these models is overcoming the data problems. The paper of A.B. Czyzewski, A. Tomaszewicz and L. Tomaszewicz reports on the method and results of reconstruction of the trade share matrices (1971-1980) for European CMEA countries and four CTN commodity groups. The authors formulate the propositions for exports and imports shares forecasting.

IV. INDUSTRIAL USE OF INPUT-OUTPUT MODELS

An application example of an INFORUM-type macromodel for Austria is given by J. Richter. Namely an attempt is described with the application of this model in microeconomic decision making, especially in the long run. It requires many additional efforts, both for the model builders and for its potential users, consisting e.g. in elaborating a kind of common language, gathering disaggregated data (using some special disaggregation techniques), applying quantities instead of values in constant prices, etc. It allows to improve decision-making of particular firms as well as to increase the reliability of the model estimates.

The use of the input-output approach for generating demand for a given industrial output within the framework of modeling the activity of this branch by econometric techniques is discussed by F.G. Adams. His paper provides a prototype for the linkage of national and sectoral models. Comments on the role of the input-output approach in industrial modeling are also made. The study presents sample period simulations and multipliers' analysis for the Italian metal mechanical industry.

A historical analysis and proposals on input-output modeling of the USSR wood and paper industry are given in A. Smyshlyaev's paper. This task was undertaken under the IIASA Forestry project. The historical analysis for the sixties and the seventies constitues a bridge between the qualitative structure of the resources development and the end-use structure.

The paper by H.-U. Brautzsch presents another example of application of the input-output approach to industrial modeling. This is an input-output submodel of the GDR's forest sector. It concerns the main flows of wood within the national reproduction process. The submodel is proposed to be linked to the model for planning the forest sector, which reflects the development of forest resources. Both of them also interact with the aggregated growth model of the national economy.

V. MODELING OF ENERGY RESTRICTIONS

The next three papers are devoted to the crucial problem of the economic development constrained by limited energy resources. Under such circumstances, several significantly important problems are to be solved by policy makers. The paper presented by T. Revesz discusses a choice between feasible variants of economic development. Selective variants (excluding raw material industries with a relatively large demand on energy) and non-selective variants (excluding none of the industries) considered for the Hungarian national economy are characterized by some economic indicators (depreciation, value of fixed assets, employment, wages, net energy costs). The results of the simulation experiments constitute a basis for such a choice, which is multicriterial in fact.

G. Antille and B. Laplanche examine another problem -- the impact of constrained energy production and import on the final domestic demand. The input-output formalization of this impact allows to take into consideration all significant interactions in the economic system. The model itself is built in physical units (as it concerns only the conversation processes of the energy carriers), but it can be easily linked with the classical input-output model in values.

Unlike the two above mentioned papers, dealing with the efficiency of energy use. P. Erdősi's paper analyzes the efficiency of energy production and distribution systems. The investigations are carried out on the basis of an input-output model, linking the demand on energy with needs for primary and secondary energy carriers, as well as needs for other economic resources (such as fixed assets, labor, wages, etc.). The study illustrates the results of some simulation experiments, based on the constructed model.

CONCLUSION

The Sixth Meeting on Input-Output Modeling proved to be a useful forum for input-output modelers to share their experience. We hope this volume may be of interest to other input-output researchers.

During the discussions, the use of the application of input-output models for international comparisons was underlined. In this context, the necessity of further development of models for centrally planned economies was emphasized. The shortage phenomena (supply constraints) should be taken into account in an internationally linked system of models.

New potential directions of the use of input-output analysis, were postulated taking into account the problems arising due to the rapid technological progress -- new technologies and new organizational systems, changes in the structure of labor markets, the growing importance of information processing, etc.

PRINCIPLES AND PRACTICES OF THE INFORUM INTERINDUSTRY MACRO MODEL

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The macro-economic models which have become the standard tools of business forecasting are, with few exceptions, aggregate models. They determine output of the economy within the framework of the quarterly National Income and Product Accounts (NIPA) with additional series on employment or financial variables. In recent years, some of the research groups that began with aggregate models have expanded them to provide industry forecasts by use of input-output tables. The technique has been to distribute - often via constant matrices - the components of final demand to industries and then to use often constant input-output matrices to calculate indicators of industry outputs. Actual outputs are then related to these indicators by regression equations or factors to adjust for the errors in the method. The results are indeed industry forecasts more or less consistent with the forecasts of the aggregate model. The method has the advantage of being easy and inexpensive once one has an aggregate model. It also doesn't "talk back" to the aggregate model, or assert any "opinion of its own" on the course of the aggregates.

The Inforum group at the University of Maryland has pursued an alternative approach. It began from an interindustry model with much attention given to developments at the industry level and gradually extended it to be a complete macro model. In the original model, the process of making a forecastbegan from an assumed level of disposable income. The model then calculated consumer demands by product, added them to exogenous government and export demands, and used input-output relations (with variable coefficients) to calculate domestic output and, in the process, imports. Invesment and labor productivity were also calculated, and employment was deducted. This employment could be compared with expected labor force and the assumptions about disposable income revised to give some target level of employment. The connection between employment and income, however, was not formally modeled.

Extensions have now closed this gap and made Inforum a true macro model by generating labor income, capital income, and indirect taxes at the industry level. Total labor compensation is then the sum of labor compensation in the different industries; total capital income is just the sum of capital income in the different industries. That seems simple enough, but it gives a model with radically different capabilities from those of an industry model run under controls from an aggregate model. For in the Inforum model, developments at the industry level - such as increasing productivity or changing input-output coefficients - affect GNP and all the

TABLE 1 Gross national product (1972$)

	1977	1980	1984
Gross National Product	1373.92	1478.42	1632.85
Personal Consumption Expenditures	864.28	926.59	1052.30
Durables	137.93	136.75	175.68
Non-durables	333.37	352.97	388.56
Services	392.97	436.86	488.06
Gross Private Domestic Investments	214.49	208.42	278.20
Structures	99.78	94.42	115.43
Residential	59.37	45.53	58.31
Non-resinedtial	40.41	48.89	57.12
Producers' durable equipment	102.10	117.97	140.64
Inventory change	12.61	-3.98	22.13
Exports of goods and services	115.05	162.66	153.92
Merchandise (producers' prices)	60.42	82.00	75.31
Transportation, trade, services	25.62	31.26	30.42
Rest of world	20.00	49.40	48.19
Imports of goods and services	91.29	101.05	153.38
Merchandise (domestic port price)	66.76	66.63	105.28
Petroleum and natural gas	9.30	7.96	6.40
Transportation, trade, services	17.69	17.90	26.26
Rest of world	6.84	16.52	21.84
Government Purchases	271.39	281.81	301.81
Federal	99.72	105.57	118.87
Defense	64.23	68.44	85.75
Compensation of employees	31.82	32.03	34.83
Structures	1.58	1.66	1.86
Other	30.83	34.75	49.06
Non-defence	35.49	37.13	33.12
Compensation of employees	16.60	17.40	16.50
Structures	3.62	3.67	3.02
Other	15.26	16.05	13.60
State and local	171.68	176.24	182.93
Education	70.89	74.15	75.81
Compensation of employees	53.22	56.09	56.57
Structures	6.51	6.77	5.68
Other	11.16	11.29	13.56
Other	100.79	102.09	107.12
Compensation of employees	44.58	47.83	47.65
Structures	18.17	18.04	17.27
Other	38.04	36.22	42.19
Addenda			
Unemployment rate	7.41	7.35	7.50
(GNP-Govt) / Private hours	10.04	10.11	10.61
PCE deflator	1.39	1.80	2.21
Index, unit compensation, mfg	100.00	132.77	173.20
Index, unit compensation, oth	100.00	129.74	169.74
M2(billions of CUR$)	1234.40	1591.70	2277.30
Disp. income per capita (1972$)	4280.20	4486.89	4938.74
Savings rate	5.94	6.02	6.09
3 mo Treasury bill rate	5.26	11.51	9.58
10 year Treasury bond rate	7.42	11.46	12.44

1985	1986	1987	1988	1989	1990	1995
1681.66	1726.68	1761.25	1797.67	1835.33	1885.75	2088.34
1097.50	1135.19	1160.95	1185.30	1211.00	1241.01	1368.72
189.32	196.01	201.15	205.62	210.95	217.55	243.24
398.76	410.41	417.68	424.60	432.07	440.65	472.51
509.42	528.77	542.11	555.09	567.98	582.81	652.98
288.48	288.87	290.81	294.23	300.54	312.19	350.28
120.86	122.93	125.61	128.39	130.85	134.51	141.51
59.12	63.53	64.94	65.29	66.48	68.22	68.19
61.74	59.41	60.67	63.10	64.37	66.29	73.32
147.52	152.13	153.45	155.35	159.41	166.39	198.74
20.10	13.81	11.75	10.49	10.28	11.29	10.03
146.44	146.86	147.83	151.23	155.75	163.61	199.62
74.03	74.50	75.03	77.25	80.17	85.34	106.79
30.42	30.63	30.78	31.55	32.55	34.21	41.13
41.99	41.74	42.01	42.43	43.03	44.06	51.70
162.57	163.46	164.58	166.24	168.77	173.23	197.29
114.68	114.60	114.53	115.47	117.35	121.02	138.33
5.93	6.36	6.90	7.41	7.88	8.41	10.56
28.18	29.32	30.21	30.98	31.60	32.36	35.85
19.72	19.54	19.84	19.79	19.83	19.85	23.10
311.82	319.22	326.25	333.14	336.81	342.17	367.00
125.69	131.84	137.72	143.61	146.30	149.00	162.47
92.42	98.43	104.17	109.90	112.20	114.50	125.99
33.02	33.28	33.28	33.28	33.28	33.28	33.28
1.93	2.01	2.09	2.18	2.21	2.25	2.42
57.48	63.13	68.79	74.44	76.70	78.97	90.28
33.27	33.41	33.56	33.70	34.10	34.50	36.48
16.13	15.75	15.38	15.00	15.10	15.20	15.70
3.08	3.16	3.22	3.28	3.33	3.38	3.64
14.06	14.50	14.96	15.42	15.67	15.92	17.14
186.13	187.38	188.52	189.53	190.51	193.17	204.53
76.76	77.68	78.12	78.52	78.94	79.77	83.46
56.97	57.37	57.78	58.18	58.58	58.98	60.98
5.82	6.06	6.37	6.77	7.24	7.76	9.92
13.97	14.25	13.98	13.58	13.12	13.03	12.56
109.36	109.69	110.40	111.01	111.57	113.40	121.07
48.22	48.79	49.36	49.93	50.41	50.90	53.32
18.35	18.73	18.99	19.26	19.52	19.83	21.38
42.79	42.17	42.05	41.83	41.64	42.67	46.37
7.12	6.60	6.54	6.65	6.68	6.26	4.08
10.64	10.74	10.81	10.92	11.06	11.22	11.85
2.28	2.37	2.47	2.57	2.67	2.78	3.61
180.83	190.04	199.57	208.92	218.20	228.87	302.87
177.47	187.49	197.57	207.39	217.44	228.84	310.37
2460.81	2652.47	2851.91	3058.70	3280.38	3518.34	4943.08
5004.19	5133.72	5183.27	5249.87	5322.37	5416.68	5857.78
4.70	5.25	5.15	5.30	5.41	5.59	7.58
7.50	6.45	6.54	6.38	6.07	5.85	7.39
11.20	9.19	8.69	8.57	8.42	8.25	9.61

TABLE 2 GNP, NNP, National income, Personal income

	1977	1980	1984	1985	1986	1987	1988	1989	1990	1995
Gross National Product	1918.35	2645,90	3655.85	3907.04	4161.44	4436.70	4714.75	5004.69	5346.50	7658.34
- Capital consumption allowances with capital consumption adj.	195.17	293.16	403.25	426.01	448.14	466.09	485.49	508.09	534.95	730.60
- Net National Product	1723.18	2352.73	3252.61	3481.03	3713.30	3970.61	4229.26	4496.61	4811.56	6927.74
- Indirect business tax and nontax liability	165.74	213.39	304.00	325.79	351.92	379.63	407.78	436.97	469.78	682.79
Business transfer payments	8.61	11.68	17.30	17.37	18.09	19.11	20.33	21.54	22.69	27.58
Statistical discrepancy	1.35	2.29	-7.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00
+ Subsidies less current surplus of govt. enterprises	3.06	5.47	17.75	18.80	20.36	21.73	23.25	24.86	26.71	37.66
- National Income	1550.51	2116.66	2960.77	3156.96	3363.96	3593.92	3824.74	4063.31	4346.17	6255.52
- Corporate profits with IVA and capital consumption adj.	167.26	175.43	286.20	288.81	299.95	325.04	352.16	377.41	407.02	511.16
Net interest	102.52	192.62	284.10	310.16	336.69	367.92	396.79	426.74	456.50	711.89
Contributions for social insur.	140.58	203.69	316.36	347.75	374.37	401.30	428.52	457.15	491.08	723.38
Wage accruals less disbursements	0.03	-0.04	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
+ Govt. transfer payments to person	199.29	285.89	412.11	442.21	473.35	511.06	549.10	587.58	627.01	898.51
Personal interest income	152.80	265.97	433.70	467.72	493.95	523.03	562.35	607.75	654.72	1081.01
Personal dividend income	39.56	56.81	77.70	82.65	87.19	92.09	97.80	104.14	111.18	146.84
Business transfer payments	8.61	11.68	17.30	17.37	18.09	19.11	20.33	21.54	22.69	27.58
- Personal Income	1540.37	2165.30	3014.82	3220.09	3425.43	3644.86	3876.76	4122.92	4407.07	6462.94
Wage and salary disbursments	983.20	1356.68	1812.75	1940.69	2075.74	2210.06	2342.29	2480.46	2645.28	3762.32
Other labor income	89.43	128.00	176.48	189.41	203.48	217.26	230.94	245.10	262.19	376.37
Proprietors income w. IVA and CCADJ	103.85	117.45	154.50	171.77	178.30	188.18	200.28	212.72	231.04	374.35
Farm	19.06	21.81	28.20	4.49	-1.94	-6.63	-8.74	-10.73	-10.73	0.43
Nonfarm	84.80	95.63	126.30	167.28	180.24	194.81	209.02	223.09	241.77	373.92

Rental income of persons w. CCADJ	24.82	31.52	62.50	58.25	56.32	55.98	56.65	58.13	61.26	97.10
Dividends	39.56	56.81	77.70	82.65	87.19	92.09	97.80	104.14	111.18	146.84
Personal interest income	152.80	265.97	433.70	467.72	493.95	523.03	562.35	607.75	654.72	1081.01
Transfer payments	207.90	297.57	429.41	459.59	491.44	530.17	569.42	609.12	649.70	926.09
Federal	169.57	246.19	355.54	379.84	405.18	436.61	468.50	500.84	533.89	760.84
State and local	29.72	39.70	56.57	62.37	68.17	74.45	80.60	86.74	93.12	137.67
Business transfer payments	8.61	11.68	17.30	17.37	18.09	19.11	20.33	21.54	22.69	27.58
- Pers. contrib. to social insurance	61.11	88.68	132.05	149.82	160.83	171.75	182.80	194.32	200.14	300.96
Disposable Income (1972 $).										
Total	943.28	1018.35	1169.57	1204.57	1235.17	1258.50	1285.69	1314.62	1349.29	1513.06
Per capita	4280.20	4486.89	4938.74	5004.19	5133.72	5183.27	5249.87	5322.37	5416.68	5857.78
Population (mid-period, millions)	220.29	227.69	236.70	238.40	240.60	242.80	244.90	247.00	249.10	258.30
Personal savings as % of disposable personal income (less interest paid to business and transfer payments to foreigners)	5.94	6.02	6.09	4.70	5.25	5.15	5.30	5.41	5.59	7.58
Total taxes/Personal income	14.70	15.54	14.44	14.68	14.72	14.70	14.67	14.70	14.81	15.59
Federal Deficit, NIPA	-44.97	-58.97	-165.66	-191.56	-185.32	-185.38	-201.47	-213.03	-212.48	-280.81
DI72RL	942.88	1021.64	1169.00	1193.00	0.00	0.00	0.00	0.00	0.00	0.00
TRASHR - Trasfer share of income	12.94	13.20	13.67	13.73	13.82	14.02	14.16	14.25	14.23	13.90
SPENDR - Spending rate	91.66	91.21	90.85	92.68	92.17	92.31	92.18	92.07	91.90	89.86

TABLE 3 Seller: Copper, millions of 1977 $.

Buyer	1977	1985	1988	1990	1995	85-95	77-85	85-88	88-90	85-90	90-95
SALES TO INTERMEDIATE											
8 Construction	47.5	41.7	42.7	43.5	44.2	0.57	-1.63	0.76	0.92	0.83	0.31
25 Ferrous metals	115.7	81.1	83.1	84.9	82.7	0.21	-4.44	0.83	1.06	0.92	-0.51
26 Copper	3482.5	3250,9	3301.5	3403.7	3574.0	0.95	-0.86	0.51	1.52	0.92	0.98
27 Other nonferrous metals	2144,9	1869.5	2080.6	2178.9	2335.7	2.23	-1.72	3.57	2.31	3.06	1.39
28 Metal products	1135.9	1003.2	1037.0	1073.8	1123.4	1.13	-1.55	1.10	1.74	1.36	0.90
29 Engines and turbines	75.2	57.3	60.2	63.3	69.1	1.87	-3.40	1.65	2.50	1.99	1.76
32 Metalworking machinery	43.0	35.8	36.4	38.4	39.3	0.93	-2.30	0.57	2.67	1.41	0.45
34 Misc.non-electrical mach.	231.3	215.7	222.3	233.5	254.8	1.67	-0.87	1.01	2.47	1.59	1.74
37 Service industry machin.	296.9	293.5	294.5	307.2	326.5	1.07	-0.14	0.11	2.11	0.91	1.22
38 Communic.EQ, electronic	137.1	182.8	218.9	243.8	298.5	4.90	3.60	6.00	5.41	5.76	4.05
39 Elec.indl.app and distrib.	198.2	180.4	178.5	186.3	202.2	1.14	-1.18	-0.35	2.14	0.65	1.63
41 Misc. electrical EQ	183.6	155.7	157.2	164.8	179.5	1.42	-2.06	0.33	2.35	1.14	1.71
43 Motor vehicles	321.1	247.4	239.1	249.2	248.6	0.05	-3.26	-1.14	2.07	0.14	-0.04
47 Instruments	126.8	127.5	133.0	140.8	160.3	2.28	0.07	1.41	2.32	1.98	2.59
48 Mics. manufacturing	95.8	89.8	97.6	101.8	109.9	2.01	-0.80	2.75	2.12	2.49	1.53
73 Unimportant industry	63.3	57.6	59.2	61.0	64.2	1.09	-1.19	0.92	1.55	1.17	1.01
SUM: INTERMEDIATE	8858.6	8027.9	8387.5	8725.6	9272.1	1.44	-1.23	1.46	1.98	1.67	1.21
SALES TO CONSTRUCTION											
1 1 Unit res. structures	49.7	33.3	40.6	41.5	36.8	1.01	-5.03	6.62	1.15	4.43	-2.42
SUM: CONSTRUCTION	109.5	92.5	93.1	95.8	96.9	0.46	-2.10	0.21	1.46	0.71	0.22
SALES TO OTHER FINAL DEMAND											
Non-defence federal	73.0	67.2	73.8	76.1	82.0	1.98	-1.03	3.10	1.57	2.49	1.48
Exports	152.0	200.0	132.4	116.6	91.5	-7.82	3.43	-13.74	-6.38	-10.80	-4.84
Imports	-741.0	-747.0	-831.3	-892.2	-978.4	2.70	0.10	3.56	3.54	3.55	1.84
Inventory change	-91.0	132.7	64.7	52.7	33.2	-13.86	0.00	-23.93	-10.29	-18.48	-9.25
SUM: OTHER FINAL DEMAND	-598.0	-332.4	-541.9	-627.6	-750.4	8.14	-7.34	16.30	7.34	12.71	3.57
SUM: FD Statistical discrepancy	162.0	176.6	149.9	145.2	137.6	-2.50	1.08	-5.47	-1.59	-3.92	-1.07
OUTPUT	8532.0	7964.6	8088.5	8339.0	8756.1	0.95	-0.86	0.51	1.52	0.92	0.98

TABLE 4 Labor compensation by industry, billion $

		1977	1980	1984	1985	1986	1987	1988	1989	9990	1995
	All industries	1152.06	1599.63	2173.20	2327.67	2492.40	2656.48	2818.54	2987.97	3189.98	4560.55
1	Farm and agricultural services	11.45	16.01	21.47	21.45	22.21	22.89	23.44	24.03	24.91	32.28
	Minerals	16.73	28.15	34.71	39.70	44.65	49.00	53.80	58.83	64.81	109.47
2	Crude petrol and nat. gas	7.42	15.01	22.40	26.50	30.26	33.37	36.85	40.63	45.00	78.25
3	Mining	9.31	13.13	12.30	13.20	14.39	15.63	16.95	18.19	19.81	31.21
4	Contract construction	60.96	86.71	112.81	125,68	136.00	147.54	160.33	172.92	187.91	290.82
	Non-durables	117.24	154.32	189.72	198.00	206.88	215.79	224.18	232.91	243.70	311.99
5	Food and tobacco	26.73	34.88	41.47	42.79	44.29	45.64	46.87	48.23	49.82	59.67
6	Textile mill products	9.98	11.97	14.29	14.42	14.99	15.63	16.09	16.55	17.20	20.76
7	Apparel and related products	11.64	14.14	16.64	17.36	18.25	19.45	20.55	21.62	22.92	30.93
9	Paper and allied products	12.19	16.21	20.80	21.75	22.72	23.63	24.44	25.38	26.55	33.28
10	Chemicals and allied products	21.57	29.41	33.59	34.76	36.32	37.61	38.84	40.08	41.73	53.33
11	Petroleum and related indust.	5.63	8.01	8.77	8.74	9.03	9.36	9.64	9.87	10.15	12.28
12	Rubber and misc.plastic prod.	10.50	13.84	18.84	20.45	21.66	22.97	24.28	25.76	27.65	39.29
13	Leather and leather products	2.42	2.93	2.54	2.56	2.62	2.76	2.84	2.93	3.06	3.96
	Durables										
14	Lumber and wood products, ex furniture	9.60	11.76	15.67	16.32	17.35	18.13	18.74	19.32	20.27	25.46
15	Furniture and fixtures	5.42	6.98	12.53	13.89	14.55	15.19	15.70	16.40	17.42	23.62
16	Stone, clay and glass prod.	10.96	14.32	16.33	17.48	18.66	19.75	20.86	22.03	23.51	32.31
17	Primary metal industries	25.88	33.14	25.92	26.45	28.17	30.00	31.80	33.37	35.39	46.03
18	Metal products	26.44	34.85	38.60	41.99	44.83	48.14	51.63	55.15	59.27	83.83
19	Trans.EQ + ord. ex.motor veh.	19.18	30.09	35.87	39.65	44.44	49.40	54.12	57.59	61.78	90.10
20	Machinery,except electrical	39.39	58.72	58.07	61.69	65.21	68.08	70.91	74.33	78.96	108.12
21	Electrical machinery	29.83	43.81	56.14	58.45	60.88	64.76	68.97	72.58	77.17	102.05
22	Motor vehicles and EQ	23.62	25.55	35.64	34.99	35.58	36.72	37.88	38.83	40.69	51.12
23	Instruments and related prod.	10.04	15.09	19.90	21.25	22.25	23.37	24.56	25.81	27.54	38.51
24	Misc. manufacturing ind.	5.28	6.65	7.71	7.99	8.50	9.04	9.50	9.95	10.51	14.12
	Transportation	51.06	69.92	85.07	93.08	100.46	106.13	110.68	116.07	121.89	159.30
25	Railroads	12.17	15.63	14.76	14.98	15.67	16.29	16.80	17.39	18.26	22.73
26	Air transportation	9.09	13.62	22.20	26.27	28.41	30.40	31.86	33.57	35.18	44.92

27	Trucking and other transport	29.79	40.68	48.11	51.83	56.38	59.43	62.02	65.10	68.45	91.65
28	Communications	24.51	35.36	49.83	52.17	55.80	59.38	63.11	66.75	70.95	98.52
30	Electric., gas and sanitary	15.28	21.61	35.73	37.81	40.33	42.88	45.33	47.97	50.96	68.79
31	Wholesale and retail trade	188.24	259.11	354.38	377.26	407.22	434.90	459.45	485.84	518.01	723.88
	Fin.insur. real estate	62.38	93.20	149.55	162.72	176.33	188.36	201.46	215.31	231.72	339.75
32	Financial and insurance serv.	52.79	78.81	127.20	138.30	149.42	159.20	170.18	181.63	195.14	283.63
33	Real estate and combinations off	9.59	14.39	22.35	24.42	26.92	29.16	31.28	33.68	36.58	56.12
	Services	163.70	248.00	405.43	444.04	485.78	526.69	568.85	612.88	665.94	1041.21
34	Hotels and repair (not auto)	16.90	24.60	36.85	40.38	43.97	47.17	50.39	53.69	57.82	86.21
35	Misc.business services	45.01	75.90	140.61	157.50	177.14	197.62	219.06	242.11	270.27	471.52
36	Auto repair	5.28	7.71	10.93	12.29	13.31	14.41	15.52	16.70	18.12	28.16
37	Motion pictures and amusements	7.96	11.60	16.61	17.86	19.14	20.27	21.44	22.66	24.16	32.90
38	Medical and functional serv.	82.61	121.61	192.01	207.19	222.85	237.33	252.03	266.75	284.00	406.58
39	Private households	5.93	6.58	8.42	8.82	9.36	9.89	10.42	10.96	11.58	15.84
	Government	234.92	306.34	412.19	435.70	456.37	480.40	503.31	529.16	556.73	769.36
40	Fed. gov't enterprises	14.82	19.82	24.89	25.77	26.64	28.05	29.11	30.13	31.01	37.10
41	State and local gov't enterprises	9.77	13.56	18.60	19.18	19.34	20.03	20.96	21.59	22.38	27.54
44	Fed. gov't general administ.	66.34	82.95	113.04	119.18	126.22	134.53	140.75	149.53	159.27	243.77
45	State and local geberal administ.	143.99	190.01	255.66	271.57	284.18	297.79	312.49	327.91	344.08	460.95
46	Rest of the world	-0.04	-0.05	-0.06	-0.06	-0.07	-0.07	-0.07	-0.07	-0.07	-0.08

aggregates. This feature allows the Inforum model to be used to answer a number of questions which cannot be addressed by an industry model dominated by an aggregate model. I should note that I use the word "macro" model to mean a model which supplies endogenous forecats of the major variables of macroeconomics such as the level of prices, unemployment, and interest rate. A "macro" model made then is either an aggregate model or a model built up from industry level detail.

Let me illustrate the combination of macroeconomics and sectoral detail by four tables. Table 1, from a recent run of the model, shows constant-price projections of GNP and its major components; Table 2 shows the income side of the account in current prices for the same run. In and of themselves there is nothing particularly noteworthy about these two tables. Any of a dozen or so aggregate models of the USA might have made them. What is significant, is their connection via Tables 3 and 4. Table 3 is simply one of 78 tables that show the sales of a particular product, in this case cooper, to each of its users. Table 4 shows employee compensation by industry. The aggregate tables 1 and 2 are little more than summations from industry tables such as 3 and 4. Imports in Table 1, for example, are just the sum of imports from 78 tables like the one for copper. The output of copper from Table 3 is a major determinant of the compensation of employees in the Non-ferrous metals industry in Table 4. The "Wage and salary disbursements" plus "Other labor income" in Table 2 is just the sum of compensation of employees from Table 4, reduced by Employer contributions for social insurance. The beginning point of the Inforum model is not aggregates such as shown in Tables 1 and 2; these are only convenient summaries, by-products of the real modeling process which goes on at the industry level as shown in Tables 3 and 4. The connection between the aggregate product accounts, such as Table 1, and the aggregate income accounts, such as Table 2, comes about because income is connected with product at the sectoral level and the aggregates are made by summing.

In this paper, I want to limit my description of the Inforum model to the merest outline and concentrate on showing by example some of the properties and capabilities of the model. In fact, a detailed description of the equations of the model would fill a rather large book, and in fact, already fills four doctoral theses which, all combined, do not describe the entire model. I hope to be able to produce such a book in the near future, but for the moment the model has, I regret to say, gotten ahead of its documentation. The model is also still in a state of constant development and many parts are not yet in definitive form. The principles of the model, however, remain fairly constant; and in section 1 I shall try to identify and illustrate them and confess to a few lapses of principle. Then in section 2 we shall look at an example of how the model can be applied to calculating the effects of protection for a few industries. This example happens to be both topical - the US Congress has just passed a bill establishing quotas for textiles and footware - and a good illustration of what can be done with this model which cannot be done with topdown, aggregate-controlled models.

Before going further, however, I should add that the model which I shall describe here is just one of three models maintained by the Inforum group. It has 78 industry sectors completely integrated, as has been said, into a macro model. Among the Inforum models it is designated as LIFT (Long-term Interindustry Forecasting Tool). A second model, DOM, the Detailed Output Model, has 425 industrial sectors but lacks income generation. Instead, it relies on LIFT for income forecasts. The third model, formally independent of the other two, is a QUarterly Aggregate Model, QUAM. It is maintained to give a short-term outlook based on the same broad assumptions as go into LIFT. It's forecasts for the next four years are diligently compared to those of LIFT and the causes of any major discrepancies are studied. Neither model, however, is used to control the other.

1. THE THREE PRINCIPLES OF INFORUM MODEL CONSTRUCTION

1.1. Use Strict Input-Output Relations to Assure Internal Consistency

LIFT relates its projections of final demands f(t), industry outputs q(t), prices p(t), and value added per unit of output v(t) via its projection of the matrices of input-output coefficients, A(t), through the following two dual equations

$$q(t) = A(t)\,q(t) + f(t)$$

and

$$p(t) = p(t)\,A(t) + v(t)$$

where q and f are column vectors and p and v are row vectors. The value of gross national product is pf = vq. These balance equations are adhered to strictly. There are no "fudge factors", or "row scalars". We believe that accounting integrity is critical in the structure of large models and do not wish to compromise it. Because of problems in the USA NIPA, we have to have to deal with statistical discrepancy, but that is done clearly and explicitly.

The f(t) vector shown here is really the sum of nearly two hundred final demand vectors. There are 78 for personal consumption expenditure, 55 for equipment investment, 31 for construction, one each for exports, imports, and inventory change, and four or more for government. Many of these are functions of prices, sectoral outputs, or incomes determined by the equations. Thus, the complete system of equations involves many more interrelations than are shown by the basic balance equations. The modeling of these other relations is the major part of the work of building the model, and it is to this work that the second two principles apply.

1.2. Model at the Detailed Level and Add Up

The second fundamental principle of Inforum model construction is to model at the detailed level and add up to get aggregate totals. Some of the applications of that principle are:

a. The import equations are estimated at the level of the 78 industries, with each industry's imports being made to depend on its domestic demand and foreign-to-domestic price ratios.

b. Similarly, export equations are estimated at industry level and relate US exports to foreign demands for the corresponding product and foreign-to-domestic price ratios. LIFT is the USA member of an international system of interindustry models and can therefore base its export forecasts on results from these other models.

c. Investment functions for equipment are estimated for each 55 industries and depend upon the output of the industry, replacement needs, and user costs of capital.

d. Construction equations are developed for 31 types of construction, many of them, such as telephone or railroad, related to specific industries.

e. Labor productivity equations are developed, as we shall see later, for 55 industries.

f. Labor income and capital income equations are developed at the level of fifty industries.

In none of these areas is there any check by adding up to an aggregate total. The model software provides for controlling the final demands to such totals if the user wishes, but such controls are never part of our standard forecasts.

The reason behind this principle is not that we imagine that we determine the aggregate more accurately by modeling it in many pieces, - though we certainly do not seem to do worse than the aggregate forecasters - but that we care about the pieces. Imports of copper, for example, are important to the copper industry. We want to be able to look at the copper row, as shown in Table 3, and know that the forecast for imports is the best that we can make. We don't want it to be merely the proration to copper of some aggregate import forecast.

There are exceptions to our no-aggregate-controls rule. The most important is in household consumption. We use a very comprehensive system of consumption functions for 72 products. The functions allow for the possibility of both complementarity and substitution among products; they include non-linear Engel curves and demographic effects. Yet the total consumer expenditure predicted by these functions is subjected to the constraint that it add up to disposable income less savings and interest paid by persons to business. The reason for the infraction of the no-aggregate-control rule is obvious. In this case, the logic of the model itself provides the total.

There are also exceptions where industry data is not available or where industry detail is of little intrinsic interest. For example, our industry data sources do not provide data on dividens comparable with the data on corporate profits. Consequently, we have only a single equation for aggregate dividends and do not show dividends at the industry level. Similarly, we generate total compensation of employees by industry. This includes Employer contributions for social insurance divided between Federal and State programs. The aggregate tables require a separate number for these contributions, and it must be divided between the two levels of government. Since we judge that no one cares about this information at the industry level, we have two aggregate equations that generate these amounts as functions of total compensation of employees.

Another partial exception is our treatment of coefficient change in the input-output tables. We would like to make each individual input-output coefficient the object of special study and produce a function defining it in terms of relative prices, time trends, or whatever appeared appropriate. We lack, however, the data, the manpower, and the know-how for in-depth study of more than a few of the coefficients. For most of them, we must be content with a simpler technique. We determine for past years how much of a product was produced, how much was exported, how much imported, and how much sold to consumers, governments, or investment including inventory change . From these amounts, we can determine how much was used as an intermediate input. Call this time series A(t) for Actual intermediate use. We can also calculate how much of the product would have been used as an intermediate input if all input-output coefficients in the row for that product had remained constant. Call this time series C(t) for Calculated use. If the ratio A(t)/C(t) is constant, we have found no evidence for coefficient change. If, however, this ratio has a trend in it, then, on average, the coefficients must have been changing. Where we detect such trends, we ask whether they should be extended into the future. If the answer is "yes" - and it frequently is - we usually fit a logistic curve to the past history of the ratio A(t)/C(t) and then apply the future percentage changes in this ratio to each and every input-output coefficient in the row. Many refinements on this technique are possible; the impediments to their use are lack of data and time to analyze it, not restrictions in the model's program. Even this simple expedient, however, catches most of the developments which industry observers have been able to tell us about. It certainly prevents grossly implausible forecasts from arising because of bad assumptions about input-output coefficients.

With this understanding, we can now look again at Table 3 to see what it tells us. We can think of this table as a window allowing a view of a small part of the model, namely the sales of copper to its buyers. The first five columns show the sales of the copper industry, in millions of 1977 dollars, to each of its major users in 1977 (the base year for our present table) 1985, 1988, 1990, and 1995, respectively. Two of the sales require a word of explanation. First, the large sale of the industry to itself. This is the sale of smelters to refiners or of refiners to copper casting and drawing. Second, the large sale to Other non-ferrous metals is the value of silver and zinc that are recovered in the course of copper refining. The other entries show sales of copper to its principal users. To the right are columns showing growth rates between selected pairs of years. Notice the wide range of growth rates for the 1985 to 1988 period; sales to Communications equipment are increasing 6.0 percent per year, while sales to Automobiles are decreasing 1.14 percent per year, and other users fall between these extremes.

My point in showing this window on the Copper industry is not to say that these forecasts are correct but to point out that our adherence to principles 1 and 2 have made it possible to look through such a specific window and see something meaningful. The detail shown is specific enough that one familiar with the Copper industry can scrutinize it. He can see exactly where we expect every pound of copper to be sold. Perhaps he will find that we have ignored important developments and can help us to make a better forecast. By adhering to our principles, we have brought into a macro model a level of detail that can be scrutinized and perhaps found wanting by people who, though they know little and care less about theories of savings behavior or putty-clay production functions may know a lot about the copper industry. We believe that a macro model that can be scrutinized in this way is intrinsically more creditable than an inscrutable one in which parts do not add strictly to totals.

1.3. Keep an Eye on the Long Run Properties

LIFT and DOM are annual models. There is no data in the US to support this approach to modeling on a quarterly basis. That does not mean that quarterly industry models using input-output tables could not be built, but they would have to be made on a top-down rather than the bottom-up approach we have been describing. Much of the detailed data on which they are based is not available until nearly a year or more after the end of the year to which they apply. Since what has happened in the last six months can be very useful in forecasting the next six, it is not to be expected that LIFT will be of great value in forecasting the year ahead. LIFT has a forecast for the year ahead, and it often proves to be about as accurate as that of the quarterly forecasters. But it is not where the model has its comparative advantage. That advantage lies in projection and analyses extending beyond a year. The fact has made us pay special attention to the long-run properties of each and every equation as well as of the model itself.

Let us take, for example, the long-term stability of the model. Over the last century or so the US economy has shown, except during the early 1930's, a remarkable ability to employ a fairly constant fraction of the available labor force. At times, this labor force has grown much more rapidly than expected, but the economy has adapted to it. Whence comes this stability? Why did the bulge in the labor force created by the baby-boom generation not lead to massive unemployment? Why did the surge of women in the labor force not swell the ranks of the unemployed? A model that showed an acceleration in the growth of the labor force as just turning into unemployment would have to be said to have history against it. But what features are necessary in a model to make employment adapt to labor force?

Conventional Keynesian theory offers no help on this point. Indeed, Keynes was interested precisely in how the economy could fail to adapt to the labor force. Likewise the idea that the growth in labor force will drive down wages and make it profitable for business to employ more people diesn't work well because driving down those wages drives down income and reduces demand. What we need, rather, is some way in which unemployment workers stimulate demand. Since that sounds rather strange, let me try to say it more clearly. We need a way in which 100 employed workers and 10 unemployed workers lead to greater demand than do 100 employed workers and 4 unemployed.

Of course, the unemployment insurance program is of some help in this direction, but it is a fairly small factor. There are, however, two important factors. The forst is the savings rate. There is a strong, though generally overlooked influence of unemployment on savings, but it may either increase or decrease the savings rate. The effect directly on the unemployed person is certainly to decrease savings. The effect on others may be to scare them into increasing their savings. This second, scare, effect seems to predominate in the current year, but the lagged value of unemployment carries a much stronger negative and stabilizing effect. In our current equation, a sustained 1 percentage point increase in the unemployment rate leads to a 1.2 percentage point decrease in the savings rate. This effect, of course, proves strongly stabilizing.

The second stabilizer working through unemployment has to do with profits. Low levels of unemployment can make it difficult for firms to keep up with demands and can therefore lead to higher prices. In LIFT, the higher prices are brought about by an effect of unemployment on the level of profits. As profits go up, prices go up and choke off the purchasing power.

These two effects serve to stabilize the economy satisfactorily. But there are other ways in which we have to keep an eye on the long run characteristics. For example, the consumption equations cannot be additive functions of price and income, for if they were, price elasticities would decrease as income increased - which does not seem plausible. Nor can they be of the often-used double logarithmic form, for it implies constant income elasticities, which, if the elasticity of some commodity is greater than one, implies that, with sufficient growth in income, spending on that commodity alone will exceed income. There are similar consideration in the import and export equations. They have led to the development of non-linear functions which, while a bit of bother to estimate, keep the forecasts from turning into nonsens in the long run.

The concern for the long-run properties has led to the almost total exclusion of one of the most-used econometric techniques, namely, the use of the lagged value of the dependent variable among the independent variables. Usually this variable is justified by reference to distributed lags or adaptive expectations. But the truth is it works well because it has exactly the same trend as the dependent variable. In long-term work, we are interested in explaining that trend, not temporary deviations from it. Thus the lagged value of the dependent variable will cheat us out of finding exactly the kind of relations we most want to discover. Furthermore, like all cheaters, it will put a good face - the fit - on pure junk. And, in the long-run, cheating doesn't pay; the fact that the equation has not gotten to the fundamentals will become obvious enough in due time. Lots of bad experiences with this technique have led me to believe it the most pernicious piece of sophistry in the econometrics business. Yes. without it, we often have sizable autocorrelation of the residuals of our equations. We use this autocorrelation in making the forecasts for the first few periods. Sometimes we have tried the Hildreth-Lu correction for autocorrelation, but have seldom found it to offer significant improvement in the trustworthiness of the regression coefficients.

2. LIFT AT WORK: THE EFFECTS OF PROTECTION

As this paper is being written (rather long after it was due) the US Congress has just passed a bill establishing rigid quotas on imports of shoes and textiles. After reigning in imports from each of our major suppliers of textiles (Taiwan, Korea, and Hong Kong) to 118 percent of their 1980 value, it allows for growth of only one percent per year. There is little chance of the bill becoming law, since the President has vowed to veto it and did not have enough votes to override the veto. Nonetheless, it shows the temper of the Congress, which reflects closely the mood of the voters on this question.

Quite aside from retaliation, such protectionist measures are bad for most Americans but benefit strongly a vocal few. Showing just who would benefit and who would be hurt by such measures is an ideal illustration of the way that LIFT can build up from the industry level. Rather than take the specific bill which passed the Congress, which treats shoes differently from textiles, we will take for purposes of this illustration a simpler but broader measure. We will impose quotas in 1986 on

Textiles
Leather and footwear
Apparel (clothing)
Steel
Motor vehicles

The 1986 quotas will be ninety percent of 1984 imports except for Textiles, where it will be 85 percent. Thereafter, the quotas will grow by the "Congressional" one percent per year. The Textile quota had to be at 85 percent to keep it below the Base case forecast, in which textile imports decline because of an anticipated decline in the dollar.

Before turning to exactly how this measure would be introduced in LIFT, I must digress to describe some results of our work on labor productivity at the industry level, for they show how industry level abalysis can affect aggregates. From working with the aggregate labor productivity function for the QUAM model, I knew that the rate of growth in productivity "turned a corner" in 1969 and has grown much more slowly since then. Just why this slowdown came about is not evident, at least not in aggregate data. This observation, however, let to the use of two time trends, one normal one, T1, and second, T2, which is zero prior to 1969 and then begins to grow by 1.0 each year. Although we have experimented with a number of ways of forecasting the labor/output ratio with various and sundry production functions and "embodied" or "disembodied" technical change, the workhorse equation that we rely upon with most confidence simply states

$$\log(L/Q) = a + b*T1 + c*T2 + d*QDOWN + c*QUP$$

where L is hours worked in the industry, Q is industry output in constant prices, and QDOWN is the first difference in Q when it is negative and otherwise zero, while QUP is the first difference in Q when it is positive. For technical reasons that need not detain us, the dependent variable is

TABLE 5 $Ln(L/Q) = a + b * T1 + c * T2 + d * QDOWN + e * QUP$

		a	b	c	d	e
1	Agriculture (1)	2.450	-0.073	0.042	-0.886	-0.524
2	Crude oil and gas (5-6)	1.003	-0.090	0.137	-0.286	0.000
3	Mining (2-4,7)	-0.789	-0.040	0.041	0.000	0.000
4	Construction	-1.587	-0.015	0.024	-0.791	0.000
5	Food, tobacco (9)	-2.024	-0.026	0.000	-0.215	-0.283
6	Textiles (10)	-1.745	-0.016	-0.024	-0.445	-0.174
7	Knitting (11)	2.931	-0.080	0.038	-0.045	0.000
8	Apparel and HHLD textiles (12)	-1.098	-0.019	-0.008	-0.166	-0.217
9	Paper (13)	-1.376	-0.028	0.004	-0.070	-0.163
10	Printing (14)	-1.699	-0.018	0.008	-0.660	-0.085
11	Agricultural fertilizers(15)	-0.387	-0.055	0.029	-0.678	-0.129
12	Other chemicals (16)	-0.918	-0.040	0.009	-0.904	-0.138
13	Petroleum refining (17)	-2.841	-0.038	0.012	-1.066	-0.207
14	Rubber and plastic prod. (19-20)	-0.907	-0.032	0.020	-0.281	-0.049
15	Footwear and leather (21)	-1.875	-0.010	-0.014	-0.449	-0.227
16	Lumber (22)	-0.847	-0.033	0.006	-0.053	-0.128
17	Furniture (23)	-1.287	-0.019	-0.007	-0.186	-0.146
18	Stone, clay and glass (24)	-1.739	-0.019	0.005	-0.390	-0.068
19	Iron and steel (25)	-3.285	-0.005	-0.013	-0.234	-0.077
20	Non-ferrous metals (26-27)	-2.354	-0.021	0.007	-0.299	-0.065
21	Metal products (28)	-1.590	-0.025	0.019	-0.290	-0.031
22	Engines and turbines (29)	-1.290	-0.032	0.015	-0.633	0.000
23	Agricultural machinery (30)	-1.726	-0.022	-0.010	-0.347	-0.145
25	Metalworking machinery (32)	-2.560	-0.005	-0.006	-0.237	-0.043
27	Special ind. mach. (33)	-1.681	-0.022	0.012	-0.649	-0.033
28	Misc. nonelec. mach. (31,34)	-2.295	-0.011	-0.010	-0.539	-0.075
29	Computers, office EQ (35-36)	0.049	-0.037	-0.047	-1.186	-0.269
30	Service industry mach. (37)	-0.379	-0.044	0.031	-0.449	-0.047
31	Communic.EQ,electron.comp. (38)	0.328	-0.044	-0.008	-1.046	0.000
32	Elec. app. and distrib.EQ (39)	-0.625	-0.033	0.019	-0.464	-0.061
33	Household appliances (40)	-0.708	-0.033	-0.008	-0.210	-0.181
34	Elec. light and wiring EQ (41)	-1.778	-0.017	0.000	-0.422	-0.069
35	TV sets, radios, phonograph (42)	1.151	-0.053	-0.033	-0.695	-0.290
36	Motor vehicles (43)	-2.170	-0.024	-0.001	-0.417	0.000
37	Aerospace (44)	-1.770	-0.021	0.021	0.000	0.000
38	Ships and boats (45)	-0.732	-0.029	0.005	-0.595	-0.176
39	Other transp. EQ (46)	-4.791	0.024	-0.030	-0.460	0.000
40	Instruments (47)	-0.190	-0.038	0.008	-0.744	-0.111
41	Misc. manufacturing (48)	-0.449	-0.033	0.002	-0.952	-0.182
42	Railroads (49)	0.740	-0.049	0.010	0.000	0.000
43	Air transport (52)	1.854	-0.074	0.050	-0.943	-0.122
44	Trucking, oth. transport (50-51)	-0.765	-0.028	-0.002	-1.418	0.000
45	Communications services (55)	-0.209	-0.037	-0.012	-1.051	-0.486
46	Electric utilities (56)	1.180	-0.074	0.064	0.000	0.000
47	Gas,water and sanitation (57,5)	-0.908	-0.053	0.053	0.000	0.000
48	Wholesale and retail trade (59)	-0.042	-0.034	0.017	-2.233	-0.232
49	Finance and insurance (62)	-1.689	-0.016	0.013	0.000	0.000
50	Real estate (63)	-1.894	-0.034	0.042	0.000	0.000
51	Hotels; repairs exc. auto (65)	0.693	-0.040	0.042	0.000	0.000
52	Business services (66)	-4.521	0.012	0.006	-1.407	0.000
53	Auto repair (67)	-0.677	-0.039	0.045	-0.644	0.000
54	Movies and amusements (68)	-1.229	-0.018	0.000	0.000	0.000
55	Medicine, educ., npo (69)	-0.407	-0.027	0.018	0.000	0.000

TABLE 6 Winners and losers in terms of change in employment in 1988

WINNERS (millions of persons)

	Base	Alt	Gain	% change
1 Agriculture (1)	3.24	3.26	0.02	0.62
5 Food, tobacco (9)	1.60	1.62	0.02	1.25
6 Textiles (10)	0.49	0.53	0.04	8.16
8 Apparel and HHLD textiles (12)	1.19	1.27	0.08	6.72
10 Printing (14)	1.49	1.51	0.02	1.34
12 Other chemicals (16)	0.86	0.87	0.01	1.16
15 Footwear and leather (21)	0.16	0.22	0.06	37.50
19 Iron and steel (25)	0.47	0.50	0.03	6.38
21 Metal products (28)	1.46	1.47	0.01	0.68
36 Motor vehicles (43)	0.76	0.82	0.06	7.89
45 Communications services (55)	1.43	1.44	0.01	0.70
51 Hotels, repairs exc.auto (65)	4.53	4.59	0.06	1.32
55 Medicine, educ., NPO (69)	12.24	12.43	0.19	1.55
Total	29.92	30.53	0.61	2.04

LOSERS (millions of persons)

	Base	Alt	Gain	% change
4 Construction (8)	6.96	6.84	-0.12	-1.72
7 Knitting (11)	0.20	0.19	-0.01	-5.00
16 Lumber (22)	0.69	0.67	-0.02	-2.90
17 Furniture (23)	0.62	0.61	-0.01	-1.61
18 Stone, clay and glass (24)	0.62	0.61	-0.01	-1.61
23 Agricultural machinery (30)	0.09	0.08	-0.01	-11.11
28 Misc nonelec. mach. (31,34)	0.72	0.71	-0.01	-1.39
29 Computers, office EQ(35-36)	0.45	0.44	-0.01	-2.22
31 Communic. EQ,electron.comp(38)	1.07	1.06	-0.01	-0.93
37 Aerospace (44)	0.93	0.92	-0.01	-1.08
38 Ships and boats (45)	0.26	0.25	-0.01	-3.85
40 Instruments (47)	0.56	0.55	-0.01	-1.79
43 Air transport (52)	0.67	0.66	-0.01	-1.49
46 Electric utilities (56)	0.84	0.83	-0.01	-1.19
48 Wholesale and retail trade (59, 60)	27.19	16.83	-0.36	-1.32
49 Finance and insurance (62)	5.42	5.40	-0.02	-0.37
50 Real estate (63)	1.66	1.65	-0.01	-0.60
52 Business services (66)	6.01	6.00	-0.01	-0.17
53 Auto repair (67)	1.09	1.08	-0.01	-0.92
54 Movies and amusements (68)	1.38	1.35	-0.03	-2.17
Total	57.43	56.73	-0.70	-1.22

Base = Base forecasts (no change in current policy).
ALT = Protection scenario (import restrictions).

TABLE 7 Winners and losers in terms of change in labor compensation by industry in 1988.

WINNERS (billions of 1984 $)

	Base	Alt	Gain	% change
6 Textile mill. products	13.34	17.51	4.17	31.26
7 Apparel and related products	16.77	22.51	5.74	34.23
13 Leather and leather products	2.38	3.63	1.25	52.52
17 Primary metal industries	25.79	26.79	1.00	3.88
22 Motor vehicles and equipment	33.11	40.46	7.35	22.20
Total	91.39	110.90	19.51	21.35
Total gain to protected industries =		19.51		
Total gain to non-protected industries =		-40.10		

LOSERS (billions of 1984 $)

	Base	Alt	Gain	% change
1 Farm and agricultural services	19.43	19.21	-0.22	-1.13
2 Crude petrol. and natural gas	32.96	32.21	-0.75	-2.28
3 Mining	13.83	13.57	-0.26	-1.88
4 Contract construction	131.27	125.81	-5.46	-4.16
5 Food and tobacco	39.53	39.28	-0.25	-0.63
8 Paper and allied products	20.25	19.93	-0.32	-1.58
9 Printing and publishing	34.02	33.59	-0.43	-1.26
10 Chemical and allied products	32.51	32.25	-0.26	-0.80
11 Petroleum and related industries	8.47	8.32	-0.15	-1.77
12 Rubber and misc.plastic products	20.00	19.66	-0.34	-1.70
14 Lumber and wood products,ex furn.	15.75	15.12	-0.63	-4.00
15 Furniture and fixtures	12.97	12.51	-0.46	-3.55
16 Stone, clay, and glass products	17.28	16.83	-0.45	-2.60
18 Metal products	42.72	42.04	-0.68	-1.59
19 Trans.eq.+ord.ex.motor veh.	45.04	43.35	-1.69	-3.75
20 Machinery, except electrical	56.50	54.93	-1.57	-2.78
21 Electrical machinery	55.35	53.93	-1.42	-2.57
23 Instruments and related prod.	20.15	19.61	-0.54	-2.68
24 Misc. manufacturing industry	7.73	7.57	-0.16	-2.07
25 Railroads	14.21	14.04	-0.17	-1.20
26 Air transportation	26.82	25.85	-0.97	-3.62
27 Trucking and other transport	51.74	50.78	-0.96	-1.86
28 Communications	53.31	52.76	-0.55	-1.03
30 Electric, gas, and sanitary	38.37	37.55	-0.82	-2.14
31 Wholesale and retail trade	386.24	375.86	-10.38	-2.69
32 Financial and insurance services	143.68	139.81	-3.87	-2.69
33 Real estate and combinations off.	25.96	25.16	-0.80	-3.08
34 Hotels and repair (not auto)	42.55	42.33	-0.22	-0.52
35 Misc. business services	183.23	179.59	-3.64	-1.99
36 Auto repair	12.96	12.58	-0.38	-2.93
37 Motion pictures and amusements	18.33	17.89	-0.44	-2.40
38 Medical and educational services	213.66	212.97	-0.69	-0.32
39 Private households	8.83	8.66	-0.17	-1.93
Total	1845.65	1805.55	-40.10	-2.17

Base = Base forecast (no change in current trade policy).
Alt = Protection scenario (import restrictions).

labor requirements per unit of output so that a negative value for b means growing productivity and a positive value for c means slowing down in productivity after 1969 by comparison to the 1958-1969 period. The results are shown in Table 5.

In general the growth of labor productivity slowed down after 1969. Slow downs were particularly marked in Agriculture, Mining, Construction, Agricultural fertilizer, petroleum refining, Rubber and plastic products, Engines and turbines, Aerospace, Air transport, Electric utilities, Gas, water and sanitation, Trade, Real estate, Hotels, and Medicine. Note that none of these slackeners face - or faced during the 1970's - any serious foreign competition. In contrast to these industries that seemed to be running out of steam there was a handful of industries that, running against the tide, accelerated the growth of productivity in these years. This honor role included Textiles, Apparel, Footwear, Iron and steel, Agricultural machinery, TV sets, radios, phonographs, and Other transportation equipment. This is almost exactly the list of industries facing stiff competition from imports. Indeed, it includes precisely the loudest seekers of ptotection.

I have no doubt that the competition of imports caused the acceleration of productivity and that removing the competition can reliably be expected to reduce the growth of productivity in protected industries and, therefore, the growth of potential GNP. We shall therefore assume in our protection scenario that productivity reverts to its pre-1969 rate of growth in the protected industries.

What shall we assume about wages and return to capital in the protected industries? The seekers of protection claim, of course, that nothing could be further from their minds that to increase prices, wages, or profits after being granted protection. All they want is to keep jobs. I undertook some analyses under the assumption of no price increases in the protected industries, but I couldn't find anyone who believed for a moment that prices would not go up the minute really effective protection was in place. The only question was by how much. Fortunately, the industry-level import functions themselves can be used to answer that question. Since each of the functions has a price elasticity, we had only to suppose that the restriction in imports would cause the effective price of those imports to rise to the level at which the demand for the imports was equal to the quota. The domestic prices would then be free to rise by the same percent. This increase in prices would be effected by increasing the return to capital and labor in the ptotected industry by the amount permitted by the price rise. The LIFT price mechanism then passes these increases on to other industries and into the overall price level that then reduces the purchasing power of people not in the protected industries.

A further consideration is the impact of the protection of the exchange rate. Because protection reduces imports, it will, in the absence of retaliation, increase the balance on goods and services. For the sake of this scenario, we assume that it would not affect the capital account and that the exchange rate will therefore have to move to maintain the same balance in Goods and Services in the protectionist as in the base scenario. This assumption implies a slight rise in the value of the dollar that reduces exports and increases imports of non-protected goods.

The results of running LIFT under this protectionist scenario are compared with those of the base run in two areas, employment and real labor compensation, in Tables 6 and 7. Table 6 shows the results for employment for 1988. Note first that the number of jobs lost, 700,000 is almost equaled by the number gained, 610,000. This result shows the equlibrating mechanisms of LIFT at work. In the first year of protection, 1986, the losses had been more severe, but the savings rate adjusted and moved back to approximate parity in total employment in the two cases. This result does make clear that all of the pious talk about protecting jobs is patently wrong. Protection just moves jobs from industries where we have comparative advantage to industries where we don't.

The big gainers from protection are the protected industries themselves, of course. But it is interesting that they are not the only ones. The high prices of clothing and automobiles in the protectionist run cause consumers to shift away from these products and to buy more Food, Communication services, Hotel services, and Medical and educational services. The increase in food purchases actually gets translated into a slight increase in Agricultural employment. The list of losers is longer but the percentage losses, except for Agricultural machinery which is very sensitive to exchange rates, are much smaller than are the gains of the ptotected industries.

Therein, of course, lies the seductive power of protection in democracies. The few groups which benefited, very much benefited and can afford to devote a lot of effort to procuring the protection, they crave. The majority is slightly adversely affected but the cost to any one group is not strong enough to make it put up a determined fight against the temptation.

Table 7 shows the winning and losing industries in terms of purchasing power of its employees. Here the damage of protection becomes more apparent. Only the protected industries are gainers, but their gains are very considerable, averaging 21 percent. The gain in Steel is low because of its high price elasticity; the reduction in imports could be achieved with a relatively low price increase. The losses of the non-protected industries total twice as much as the gains of the protected ones, but average only 2 percent. Here again the seductive temtation of protection becomes clear.

This example makes clear, I hope, how the ability of the Inforum model to begin at the industry level can be useful for studying the effects of policies that aim at the changing of structure at the industry level rather than changing some broad aggregate, such as the quantity of money - though LIFT handles that well also.

THE USE OF IMPACT TABLES IN POLICY APPLICATIONS OF INPUT-OUTPUT MODELS

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1. INTRODUCTION

MODIS IV is the fourth generation in a series of macro-economic models constructed and used by the Central Bureau of Statistics of Norway. Like its predecessors, MODIS IV combines a disaggregated input-output framework with a number of additional relations and auxiliary assumptions.

The MODIS-models are closely linked to three parts of its environment. First, the data base of National Accounts, secondly, the main user - the Ministry of Finance, and thirdly, the computer and the programming system. MODIS IV was constructed partly as a result of the experience gained by using earlier MODIS-versions, and partly because the revision of the national accounts of Norway in conformity with the revised SNA of the UN has made the use of MODIS III outdated.

The structure of MODIS IV is described in Chapter 2, while the administrative use of the model in the macro-economic planning process in Norway is outlined in Chapter 3.

One convenient way of using the model to analyse the effects on macro-economic targets like employment, domestic product and consumer price index bychanges in the policy instruments like taxes, government consumption etc., is to compute impact tables. Impact tables have been compiled by means of MODIS IV since 1974, and they show the effects which are to be expected from a partial ten percent increase of exogenous variables or group of exogenous variables in the model. A fairly aggregated impact table for the model is presented in Chapter 4. Chapter 5 discusses the use of impact tables in the preparation of input for sequences of model runs and ad-hoc analysis. The use of impact tables in adjusting the economic plan during the plan period is also discussed in this chapter.

The use of impact tables in testing the model structure is analysed in Chapter 6. The stability of the input-output coefficients and the necessity of the annual updating of the model are especially analysed and some further tests are outlined.

2. THE STRUCTURE OF MODIS IV

The structure of MODIS IV may be outlined as in Figure 1. Fulldrawn boxes indicate formalized parts of the model. Dotted boxes indicate still unformalized parts. Other informal models, e.g. sector models, might be added to the diagram. The connection between informal models and MODIS IV is

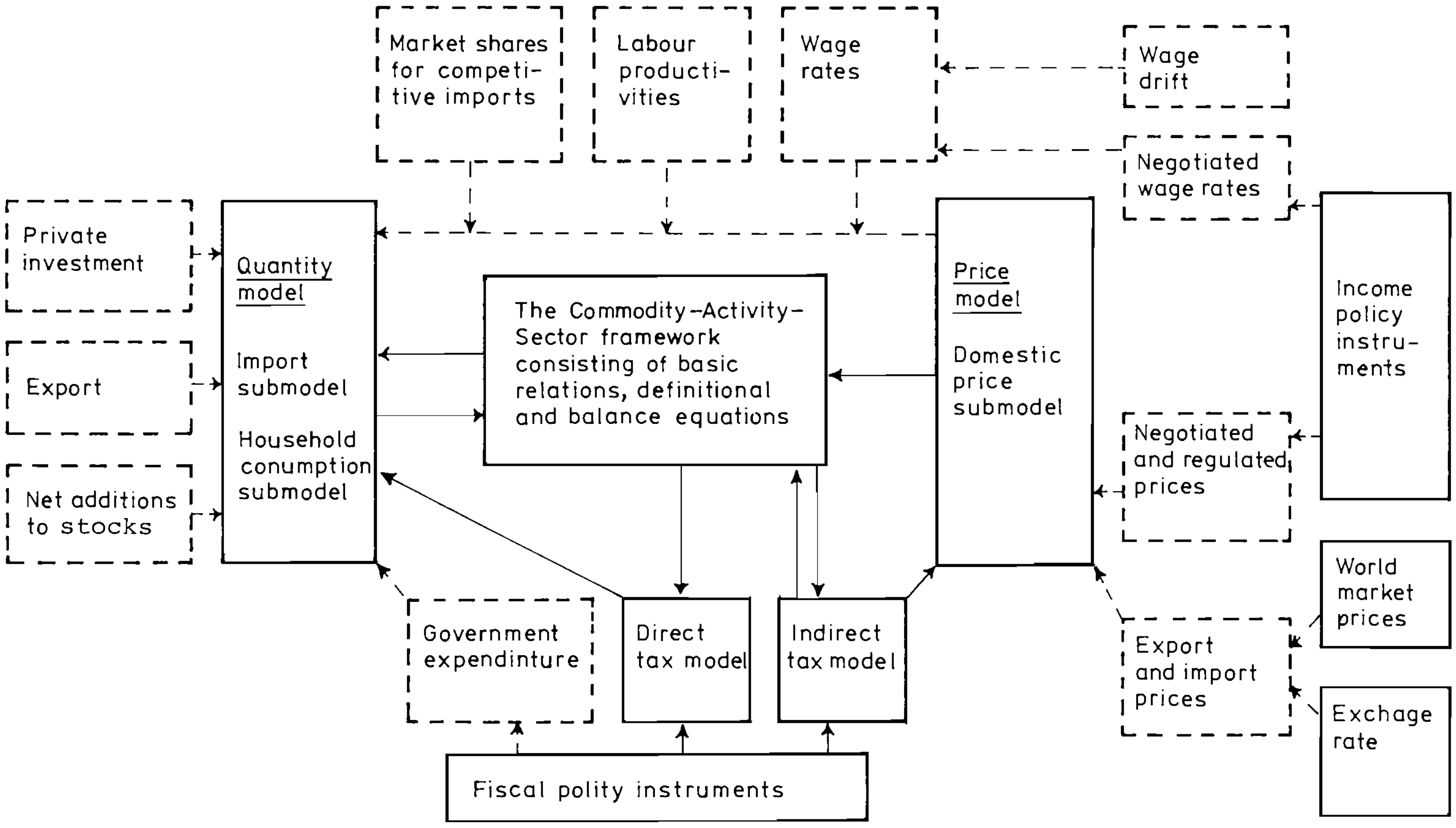

Figure 1. Structural map of MODIS IV.

mediated through exogenous variables and parameter changes. At the present stage, the model is, thus, "closed" at various points by exogenous assumptions instead of appropriate additional models.

The central part of the model are the conceptual and accounting definitions and the basic relations representing the technological structure and the cost structure of the economy. The technological and cost structures are modelled by using a modified form of the input-output formulation of Leontief.

Apart from the accounting definitions and the basic structural relations the model consists of a number of parts, or submodels, the main ones being those belonging to the quantity model and the price model. At present, there are in addition two submodels for direct and indirect taxes. respectively.

Indicated in Figure 1 are also additional submodels which at the present time are not formalized but which reside in the administrative environment. The point of view adopted is that the full model of the functioning of the economy by the user may not be fully formalized, too complex or too vague to be included in the computational set-up.

The core of the model is the input-output formulation of the technological and cost structure of the economy. The model has moved slightly away from its predecessors in that a distinction is made between <u>commodities</u>, <u>sectors</u> and <u>activities</u>. By commodity is meant a grouping of goods and services, by sector a functional unit of the economy which takes part in the commodity circulation, and by activity a subdivision of sectors according to characteristic properties of the type of commodity generation, absorption or transformation which is taking place. Within each activity there are assumed fixed proportions between commodity inputs and commodity outputs. The coefficients are estimated from commodity-sector input and output tables for the <u>base year</u> of the model (usually the year prior to the current year).

The main points to be made about the model are the following:

a. The model has an internal representation of the national accounts of almost the same amount of detail as the accounts themselves. Accounting definitions, accounting rules and accounting consistency requirements are strictly adhered in the model. This is indicated by the central block in the map. All variables refer to calender years as time unit.

b. The quantity model and the price model are the main parts of the model structure. These are both input-output models related to the original Leontief scheme. The quantity and the price parts are duals of each other, althougt not in a strict mathematical sense. The input-output framework underlying the quantity and price model differs from the traditional Leontief framework based on a square matrix of intersectorial transactions by being rectangular in commodities by activities. This modification of the traditional input-output framework is made possible by the new UN Standard of National Accounts. Similar approaches have also been adopted as the standard framework in some other countries, notably in Canada. It is believed by us that this framework implies a better use of the underying observational data as well as advantages with regard to the rest of the model. On the other hand, the beautiful simplicity of the Leontief is no longer present.

c. The basic logic of the quantity model is that of Keynesian demand management. Final demand apart from private consumption is treated mostly as exogenous variables. Some sectors are given special treatement with exogenous production levels. It is assumed that labour is mobile and that there are no quantitative restrictions on commodity imports.

d. The price model is based on the Aukrust hypothesis of a dichotomy of sheltered and exposed industries with some refinement compared to the original crude hypothesis.

e. There are submodels for imports, private consumption, direct taxes, indirect taxes and depreciation. These submodels are more or less integrated in the quantity and price parts. The private consumption submodel includes a macro consumption function explaining total consumption as a function of real disposable income in socio-economic groups and distribution relations using relative prices and total consumption as explanatory variables. With regard to the tax models an attempt has been made to have the institutional rules as given by tax laws etc. represented in full detail, that is with micro tax rules represented within the macro model.

f. The model is basically a static model. The only dynamic element of any importance is the presence of a lag effect in the macro-consumption function. The absence of more dynamic relations may be seen as a weakness, especially in short-term analysis. The importance of this may, to some extent, be subdued by a more sophisticated use of the model.

g. The exogenous variables of the model fall into different groups. One group may be called the truly exogenous variables such as, for instance, the world market prices. Another group are the instruments or policy parameters. The remaining exogenous variables have an intermediate or more questionable character. There are many variables in this last group and for a proper use of the model it is necessary that the user has a through understanding of the model as well as of the interrelationships of the economy, especially of those insufficienctly taken care of in the model. The model is thus not designed to serve as a black box.

h. The size of the model may be indicated by some key numbers. The number of commodities is nearly 210, the number of production activities is more than 250. Exports and imports are specified by commodities. Final demand categories are quite disaggregated with nearly 45 private consumption categories, and 225 investment categories. All variables connected with government budgets are as a rule quite disaggregated. There are, for instance, specified around 90 types of indirect taxes and subsidies. For a complete solution of the model it is necessary to insert values for about 2 400 input variables while the number of result variables coming out of the model is about 5 000. As the model can be - and usually is - solved for a number of years and alternatives simultaneously, hundreds of thousands of individual values are going into and out of the computer in a single solution of the model.

i. The quantity and price models viewed separately are almost linear equation systems and they are solved in a linear form with an iteration procedure to take care of non-linearities. The interrelations between the quantity part and the price part make it necessary to solve the price model preliminarily, then the quantity and the price models are solved in successions and, finally, some subsidiary calculations and the complete set of accounts are worked out.

3. THE ADMINISTRATIVE USE OF THE MODEL

The MODIS model is resident in the Central Bureau of Statistics. The construction, maintenance and use of the succesive version of the model have been major tasks of the Research Department of the Bureau since 1960. The official national accounts of Norway have been prepared and published by the Central Bureau of Statistics since 1946 and within the Research Department since it was established in 1950. The Research Department of the Bureau also published regular business cycle surveys and plays a major role in tax research and analysis in Norway.

The model building work has, thus, been performed in close coordination with the national accounting effort. On numerous occasions the detailed specifications and conventions in the national accounts have been changed to provide a better data base for the model. Such changes have, of course, been mainly related to details rather than to principles. The coordination with the national accounting work is of particular importance for the regular updating procedures of the model.

The other main link streching out from the model is to the Ministry of Finance which has been and still is, to an overwhelming extent, the main user of the model. The decisions on the development and use of the MODIS model have been taken by the Bureau in close cooperation with the Ministry of Finance.

Macro-economic planning in Norway is a part of the responsibility of ordinary government agencies. There are no separate planning institutions. Ministries, directorates and other administrative agencies take part in the planning process. For the short-term planning and the national budget, in particular, the Economic Division of the Ministry of Finance coordinates the plan preparations and mediates between the political decision-making bodies and the agencies taking part in the planning process. The Ministry of Finance is, thus, the main user of the model.

The model plays a central role in the preparation of the national budgets. The national budget is a government document containing a declaration of the policy which the government intends to pursue in the coming calender year as well as a comprehensive description of the development in the economy which es expected to follow if the proposed policy is put into effect. The national budget is prepared during summer, presented to and thoroughly discussed by the Storting in the autumn of the year prior to the budget year but it is not formally acted upon by the Storting. After the first round of computations the results are analysed and proposals and estimates are revised by the Ministry or the relevant agency. The time schedule allows 4-6 rounds of model computations during the preparation of the national budget. Each round may include a number of alternatives. A similar process takes place in the winter as a preparation of the revised national budget.

The model is also used in the preparation of the four-year plan in much the same way as for the national budgets. This plan is presented to the Storting every fourth year. In the recent years, the Ministry of Finance has, as a background for the national budgets, usually prepared five-to-seven-year projections more than once a year by means of the model.

The national budgeting is the task the model has been designed to tackle. The extension to cover also medium term projections has been a natural development. In the recent years, the model has been used also on many other occasions than in the plan-preparation process. The model has been employed, on numerous occasions of ad hoc policy analyses, often of a very aggregate character relative to the specifications of the model. The advantage of the model in such situations is that the particular policy issues are analysed within the framework of the current national budget or four-year plan. The disadvantages are basically that the model may have little to offer pertaining directly to the problem under consideration and it may seem a big apparatus to put into motion for a problem formulated in very aggregated terms.

The demand from the administrative environment is for a highly operational model. By that term we shall mean a computer program and computer facilities which fulfill a number of conditions (apart from being a computationally correct representation of the relations of the model). The model must be available for the user on short notice at almost any time, and the time lag between the user's final decision on input assumptions and the output of edited results should be minimized. At present, the normal time lag is from late afternoon till next morning. A shorter time lag is difficult to achieve with a model of this size. During the user's intensive work sessions the input assumptions may be revised at very short intervals.

The model is a very incomplete representation of the interrelations of the economy. The inaccuracy of the coefficients of the model is one aspect of this, the unavoidable uncertainty of many of the model's relations is another. The model is also incomplete in the sense that important interrelations of the economy are completely left out of the model. This incompleteness makes the model very open. The set of exogenous variables includes several variables than can hardly be regarded as independent relative to the whole set of endogenous variables of the model. While the computer will take care of the consistency built into the relations of the model it is left to the user to check consistency in a wider sense, paying attention also to interrelations not covered by the model. The iterative use of the model through a sequence of runs is of great importance for this purpose.

In extending the MODIS system, the strategy chosen is to leave the formal model as it is with only modest improvements in its basic structure and improve the use and usefulness of the model by its combined use with other models. These models are of two kinds: General models considerably more aggregated than MODIS IV but covering the whole economy and special support models to improve deficient or simply non-existent parts of MODIS IV.

Several of the support models are designed to provide estimates of exogenous variables in MODIS IV "pre-models" . Most of these pre-models include variables which are endogenous in the main model. This means that an iterative use of the system is necessary to achieve fully consistent solutions. With the more or less continous use of the MODIS model satisfactory degrees of consistency are usually well within reach.

Another group of support models uses results from the main model for further calculations ("post-models"). These models are using MODIS results in combination with variables not included in the MODIS-model itself.

A more aggregated version of MODIS IV, called MODAG-MODel of AGgregated type - has recently been built. This model has about 30 sectors and is programmed in an interactive data system. MODAG is a more complete model of the economy and many of the support models are included. Results from exercises with the more aggregated model can be spread out in full MODIS IV detail by appropriate translation of assumptions and results into exogenous variables and parameters of MODIS IV. In this way, one will try to combine the development of more complete models while still retaining the links with the details of MODIS IV.

4. IMPACT TABLE FOR THE MODEL

The representations of instruments such as direct and indirect taxes, government consumption expenditure etc., are very detailed in MODIS IV. The model is, therefore, very well suited to analyse the effects on macroeconomic targets such as employment, domestic product, consumer price index and so on of changes in the instruments. One convenient way of using the model for this purpose is to compute impact tables. Impact tables have been compiled yearly by means of MODIS IV since 1974. The tables are freely available and are used for widely varying purposes when a full model run is

TABLE 1 Impact on macro-economic variables of a 10 percent increase in exogenous variables. Percentage change.

		10 percent increase in		
	Base year figures 1983	Central government expenditures, consumption purpose	Domestic prices	Wage rates for wages and salaries
Percentage impacts on	0	3	18	23
Domestic product, main components				
Constant prices:				
Private consumption	192480.8	0.77	-3.06	3.22
Government consumption	78521.6	4.18	0.20	-0.15
Gross fixed capital formation	100681.6	0.00	0.00	0.00
Increase in stocks	-2256.8	1.60	-9.33	5.64
Exports	185187.4	0.00	0.00	0.00
Imports	152581.4	0.81	-1.20	1.59
Gross domestic product	401768.5	0.86	-0.92	0.87
Gross domestic product excl. oil production and ocean transport	316329.1	1.09	-1.15	1.10
Gross domestic product excl. oil production	328365.1	1.06	-1.12	1.07
Net domestic product	343099.9	1.01	-1.08	1.03
Price indices:				
Private consumption	100.0	0.00	3.82	2.06
Government consumption	100.0	-0.09	0.30	7.92
Gross fixed capital formation	100.0	0.00	2.69	2.96
Increase in stocks	100.0	0.00	0.84	-1.09
Exports	100.0	0.00	0.01	0.14
Imports	100.0	0.00	0.03	0.01
Gross domestic product	100.0	-0.02	2.54	3.33
Gross domestic product excl. oil production and ocean transport	100.0	-0.02	3.02	4.22
Gross domestic product excl. oil production	100.0	-0.02	2.89	4.11
Net domestic product	100.0	-0.02	2.52	3.54
Factor income, main components				
Current prices:				
Gross domestic product	401768.5	0.85	1.59	4.23
Consumption of fixed capital	58668.6	0.00	2.65	2.08

Net domestic product	343099.9	...	0.99	...	1.41	...	4.60
Indirect taxes	68495.9	...	0.69	...	0.43	...	2.81
Subsidies	-24652.0	...	0.04	...	-0.14	...	0.11
Factor income	299256.0	...	0.98	...	1.51	...	4.65
Compensation of employees	198288.8	...	1.29	...	-0.68	...	10.58
Operating surplus	100967.2	...	0.38	...	5.83	...	-7.08
Exports surplus, current prices	32606.0	...	-3.80	...	5.57	...	-6.68
Budget deficit before lending	12261.0	...	-14.16	...	-2.25	...	39.36
Direct taxes, households	62688.0	...	1.08	...	0.28	...	10.40
Employment in 100 man-years worked by employees	14916.0	...	1.38	...	-0.73	...	0.67
Consumer price index	100.0	...	0.00	...	3.85	...	2.06

not needed. Not only by the Ministry of Finance, but also by other Ministries, directorates, political parties and by private companies and agencies. Impact tables calculated by means of the model may be used to analyse the relation between exogenous and endogenous variables in general, and between instrument and target variables in particular, without performing actual runs. InTable 1 a fairly aggregated impact table for the model is displayed. On the left side of this table, there is listed a selected number of macro-economic variables. Selected exogenous variables (in fact, groups of similar individual exogenous variables in the model, called impactvariables) are entered at the top. The table shows along the columns, the effects which according to MODIS IV, are to be expected from a partial ten percent increase of the exogenous variable ot that column on each one of the endogenous variables listed on the left[1]. The effects are expressed as percentage change. Column 3 tells us, for instance, that ten percent increase in central government consumption expenditures has no impact on the consumer price index, but it increases the volume of private consumption and net domestic product by 0.77 and 1.01 percent respectively, while the employment increases by 1.38 percent. If read row-wise, the table gives for each endogenous variable information about which exogenous variables are particularly influential on that variable.

The impact table showed in Table 1 was estimated for 1983, and the levels the macro-economic variables for that year are listed in column 0. All the effects are related to this level.

Because of the linearity in the model's equation systems, the calculated effects may be used as a first approximation at all levels of changes in the exogenous variables. Therefore, the combined effect of a simultaneous change in two or more exogenous variables may be calculated by adding together

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[1] The exogenous variables are usually given a ten percent increase.

the effects of each variable taken separately (row-wise). A ten percent increase of the domestic prices and the wage-rates (column 18 and 23 in the table) will, for instance, raise the consumer price index by 3.85 + 2.06 = 5.91 percent. In this manner, the table can help providing quick estimates of the indirect effects on the endogenous variables represented in the model of any event whose direct impact on the exogenous variables of the model can be foreseen.

On the other hand it has to be strongly emphasized that the impact tables express partial effects of changes in groups of exogenous variables while the others are left unchanged. Many economic relationships are not represented in the model, and the economy is adjusted to the new market situation without any delay or lag effects.

In the next chapter, the use of impact tables is examplified by summing up the effects on macro-economic targets of changes in two or more impact-variables in such a way that the impact on, for instance, employees is put at zero. It must be clear from the discussion above that a complete analysis of such problems must include economic relations or models of another type than MODIS IV. Other macro-economic models might provide evidence about such relationships and how they affect the exogenous variables in MODIS IV. In that case, or if the model-user has other information about the working of the economy, the impact tables may also be used to calculate the effects of such changes. The total impacts in the economy will be obtained by summing up the effects on the variables calculated in each step of the process.

5. THE USE OF IMPACT TABLES IN POLICY APPLICATION

5.1. Preparing the model input

For the Ministry of Finance the operationality of the model is especially important. The normal time lag between the user's final decision on input assumptions and the output of edited results is from late afternoon till next morning. The openness of the model makes it necessary for the user to coordinate the input accurately. To save a lot of model computations and to get the first information about the effects of the different groups of exogenous variables, impact tables have been very useful. Different groups of exogenous variables will as a rule be prepared by different agencies in the administrative environment. The responsibility of filling out the forms for exogenous variables is divided between various economists in the Ministry. One person will have the main responsibility for private consumption, another for investment, and so on for the other main demand-side components. There is also divided responsibility for the information about the production side based upon current indicators and direct information from the Ministry of Industry. MODIS IV, therefore, serves as the central point of the department and makes the economists speak the same language and organize all information and judgement in a consistent way.

Considerable work has been invested in adjusting the actual administrative "language" to the relevant input variables of MODIS IV. It is always necessary to transform the administrative variables, especially on direct and indirect taxes and the detailed specification of government consumption, into the exogenous variables that really are input in the model. Allready constructed impact tables give an excellent opportunity to consider the result of this transformation through the effects given in the tables. The impact tables also give the model user the first possibility to consider all of the inputs for the exogenous variables at the same time and to reveal any over-determination and, thereby, force consistency on the system. Even if the impact tables only give first approximation to a full model run, a substantial part of the model result will be explained due to the linearity in the model.

The usefulness of the impact tables in the preparation of the model input will, to a great extent, depend upon the specification of the groups of exogenous variables - impactvariables - and the endogenous variables specified in the tables. In Table 1 the impacts on a selected number of macro-economic variables from changes in groups of exogenous variables are displayed. In the annual updating of the impact tables, the exogenous variables are specified in 150 groups. In addition to the endogenous variables in Table 1, there are specified more disaggregated variables both for consumption, imports and the production sectors. There are also constructed tables for direct and indirect taxes, government consumption and income for three socio-economic groups. In the annual updating of the impact tables an important task is to take care of the Ministries' daily needs for such tables in the planning process. Relevant impact tables will in this way improve the input to the model.

In the departments' judgement of the economic situation, the effects on macro-economic targets will play a central part. Especially the impacts on employment, economic growth and inflation. But the impacts on the budget deficit before lending, export surplus and the distribution of the demand between different demand components and the distribution of economic growth between production sectors, will also be taken into account. The use of MODIS IV can, only to a certain degree, answer many of these questions. But the model user will in a quick way with the help of impact tables have the first impression of the functioning of the economy given the relationships that are taken care of in the model. Usually it will be necessary to have other information based upon experience and other models. The preliminary models' results are to be judged in relation to the government goals for the economic development in the society. As a result of this, the exogenous model input might be revised so that the aims of the government will be better fulfilled. Conflicts between different goals, for instance, between employment and inflation, may lead to a revision of the economic policy. The preliminary results might also be put up against earlier model runs and computations with other macro-economic models, support models and so on.

The planning models in Norway today do not include the supply side of either labour or capital. The model results therefore have to be judged against the labour-market situation and the capacity utilization in the firms. To avoid press tendencies in the economy the possible effects of the model results have to be analysed in regard to the supply side and possible "overheating" of the economy in certain areas or sectors of production.

The construction of impact tables tries to take care of the planners possible needs in analysing the economic situation. When the tables are allready computed, the use of impact tables depends upon the specification of the variables. It is, of course, possible to compute other tables in the ordinary manner by running the model with an additional specification of both exogenous and endogenous variables.

5.2. Adjustment to the plan, ad-hoc analysis

The use of impact tables in adjusting the plan or in ad-hoc analysis can in the model be divided into the following three kinds due to types of changes that occur:

1. Changes in truly exogenous variables such as, for instance, the world market prices in Norwegian exports.

2. Changes in model-exogenous variables that are not exogenous in the economy. For instance wage rates or investments.

3. Changes in the instruments or policy parameters, such as, for instance, tax rates or government expenditure.

The openness of the Norwegian economy through foreign trade causes a substantial uncertainty in the planning process. The export forecasts in the 1970's have been evaluated by combining the observed values with the annual economic plans from the national budgets. The main impression from the evaluation were great discrepancies between forecasts and observed values, especially for exports. The average absolute deviation between forecasts and observed annual percentage change was calculated at 6.6 percent for commodity exports, while the deviation for private consumption and gross domestic product were calculated at 1.7 and 1.5 percent respectively.

Local government consumption is usually handled as an exogenous variable in the models such as MODIS IV. An evaluation of the forecasts from the national budgets, combined with the observed values during the last 10 years, showed that the observed values on the average were nearly twice as high as the forecasts for the growth rate in the period. The experience and the functioning of the economy clearly indicate that local government consumption is certainly not a pure instrument or policy parameter for the planning authorities.

In three examples, we will show how impact tables can be used to calculate macro-economic effects of changes in all the three different groups of exogenous variables.

TABLE 2 A decrease in exports compensated by an increase in government expenditures.

Percentage changes in	A 10 percent decrease in exports excl. ocean transport and oil production	A 11.4 percent increase in central government expenditures	The total effect 3 = 1+2
Percentage impacts on	1	2	3
Constant prices:			
Private consumption	-0.94	0.87	-0.07
Government consumption	0.17	4.76	4.93
Exports	-4.34	0	-4.34
Imports	-2.64	0.92	-1.72
Gross domestic product	-1.19	0.98	-0.21
Current prices:			
Compensation of employees	-1.54	1.46	-0.08
Operating surplus	-1.17	0.43	-0.74
Budget deficit before lending	-16.23	-16.11	-32.34
Employment in 100 man-years	-1.57	1.57	0

Table 2 shows in column 1 the impacts of a 10 percent decrease in exports excl. ocean transport and oil production. The reduction in exports is compensated by a 11.4 percent increase in government expenditure so that the total employment is left unchanged. The decrease in exports will, for instance, decrease the volume of private consumption and gross domestic product by 0.94 and 1.19 percent respectively, while the employment decreases by 1.57 percent or 23 400 man years. Government consumption has to increase by 11.4 percent to cancel the negative effect on the employment caused by the decrease in exports. The combined effects of these changes in exogenous variables are displayed in column 3, and cause a great decrease in the budget deficit before lending but give only small changes for the private consumption and domestic product. Other relationships and further judgements are not taken care of in the example, which of course are necessary in a complete analysis.

TABLE 3 A decrease in the employers' contribution to social security schemes compensated by an increase in indirect taxes.

Percentage changes in	A 10 percent decrease in the employers' contribution to social security schemes	A 5.1 percent increase in the commodity indirect taxes	The total effect 3 = 1+2
Percentage impacts on	1	2	3
Constant prices:			
Private consumption	0.33	-1.00	-0.67
Imports	0.14	-0.42	-0.28
Gross domestic product	0.10	-0.30	-0.20
Current prices:			
Compensation of employees	-1.26	-0.22	-1.48
Operating surplus	1.22	-0.57	0.65
Budget deficit before lending	-13.20	13.20	0
Employment in 100 man-years	0.11	-0.24	-0.13
Consumer price index	-0.30	1.05	0.75

In Table 3 the impacts of a 10 percent decrease in the employers' contribution to social security schemes are displayed in column 1. The reduction in the employers' social taxes is compensated by a 5.1 percent increase in the indirect taxes so that the budget deficit before lending is left unchanged. The decrease in the employers' social taxes causes a considerable drop in the budget deficit, but only minor changes in other variables. For instance, the consumer price index decreases by 0.3 percent, the private consumption increases by 0.3 percent, while the operating surplus increases by 1.2 percent. The indirects taxes have to increase by 5.1 percent to cancel the negative effect on the budget deficit caused by the tax-decrease. The combined effect of these changes in exogenous variables is shown in column 3, and it causes a substantial increase in the consumer price index and the operating surplus. Due to the price increase that follows from the indirect tax increase, both private consumption and domestic product decrease by 0.67 and 0.20 percent respectively. The combined effect ensures that the budget deficit remains unchanged, it gives an income increase to the owners of the enterprises and a reduction in wages and production.

Table 4 shows in column 1 the impacts of a 10 percent increase in the wage rates. The increase in the wage rates increases the private consumption

TABLE 4 An increase in the wage rates and compensation to the pensioners by the increase in the consumer price index.

Percentage changes in	A 10 percent increase in the wage rates for wages and salaries	A 2.06 percent increase in the government transfers to households	The total effect 3 = 1+2
Percentage impacts on	1	2	3
Constant prices:			
Private consumption	3.22	0.46	3.68
Imports	1.59	0.21	1.80
Gross domestic product	0.87	0.13	1.00
Current prices:			
Compensation of employees	10.58	0.10	10.68
Operating surplus	-7.08	0.14	-6.94
Budget deficit before lending	39.36	-5.05	34.31
Employment in 100 man-years	0.67	0.12	0.79
Consumer price index	2.06	0	2.06

considerably by 3.22 percent and the gross domestic product by 0.87 percent. The operating surplus decreases by 7.08 percent, while the budget deficit increases considerably. The consumer price index increases by 2.06 percent, and in connection with the income settlements for income and wages the effects of compensation to the pensioners can be calculated by using impact tables. A compensation of 2.06 percent in the government transfers to households will cancel the negative effect on the pensioners' income caused by the wage increase. The combined effects of these changes in exogenous variables are shown in column 3. The compensation to the pensioners will give an additional increase in both income, production and employment. It is indeed very likely that other groups also will try to compensate the drop in their income due to the increase in the wage rates and prices. In this way, the model user can calculate the effects that might occur, step by step, from an original increase in, for instance, the wage rates.

6. THE USE OF IMPACT TABLES IN TESTING THE MODEL

The yearly updating of the model is based upon the national accounts for the preceding year, and the updating procedure usually takes place in May and June. The national accounts are, therefore, the main data base for the model. The annual updating of the model has proved to be useful especially after the increase in energy prices and the emergence of the oil sector in the Norwegian economy. In the planning procedure, it is also very important that the model can reproduce the base year automatically, and that the base year of the model is the same as the latest national accounts. The base year may be atypical for certain industries, however, so it might have been better in that case, to estimate the input-output coefficients with a two- or three-year moving average.

The usefulness of the impact tables is, of course, heavily dependent upon the stability of the economic structure and the fixed coefficients in the model. The main sources of errors between estimated and observed variables in the model are the fixed input-output coefficients. They are re-estimated every year. The matrix of import shares is also estimated from the national accounts every year, and this matrix plays an important role in the import sub-model. In addition, there are the fixed coefficients in the macro consumption function and the Engel and Cournot derivatives in the set of distribution relations of the private consumption sub-model also re-estimated every year by using a combination of cross-section and time series variables.

The combination of impact coefficients calculated by the same specification of impactvariables from different years, will, therefore, indirectly be a test of the stability of the model formulation and the fixed coefficients in use in the model. A relative percentage change in an impact-variables calculated for a specific year will have a certain impact on the endogenous variables that year. The impact coefficients from that year can be combined with the same group of coefficients estimated for another year. The discrepancies between the coefficients will indicate stability or not in the fixed parameters and in the model structure. This indirect method of testing the stability will also give information on the gains that should be expected from updating the model. Likewise the method of testing the stability will also indicate the usefulness in adjusting the plan in the plan period by impact tables.

In Table 5, the impacts on macro-economic variables of a 10 percent increase in selected groups of exogenous variables are displayed. The table shows the impact-coefficients calculated from the base years 1978 and 1983. The macro-economic variables are the same as in Table 1 above, and the selected impact variables are the same as in Tables 2, 3 and 4. The impact-variables are specified in column 1 to 6 in the table, and each column has impact-coefficients for two years, namely 1978 and 1983.

The main impression from the table is that the impacts on the macro-economic variables in 1978 and six years later in 1983, have a great deal of common effects. Even if there are discrepancies, the deviations are, as a rule, rather small related to the time period of six years. The impacts of a 10 percent increase in exports are displayed in column 1. The impact-coefficients for 1978 have a relatively smaller effect on imports and a bigger effect on production than the coefficients for 1983. This result is partly due to an increase in the import share over time, and the fact that the exports of commodities are decreasing in the economy, especially since the emergence of the oil sector. Column 2 shows the impact of a 10 percent increase in central government expenditures. Also in this case the production effects are bigger and the import effects smaller that coefficients for 1978. On the other hand, the impacts on employment are exactly the same. The reason for this are the labour consuming activities in government production and the fact that the demand for labour from this sector is relatively higher in 1983 than in 1978.

In the three next columns the impacts of an increase in the employers' contribution to social security schemes, commodity indirect taxes and wage rates are displayed. The main impression is the same as above, but the discrepancies are somewhat smaller than in the first two tabulated cases. Column 6 shows the impacts of an increase in government transfers to households. Despite the higher import share in 1983 than in 1978, the impacts on both production and employment are bigger than the impact coefficients for 1983. The main reason for this is the growth in pensions and the growth in unemployment.

In chapter five impact-coefficients for 1983 were used in calculating macro-economic effects of changes in impactvariables in three different examples tabulated in Tables 2, 3 and 4. Tablw 2 shows the effects of a reduction in exports compensated by an increase in government expenditures

TABLE 5 Impacts on macro-economic variables of a 10 percent increase in exogenous variables. Percentage change. Impact coefficients for 1978 and 1983.

10 percent increase in	1		2		3		4		5		6	
	Exports excl. ocean transport and oil production		Central government expenditures, consumption purpose		Employers' contribution to social security schemes, tax rate 3		Commodity indirect taxes, tax rates		Wage rates for wages and solaries		Government transfers to households	
Percentage impacts on	1983	1978	1983	1978	1983	1978	1983	1978	1983	1978	1983	1978
Domestic product, main components												
Constant prices:												
Private consumption	0.94	1.42	0.77	0.94	-0.21	-0.25	-1.96	-2.24	3.22	3.77	2.22	1.89
Government consumption	-0.17	-0.18	4.18	4.57	0.01	0.02	0.08	0.07	-0.15	-0.13	-0.11	-0.08
Gross fixed capital formation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Increase in stocks	40.68	7.28	1.60	0.60	-0.54	-0.17	-3.73	-1.25	5.64	2.13	4.70	1.17
Exports	4.34	5.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Imports	2.64	2.73	0.81	0.72	-0.09	-0.11	-0.82	-0.98	1.59	1.78	1.02	0.85
Gross domestic product	1.19	1.75	0.86	1.03	-0.06	-0.09	-0.59	-0.75	0.87	1.20	0.63	0.61
Gross domestic product excl. oil production and ocean transport	1.48	-	1.09	-	-0.08	-	-0.75	-	1.10	-	0.79	-
Gross domestic product excl. oil production	1.46	-	1.06	-	-0.08	-	-0.72	-	1.07	-	0.77	-
Net domestic product	1.40	2.09	1.01	1.23	-0.07	-0.10	-0.69	-0.89	1.03	1.43	0.73	0.73
Price indices:												
Private consumption	0.00	0.00	0.00	0.00	0.18	0.19	1.96	1.82	2.06	2.23	0.00	0.00
Government consumption	0.00	0.00	-0.09	-0.11	0.68	0.76	0.50	0.55	7.92	8.81	0.00	0.00
Gross fixed capital formation	0.00	0.00	0.00	0.00	0.25	0.27	0.76	0.82	2.96	3.10	0.00	0.00
Increase in stocks	0.00	0.00	0.00	0.00	-0.10	-0.16	-0.67	-0.25	-1.09	-1.80	0.00	0.00
Exports	0.00	0.00	0.00	0.00	0.01	0.01	0.07	0.09	0.14	0.13	0.00	0.00
Imports	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00

TABLE 5 Impacts on macro-economic variables of a 10 percent increase in exogenous variables. Percentage change. Impact coefficients for 1978 and 1983. Continued.

Gross domestic product	0.00	0.00	-0.02	-0.02	0.29	0.33	1.24	1.36	3.33	3.86	0.00	0.00
Gross domestic product excl. oil production and ocean transport	0.00	-	-0.02	-	0.36	-	1.56	-	4.22	-	0.00	-
Gross domestic product excl. oil production	0.00	-	-0.02	-	0.36	-	1.52	-	4.11	-	0.00	-
Net domestic product	0.00	0.00	-0.02	-0.02	0.31	0.36	1.36	1.46	3.54	4.21	0.00	0.00
Factor income, main components												
Current prices:												
Gross domestic product	1.19	1.75	0.85	1.01	0.23	0.25	0.65	0.60	4.23	5.11	0.63	0.61
Consumption of fixed capital	0.00	0.00	0.00	0.00	0.18	0.18	0.59	0.84	2.08	2.03	0.00	0.00
Net domestic product	1.40	2.09	0.99	1.20	0.23	0.26	0.65	0.56	4.60	5.70	0.73	0.73
Indirect taxes	0.85	1.29	0.69	0.87	-0.02	-0.05	6.18	6.36	2.81	3.66	1.21	1.20
Subsidies	0.07	0.21	0.04	0.10	-0.01	-0.03	0.00	-0.12	0.11	0.36	0.09	0.19
Factor income	1.41	2.08	0.98	1.16	0.27	0.31	-0.67	-0.90	4.65	5.62	0.57	0.56
Compensation of employees	1.54	1.96	1.29	1.30	0.79	0.78	-0.44	-0.54	10.58	10.83	0.52	0.47
Operating surplus	1.17	2.53	0.38	0.61	-0.76	-1.55	-1.12	-2.32	-7.08	-14.81	0.68	0.92
Exports surplus, current prices	12.33	19.40	-3.80	-3.36	0.47	0.51	4.25	4.68	-6.68	-8.32	-4.78	-3.98
Budget deficit before lending	16.23	27.00	-14.16	-11.60	8.25	12.60	25.90	32.50	39.36	78.72	-24.55	-29.12
Direct taxes, households	1.38	1.68	1.08	1.05	-0.12	-0.13	-0.64	-0.74	10.40	11.30	2.29	1.77
Employment in 100 man-years worked by employees	1.57	1.97	1.38	1.37	-0.07	-0.08	-0.48	-0.58	0.67	0.91	0.57	0.51
Consumer price index	0.00	0.00	0.00	0.00	0.18	0.21	2.06	2.08	2.06	2.39	0.00	0.00

so that the total employment is left unchanged. With impact-coefficients for 1978 the government expenditures have to increase by 14.4 percent instead of 11.4 percent in the example with coefficients for 1983 to leave the employment unchanged. The main reason for this is especially the higher impact on domestic production and employment of a 10 percent export-increase in 1978 than in 1983. The changes in the total effects on the macro-economic variables are, nevertheless, rather small in relation to the impacts in Table 2. The total impacts on both private consumption and domestic product are almost unchanged, but the budget deficit before lending decreases substantially.

In Table 3, the impacts of a reduction in the employers' social taxes compensated by an increase in the indirects taxes to ensure unchanged budget deficit before lending are displayed. The main difference in this case is that the indirect taxes have to increase by 6.2 percent inctead of 5.1 percent with coefficients from 1983. The growth in indirect taxes has been higher than the growth in the employers' social taxes in the period. To cancel the macro-economic effects of a 10 percent decrease of the employers' social taxes with coefficients for 1978, the increase in indirect taxes, therefore, has to be higher than in 1983. The changes in the total effects on the macro-economic variables are in spite of this rather small. The private consumption and the gross domestic product decrease by 0.3 and 0.15 percent respectively more than with impact-coefficients from 1983, while the consumer price index increases by 0.2 percent more.

Table 4 shows the effects of an increase in the wage rates and compensations to the pensioners for the increase in the consumer price index caused by the increase in the wage rates. The impact-coefficients from 1978 lead to an increase in the consumer price index of 2.39 percent as compared with 2.06 percent for 1983 coefficients. The government transfers to households, therefore, have to increase somewhat more this year than in 1983. Together with the bigger effects on domestic production and employment caused by the increase in the wage rates, the total effects on the macro-economic variables are greater with impact-coefficients from 1978. The private consumption and the gross domestic product increase by 0.75 and 0.35 percent respectively more than with impact-coefficients from 1983.

As mentioned earlier in this chapter there are many reasons for discrepancies between the impact-coefficients calculated for 1978 and 1983. Some of the most important sources of discrepancies are obviously the fixed input-output coefficients. Changes in these coefficients reflect both the structural changes on the demand side, especially between the main demand components, and the technological changes in the production sectors. The national accounts used as data base in the model are calculated in current prices, and discrepancies between the impact-coefficients may also be due to changes in the relative prices in the period. In addition, there are some important errors in the model-formulation apart from the input-output structure. The macro consumption function is re-estimated every year and the marginal propensity to consume does not exactly have the same values in the two years in question. The estimated parameter for wage and salary earners is higher in 1978, but lower for self-employed and pensioners than in 1983. The import sub-model with constant market shares has a tendency to underestimate the demand for imports in the Norwegian economy. The content in the impactvariables can also differ somewhat between the two years, but it is probably not a reason for great differences.

In the further work with testing the model it is important to single out different main sources of discrepancies between impact coefficients calculated for different years. In doing this a decomposition of the discrepancies due to wrong specification of the model will be necessary.

In this test, we will try to trace the errors back to different relations or submodels of the model system and the whole range of fixed input-output coefficients. This will, of course, be a much better test than the indirect method of testing the stability of the model used in this paper, but it will most certainly also be a more difficult task to fulfill.

7. REFERENCES

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ON POLICY APPLICATIONS OF INPUT-OUTPUT MODELS IN THE FEDERAL REPUBLIC OF GERMANY

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1. GENERAL REMARKS AND SURVEY

Input-output analysis, some thirty years ago, was thought to be identical with economic planning.[1] Within those thirty years, especially within the last fifteen years, however, many problems were posed before the society for which answers had to be based on a disaggregated, yet macro-economic approach. Although, input-output analysis never came to play a major role in the decision-making process, quite a number of studies were initiated by various authorities, using input-output techniques.

One of the reasons for this state of affairs is rooted deeper, methodologically. General economists, as a rule, are familiar with the open static Leontief model, and for them this in the only feature of input-output analysis. Thus, all the constraints of this special feature are thought to be basic ones for any input-output technique. And input-output "experts", in the Federal Republic of Germany, have done too little to eliminate this misunderstanding.

Besides, working with as many data as input-output techniques need in order to be put to use makes economists feel uneasy, since the time lag between the period observed and the full set of data available on it still averages a few years. Here, too, a lot needs to be done yet to propose the input-output method which would be a very handy one in collecting data consistently and which would speed up the process of data assessing.

The attached survey of input-output activities initiated by governmental authorities for better information in political discussions must remain selective. Yet it might impress by the manifold topics input-output analysis was applied for in the last ten to fifteen years.

Reviewing the process of learning by doing within the last fifteen years at the German Institute for Economic Research DIW - which is the only institution in the Federal Republic of Germany that has a remarkable tradition in setting up tables and applying input-output techniques to economic analysis - we concentrate here on discussing a few studies which we feel might have had a slight impact on arguing in political processes.

2. ON APPLYING INPUT-OUTPUT TECHNIQUES FOR PRICE CALCULATIONS

In the course of events induced by the oil crisis in 1973, when prices started to climb rapidly, and all those increases were blamed on the direct and indirect input of oil, we used input-output techniques to calculate the

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[1] See: Krengel (1979).

TABLE 1 Survey of selected policy applications of input-output models in the Federal Republic of Germany[a].

Institutes in charge	Title of the report	Year	Commissioned by	Objectives	Policy issue
DIW	Anwendung von Input-Output-Tabellen zur Darstellung der Rückwirkung von Veränderungen im landwirtschaftlichen Produktionsaufwand auf die Wirtschaftszweige	1971	BM[b] Landw. u. Forsten	Calculation of feedbacks of changes in the level and structure of agricultural production on the other economic sectors	Structural measures
RWI	Die Auswirkungen alternativer Entwicklungen bei der Förderung von Steinkohle auf die Ruhrwirtschaft	1976/77	Minister d. Wirtschaft, Mittelstand u. Verkehr des Landes Nordrhein-Westfalen	Quantifying the impact of changes in the level of coal mining vis a vis a growth target projected up to 1985 for the "Ruhrgebiet"	Desings in energy policies
DIW/ Infratest-Industria	Verwendung und Bedeutung ausgewählter Rohstoffe in der deutschen Wirtschaft	1976	BM Wirtschaft	Simulating bottle-necks in thirty raw materials each, according to various scenarios assumed	Raw material provision
DIW	Input-Output-Analyse zur Evaluierung der Binnenwirtschaftswirkungen der der deutschen Entwicklungshilfe	1977	BM wirtschaftl. Zusammenarbeit	Evaluation of domestic effects induced by exports financed by development aid	Design in development aid policies
DIW	Direkte und indirekte gesamtwirtschaftliche Auswirkungen von Kostenänderungen durch verkehrpolitische Massnahmen auf Preise, Produktion und Beschäftigung	1977	BM Verkehr	Quantifying the effects induced by traffic policies railroad tariffs, for instance on production, employment and prices	Shaping traffic policy measures
Prognos	Arbeitsplatzsicherung durch Entwicklungshilfe - Kredite und Exporte in Entwicklungsländer	1978	BM wirtschaftl. Zusammenarbeit	Assessing the employment effects of development aid via German exports	Designs in development aid policies

IAW/ ISI/ ISM	Modell chemische Technik: Anwendung für die Bereiche Düngemittel, Waschmittel, Farben und Lacke	1979	BM Forschung u. Technologie	Analysis of the raw material content of products of the fertilizer, washing powder, paints and varnishes industries	Policies of research in technology and resources
DIW	Sektorale Verteilungswirkungen von Umweltschutzmassnahmen - die Input-Output-Rechnung als Entscheidungshilfe für die Umweltpolitik	1979	Umweltbundesamt	Assessment of data necessities for applying input-output analysis to environmental decisions. Calculations of production and employment effects of a "future investment program"	Impacts of environmental policies
DIW	Struktur und Wachstum der Berliner Wirtschaft bei rückläufiger Bevölkerung	1979	Regierender Bürgermeister von Berlin	Presentation and application of a demographic-economic system of projections on Berlin West economy	Long term regional projections
DIW	Macro-Economic Effects of Disarmament Policies on Sectoral Production and Employment in the Federal Republic of Germany, with special Emphasis on Development Policy Issues	1980	German Federal Foreign Office	Quantification of impacts of defence spending and development aid on sectoral production and employment	Defence and development aid issues
DIW/ Infratest-Industria	Verwendung und Bedeutung von Mineralöl in der deutschen Wirtschaft	1981	BM Wirtschaft	Simulation of impacts of potential bottle-necks in the supply of mineral oil and imported mineral oil products on sectoral productions and employment	Resource policies
DIW/Ifo/ RWI/IfW	Strukturberichterstattung 1980 und 1983	1981, 1984	BM Wirtschaft	Analysis of interactions between final demand, primary inputs and production, including intermediate products	Assessment of structural development and

TABLE 1 Survey of selected policy applications of input-output models in the Federal Republic of Germany[a]. Continued.

					gaps to shape overall structural policies vis a vis guestions on labour markets subsidies, imports, exports, energy, and prices
DIW	Direkte und indirekte sektorale Auswirkungen der Investitionsaufwendungen der Deutschen Bundespost für Fernmeldeanlagen auf die Produktion und Beschäftigung in der Bundesrepublik Deutschland	1982	BM Post- u. Fernmeldewesen	Quantification of employment effects to be induced by planned investments of the "Deutsche Bundespost"	Investment policies
DIW	Alternativen des U- und S-Bahn-baus - Abschätzung von Folgewirkungen des investiven Bedarfs für die Berliner Wirtschaft	1983	Senator für Wirtschaft u. Verkehr d. Landes Berlin	Calculation of alternate policies for subway and/or surface rail system in Berlin West	Regional investment policies
IABG/ DIW	Indirekte Beschäftigungseffekte von Fernstrasseninvestitionen	1985	BM Verkehr	Calculation of the sectoral and total employment effects of investing into various types of main roads	Investment policies

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[a] The survey includes studies only as long as they were commissioned by governmental authorities. It does not include studies with political implications commissioned by enterprises or business organizations.

[b] BM = Bundesminister für - Federal Ministry for .

Source: DIW = German Institute for Economic Research.

average sectoral percentage of oil inputs, in value terms, on the basis of the input-output table for 1967. Any expected increase in the oil price, either in percentage or value terms, could then be easily transformed into sectoral price increases, which, de facto, were to be blamed on the oil price. The results were published rather soon after the oil price shock and helped a little to de-emotionalize the price making process.

Table 2 shows these published results for a 100 percent increase in the oil price, based on the table for 1967, and the results we obtained later on from a revised and updated table for 1972 depicting the actual situation at the moment of the oil crisis.[2] Except for paper milling and shipping, and an institutional shift between electricity and gas and water, there are hardly any major differences, especially in the key branches which we were most concerned about. The overall impact on final demand is slightly less, just 1.07 percent as compared with the previous results of 1.21 percent, respectively. With the oil price still declining in the late sixties, this difference is quite plausible.

In the early eighties, i.e. at present (because there have been no dramatic macro-economic changes since then), the overall impact on final demand of another 100 percent increase in the price for crude oil and imported oil products would be close to 3.5 percent, in spite of much energy saving - realized one; a tripling of the price, as observed between 1972 and 1974, accordingly, would bring up this overall impact to roughly 7 percent. Hopefully, the chances for this situation to occur seem to be bygone.

Meanwhile, this sort of price calculations is accepted in economic reasoning. Similar calculations were published by the DIW for wage increases, import prices, and steel.[3] Nevertheless, there still is some methodological misunderstanding: by calling these calculations a "price model", economists have done input-output techniques very little of a favour. With general economists, there is a feeling that models should explain why prices rise and forecast how much prices will rise. The input-output approach is a different one asking: What are the hypothetical impacts on sectoral price levels of changes in prices for primary inputs? and/or: How much of an observed price increase can be allocated to the verious primary factors of production being the "ultimate winners" of any price increase? With those calculations at hand, arguments can be based on a rather detailed quantitative assessment.

3. ON APPLYING INPUT-OUTPUT TECHNIQUES FOR THE SIMULATION OF BOTTLE-NECKS

At least since the oil crisis, it is a common knowledge that the economy of the Federal Republic of Germany operates quite dependent on raw material imports. The Federal Ministry for Economic Affairs initiated a study in the middle of the seventies to calculate the potential impacts on production and employment of a major disruption in raw material supply, for thirty types of material each.[4] Here, input-output analysis was put to its genuine use.

The general idea of how to cope with the problem stated was
- to, first, disaggregate the input-output table according to the special current uses of the various raw materials to be considered. With mineral oil being included in the analysis[5], the basic input-output table for tho-

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[2] See: Filip-Köhn (1982).
[3] Filip-Köhn (1976); Filip, and Filip-Köhn (1980).
[4] Filip, Filip-Köhn, Geissler, Horn, and Ziervogel (1976).
[5] Filip, Filip-Köhn, Geissler, Röhricht, and Ziervogel (1981).

TABLE 2 Price impact of a 100 percent increase in the price for imported crude oil and mineral oil products, in percent

Sectors	I-O-T 1967	revised I-O-T 1972
Agriculture, forestry, fishing	1.04	0.93
Electricity	1.46	2.38
Gas and Water	2.52	1.07
Mining		
Coal mining	0.86	0.72
Iron ore mining	1.28	1.40
Potash and rock salt[a] mining	7.06	1.40
Mineral oil extraction	6.36	1.78
Mining n.e.s.	1.77	0.41
Primary metals and basic products		
Building materials	2.38	2.59
Iron and steel	0.99	1.13
Iron and steel foundries	0.64	0.66
Steel drawing and cold rolling mills	0.77	0.66
Non-ferrous metals	0.54	0.44
Chemicals	1.68	3.29
Mineral oil refining	27.66	30.06
Rubber and asbestos manufactures	0.69	1.49
Sawmills and timber processing	0.87	0.95
Cellulose and paper processing	1.30	2.12
Engineering industry		
Constructional steel	0.55	0.53
Machinery	0.50	0.58
Vehicles	0.78	0.81
Aerospace	0.43	0.31
Shipbuilding	0.57	0.55
Electrical engineering	0.44	0.57
Precision engineering and optics	0.48	0.53
Steel forging	0.69	0.55
Hardware and metal goods	0.60	0.63
Consumer products		
Fine ceramics	1.01	0.74
Glass	1.58	1.78
Timber manufactures	0.58	0.69
Musical instruments, toys, jewelry sport articles	0.43	0.81
Paper and board manufactures	0.78	1.14
Printing and duplicating	0.51	0.58
Plastics manufactures	0.83	2.73
Leather	0.52	0.60
Textiles	0.63	0.95
Clothing	0.41	0.47

Food, beverages and tobacco		
Grain milling	0.73	0.60
Edible oils and vegetable fats	0.44	0.63
Sugar	1.25	1.55
Brewing and malting	0.57	0.74
Tobacco manufactures	0.14	0.15
Other food and beverages	0.80	0.80
Handicraft trades, small enterprises, other manufacturing	0.63	0.62
Construction	0.88	0.86
Wholesaling	0.47	0.38
Retailing	0.41	0.42
Railways	0.95	0.77
Shipping, waterways, harbours	10.67	4.02
Road and air transport	3.05	1.91
Communications (Bundespost)	0.29	0.40
Banks and insurance	0.28	0.27
Rented dwellings	0.42	0.30
Other services	0.40	0.38
Public sector (incl. social insurance)	0.58	0.55
Components of final demand of which:		
Private consumption	1.48	1.25
Government consumption	0.58	0.55
Gross fixed capital formation	0.74	0.76
Exports	1.45	1.44
Total final demand	1.21	1.07

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[a] Including stockpiling activities of mineral oil in 1967.

Source: Nominal input-output tables of the DIW for 1967 and 1972 (revised version).

se calculations was holding 384 sectors of production[6],
- to, then, enter a set of information gained from technical management in the various branches of the economy on the short-to medium-term potential in substitutes for special inputs; i.e., we entered a very voluminous list of information on how much, at what costs, "critical" inputs could be substituted by others in a relatively short time on the various stages of production;[7]
- to, finally, simulate complete, new input-output tables according to various assumptions on handling the bottle-neck. The programs designed to combine all the information and scenarios entered, operate wthout inverting any matrix.[8] Due to this convenient feature, the simulations were quite time saving, and it was easy to enter additional information. This proved to be necessary, especially in the case of taking care of substitution potentials at very "indirect" stages of production.

By comparing the basic table with the simulated ones, the percentage changes in gross production can be obtained. Accordingly, the potential of "idle" labour can be assessed.

Two basic approaches for simulations were used:
- the intermediate flow method and
- the final demand method.

Using the intermediate flow method, a "critical" input is followed throughout the whole of the economy, thus getting information on all the matrix elements that might be involved. This approach reflects the spreading of bottle-necks in the economy (and its feedbacks on intermediate demand) and allows for entering responses on the various stages of the simulation process. By means of the final demand method, the amount of "bottle-necked" inputs is saved by curtailing final demand, either according to the maximization rules or the optimizing aspect, i.e. with upper levels of final demand for each product to be maintained. Applying this procedure, one learns about the output structures that would be consistent with a "maximized" or "optimized" national product in a bottle-neck situation, starting from cuts in final demand.

The results of this study were classified. Once in a while, though,

results of what we called a "horror scenario" are reflected publicly. The "horror scenario" assesses the potential impacts of a surveyed input by the intermediate flow method; it allows for substitutes on the various stages of production, but for no major shift in output structures. It was meant to provide an insight into the relative importance of raw material inputs under the condition of unchanged market access of suppliers.

With this scenario we arrived at nine raw materials out of the thirty ones that seemed to be crucial, two were rather important, an additional two to four materials would have a non neglectable impact on production, and a bottle-neck in the rest of them, i.e. roughly sixteen imported raw materials, would practically affect production by zero points. Technology has changed since then, and asbestos, for instance, most probably would no more be identified as a crucial material today. Maybe some other input would take its place.

Certainly, both approaches can be combined and the programs can be expanded to simulate a bottle-neck for any combination of "bottle-necked" inputs. This feature was employed in the survey on mineral oil, since here it was necessary to look at gasoline, fuel, petrochemicals etc. individually

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[6] Filip, and Filip-Köhn (1981)
[7] For further information compare: Filip-Köhn (1982).
[8] Filip (1980).

and in total.

Indeed, the results of simulations like these are quite hard to be understood by "normal" persons. We felt that a clear cut, definite answer normally is expected when asking for the impact of a sudden decline in oil imports by, for example, thirty percent that would imply a loss in real production of roughly 8 percent points for example . Using input-output techniques, they are maybe taught: According to how this bottle-neck is handled by the market and by authorities, the impact might range from 6 to 26 percent points for example . Table 3 is taken from the authentic report on mineral oil and shows the range of impacts for one of the 17 oil products examined and 35 sectors of production only out of the 384 ones considered. Besides the scenarios listed, there could be thought of a number of alternatives not yet simulated.

Having in mind all the constraints of the scenarios, an interesting aspect of the results is to be mentioned: In quite a number of cases, the calculated losses in real production under intermediate flow method conditions were below those obtained by the final demand method, even in its maximizing version. The reason for this seems quite simple: the wide range of responses to bottle-necks at the various stages of production could by no means be incorporated into the final demand approach. Here, just the information on substitutes at the first two, at least three stages of production could be entered.

On the basis of the results of this first attempt to model the economy according to scenario conditions in a nearly cybernetic way of tracing interactions, we may provide, for practical purposes, the advice: politicians who face such a situation of a short-term crisis, should preferably but not principally let the bottle-neck spread and let those challenges be respodded by the individual economic actor. They should, however, watch the results very closely and interfere in final demand, i.e. in output structures, when those results seem to march out of the margins simulated. Thus, input-output techniques can inform on crucial matrix elements very rapidly, macro-economically consistently and quite in detail.

4. IMPACT OF DEFENCE SPENDING ON PRODUCTION AND EMPLOYMENT IN THE FEDERAL REPUBLIC OF GERMANY

After discussing a rather complicated, but highly interesting use of input-output techniques we describe results obtained by employing the very simple open static Leontief model.

When debating the national impact of defence spending versus increases in development aid at the United Nations' level, the German Federal Foreign Office, in 1979, commissioned a report to obtain the relevant figures for the Federal Republic of Germany.[9] Input-output techniques, in these cases, are of advantage for consistently assessing the overall and sectoral impacts of a special kind of expenditure. For the disarmament part of the study, the results show the proper economic magnitudes of defence activities, or a linear cut in them, respectively.

Table 4 shows the hypothetical output and employment impacts of such a linear cut by 10 percent, for sectors and in total, as well as for 1972 and 1976. Taking account of increases in productivity and prices since then, a worldwide 10 percent linear cut in defence expenditures, by the end of the seventies, would have released a labour force of roughly 95 000 persons in the Federal Republic of Germany, that would be equal to about 0.35 percent of the total labour force at that time.

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[9] Filip-Köhn, Krengel, and Schumacher (1980).

TABLE 3 Range of potential impacts on gross production and final demand of a short term, 30 percent bottle-neck in one of the 17 oil products analysed - according to scenarios, in percent, selected example

Sectors[a]	Scenario 1: No major shifts in output structures, substitutions				Scenario 2: Shifts in output structures, substitutions excluded				Scenario 3: Shifts in output structures, substitutions included			
	excluded		included		maximization		optimization		maximization		optimization	
	gross production	final demand	gross production	final demand	gross production	final demand	gross production	final demand	gross production	final demand	gross production	final demand
13016	20.27	0.0	3.80	0.0	2.46	0.0	7.18	0.0	2.64	0.0	7.67	0.0
13017	21.07	0.0	4.54	0.0	4.88	0.0	27.74	50.0	4.92	0.0	27.96	50.0
13018	24.34	0.0	3.49	0.0	1.72	0.0	8.18	0.0	1.76	0.0	8.37	0.0
13019	25.88	0.0	5.15	0.0	6.09	0.0	7.75	0.0	6.16	0.0	8.10	0.0
13020	20.21	0.0	3.50	0.0	2.97	0.0	14.74	0.0	3.01	0.0	14.91	0.0
13021	13.64	0.0	2.11	0.0	7.94	0.0	12.97	0.0	8.25	0.0	15.94	0.0
13022	22.79	0.0	3.83	0.0	7.46	0.0	15.88	0.0	7.50	0.0	16.27	0.0
13023	20.33	0.0	3.36	0.0	4.12	0.0	14.08	0.0	4.12	0.0	14.13	0.0
13024	27.50	0.0	4.64	0.0	16.02	0.0	24.32	50.0	16.22	0.0	24.46	50.0
13025	27.95	0.0	5.97	0.0	9.02	0.0	18.17	0.0	9.22	0.0	22.27	0.0
13026	23.36	0.0	4.68	0.0	13.36	0.0	21.01	0.0	14.35	0.0	23.24	0.0
13027	15.19	0.0	2.96	0.0	4.77	0.0	10.05	0.0	4.92	0.0	10.53	0.0
13999	23.85	0.0	4.13	0.0	10.00	0.0	12.29	0.0	10.09	0.0	13.96	0.0
14001	30.00	30.27	5.05	0.0	0.45	0.0	24.70	0.0	0.46	0.0	24.94	0.0
14002	30.00	30.49	6.74	7.71	3.26	0.0	7.80	0.0	3.30	0.0	8.07	0.0
14003	9.00	0.0	2.02	0.0	2.33	0.0	3.60	0.0	2.37	0.0	3.82	0.0
14004	30.00	30.03	0.33	0.0	0.13	0.0	2.46	0.0	0.13	0.0	2.47	0.0
14005	7.21	0.0	1.94	0.0	0.92	0.0	2.32	0.0	0.94	0.0	2.39	0.0
14006	30.00	30.01	2.81	2.28	0.45	0.0	1.36	0.0	0.46	0.0	1.45	0.0
14007	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	50.00	50.0
14008	30.00	30.00	2.81	2.17	0.20	0.0	43.55	50.0	0.21	0.0	43.47	50.0
14009	2.40	0.0	0.54	0.0	0.13	0.0	0.44	0.0	0.14	0.0	0.46	0.0
14010	1.36	0.0	0.30	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0
14011	11.43	0.0	0.23	0.0	0.24	0.0	0.51	0.0	0.25	0.00	0.54	0.0

14012	30.00	38.05	4.87	0.0	17.75	0.0	24.45	0.0	17.82	0.0	24.77	0.0
14013	17.04	0.0	2.49	0.0	1.01	0.0	4.22	0.0	1.07	0.0	4.64	0.0
14014	25.45	0.0	3.68	0.0	0.95	0.0	7.18	0.0	1.00	0.0	7.27	0.0
14015	25.56	0.0	5.06	0.0	4.26	0.0	13.57	50.0	4.40	0.0	18.25	50.0
14016	26.98	0.0	4.93	0.0	1.67	0.0	11.75	50.0	1.76	0.0	12.26	50.0
14017	17.33	0.0	3.29	0.0	1.01	0.0	7.24	50.0	1.08	0.0	26.24	50.0
14018	19.40	0.0	3.25	0.0	0.54	0.0	8.64	0.0	0.57	0.0	9.37	0.0
14019	23.62	0.0	0.58	0.0	21.26	100.0	44.59	50.0	21.26	100.0	44.58	50.0
14020	5.00	0.0	1.11	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0
14021	30.00	30.00	5.95	0.0	0.27	0.0	34.79	0.0	0.28	0.0	34.99	0.0
14022	20.00	0.0	4.50	0.0	0.14	0.0	3.31	0.0	0.12	0.0	4.70	0.0

[a] 13016 through 13999 = non-ferrous metal production, in particular lead;
14001 through 14022 = 22 subsectors of the chemical industry which was split into 59 sectors in the basic table holding 384 sectors of production.

Source: Example taken from an unpublished report on mineral oil: input-output calculations of the DIW.

Scenario 3 (optimization, including substitution) results in impacts that are slightly above those of scenario 2, excluding substitutions. At first glance, this seems to be illogical. The unexpected effect can be explained quite easily: by entering the information on substitution potentials, the overall needs for imports of crude oil and oil products declined by a considerable amount, but, for this particular oil product analysed, as the only one, substitutions induced a slight increase in intermediate demand.

TABLE 4 Output and employment effects of a worldwide linear cut in defence spending by 10%, 1972 and 1976 at current prices, in DM million and 1000s respectively

	Economic sectors (input-output accounts for structural reporting)	1972		1976	
		Output effects (-)	Empl. effects (-)	Output effects (-)	Empl. effects (-)
1	Ag., for. and fishing	28	1.1	36	1.0
2	El., gas and water	43	0.2	83	0.3
3	Coal mining	18	0.3	31	0.3
4	Other mining	2	0.0	3	0.0
3-4	Mining				
5	Chemicals	79	0.7	121	0.6
6	Oil industry	52	0.1	124	0.1
7	Plastics and rubber	40	0.6	57	0.5
8	Stone, sand and clay	25	0.3	39	0.3
9	Fine ceramics and glass	12	0.2	14	0.2
10	Metal industry	138	1,6	179	1.4
11	Constr. steel, EDP	34	0.6	34	0.4
12	Engineering	66	1.0	100	0.9
13	Vehicle building	307	4.0	481	4.0
14	Electrical equipment	193	3.0	235	2.5
15	Prec. eng., optics, met. prods	110	2.0	155	1.9
16	Timber, paper, printing	74	1.2	81	0.9
17	Textiles	30	0.5	27	0.3
18	Leather and clothing	14	0.3	26	0.4
19	Food and drink	71	0.6	95	0.5
20	Tobacco	3	0.0	4	0.0
5-20	Manufacturing				
21	Building	83	1.3	139	1.7
22	Finishing	64	1.0	84	1.0
21-22	Construction				
23	Wholesale trade	184	3.4	170	2.2
24	Retail trade	40	1.1	33	0.6
23-24	Wholesale and retail trade				
25	Railways	27	0.8	33	0.8
26	Shipping	6	0.1	8	0.1
27	Other transport	60	0.7	83	0.6
28	Communications	34	0.9	47	0.7
25-28	Transport and communications				
29	Banking	21	0.3	30	0.3
30	Insurance	6	0.1	8	0.1
29-30	Banking and insurance				
31	Residential letting	0	0.0	0	0.0
32	Other services	149	2.5	230	2.5
1-32	Business sector, total	2 013	30.5	2 790	27.1
33	Public sector	1 156	67.9	1 613	68.7
34	Priv. househ., non-prof. orgs	0	0.0	0	0.0
1-34	generated by domestic demand	3 169	98.4	4 403	95.8
generated by exports		~ 240	~ 3.6	~ 367	~ 3.6
Total domestic effects (-)		3 409	102.0	4 770	99.4

TABLE 4 (continued)

Imports of intermediate products (-)				
ex domestic demand	130	-	255	-
ex exports	∼ 16	-	∼ 34	-
Final imports (-)				
ex domestic demand	199	-	317	-
Total imports (-)	345	-	606	-

Source: DIW.

5. CONCLUDING REMARKS

When discussing the present state of affairs concerning the application of input-output techniques in the overall decision-making process, notice should be taken of a growing, rather favourable attitude towards this method. With the "chip" revolution, and increasing awareness of the gaps to get a clear cut picture of its overall economic effects, input-output techniques seem to be less reluctantly accepted as supporting instrument than previously.

Maybe hopes placed in them are too great. At least, we started on the subject by simply assessing the shares of information goods and services in the national product in the years 1970 and 1980. Because of the specific logical implications of input-output analysis, it - here - was possible to group the hundreds of items and activities listed according to the conventions of National Accounts, and a fairly reliable percentage share could be calculated.[10]

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TECHNOLOGICAL PROGRESS ANALYSIS: SOME INPUT-OUTPUT APPROACHES

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INTRODUCTION

If the cost decrease is a target of technological progress, one of the progress assessments is a change in the cost structure. It is due to the uneven impact of new technologies on different elements of product costs. Hence it is possible to determine three types of technological progress: labor saving, fixed capital saving and material saving. In reality, any new technology or technological progress as a whole changes all the three elements of costs, but historically it is possible to determine the periods when one of them dominated. The reasons of such an uneven influence are the dynamics of relative prices of each resource, on the demand side, and the objective dynamic possibilities of scientific and technological development.

1. METHODOLOGICAL APPROACHES

In our investigations we use 7 input-output tables of Japan for 1951, 1955, 1960, 1965, 1970, 1975, 1980 (sources: 1-3). All the tables were aggregated to an 18-industries level and reestimated into the 1970 prices (source: 5). Thus we have got the time series of completely comparable input-output tables:

$$b_j = \sum_i a_{ij} b_i + l_j \tag{1}$$

where

b_j, b_i - total labor requirement coefficients,

l_j - direct labor requirement coefficient,

a_{ij} - input-output coefficients.

We can divide a_{ij} into two parts:

$$a_{ij} = \alpha_{ij} + \beta_{ij} , \tag{2}$$

where α_{ij} reflects the use of materials produced by a i-th industry and β_{ij} reflects i-th capital consumption for unit production in a j-th industry.

In order to estimate α_{ij}, it is necessary to disaggregate capital consumption allowances for each industry into its elements - fixed capital goods produced by certain industries. We have chosen five such industries - construction (c), general machinery (gm), electrical machinery (em), transportation equipment (te), agriculture (a) - as well as a technological structure of fixed assets: houses (1), constructions (2), eqipment and machines (3), ships (4), other transportation equipment (5), instruments and fixtures (6), land improvement (7), plants and animals (8), incomplete construction (9).

The algorithm of industrial classification transformation is shown in Table 1.

TABLE 1 Industrial classification transformation.

Industries	Technological structure of assets
(c)	1, 2, 9
(gm)	3
(em)	6
(te)	4, 5
(a)	7, 8

Then we got the experts' estimates (source: 7) of life-time for different types of fixed capital assets as:
33 years - for houses and constructions,
11 years - for industrial equipment,
5,7 years - for transportation equipment,
8 years - for plants and animals in agriculture.
As a result we estimated the distribution structure for capital consumption allowances in each industry (Φ_j) (see Table 2) based on the use of the real structure for 1965 (source 6) and assumptions about average life-time mentioned above.

TABLE 2 Distribution structure for capital consumption allowances, %.

	Material production (No 2-13,17)*	Agriculture (No 1)	Transportation and Communication (No 16)	Non-material production (No 14,15,18)
3.c	30	27	27	50
10.gm	43	40	40	-
11.em	7	7	6	12
12.te	20	20	27	37
1.a	-	6	-	-
	100	100	100	100

*Numbers of industries correspond to the list in Table 5.

The data in Table 2 mean that for industry No 8, for instance, its capital allowances (Φ_8) will be distributed as flows of capital goods x'' in the following way:

$$x''_{3,8} = 0.30\Phi_8$$
$$x''_{10,8} = 0.43\Phi_8$$
$$x''_{11,8} = 0.07\Phi_8$$
$$x''_{12,8} = 0.20\Phi_8$$

This method permits to develop the matrix of fixed capital allowances as

$\beta_{ij} = x''_{ij}/x_j$ estimated by the above mentioned methods (3)

$x_{ij} = x'_{ij} + x''_{ij}$ (4)

$\alpha_{ij} = x'_{ij}/x_j$ from input-output tables (5)

$a_{ij} = \alpha_{ij} + \beta_{ij}$ new input-output coefficients

Thus we have transformed the capital consumption row of the third quadrat of the input-output table into additional elements of input-output coefficients.

In the post-war Japanese economy imports traditionally covered a certain part of input. To exclude the influence of imports we need the same purification of input-output tables. The most reasonable approach is based on import substraction from the input-output matrix, element by element. But there are only 2 import matrices in the Japanese statistics (for 1970 and 1980) and we had to develop an approximate algorithm of such an elimination.

If $M_{i,t}$ is a volume of imports of products of the i-th industry, $x^d_{i,t}$ is a volume of this industry's domestic production (all in year t), the share of domestic production in the total i-th product consumed in the economy will be the following:

$$d_{i,t} = x^d_{i,t} / X^d_{i,t} + M_{i,t} \tag{6}$$

Of course, we used a rather strong assumption that for a given year t the import share is the same for different ways of product use. But it will change in dynamics, from one year to another.

The modified flows, purified from the import part, will be for each input-output table:

$$x^d_{i,j} = x_{i,j} \cdot d \tag{7}$$

where $x_{i,j}$ is taken from (4).

In order to prove the applicability of this method we compared two matrices of domestic flows - the first one was estimated from the official import statistics for 1970 and the second one was estimated for the same year by using the proposed method.

The correlation coefficients for these two vectors estimated for each industry (from the 1st to the 18th) were more than 0.99 except for one case - transportation and communication - where the coefficient was 0.92. These results can be treated as evidence of the method acceptability.

Thus we got reconstructed input-output tables where the flows of products were purified from import and divided into material and fixed capital consumption. It is possible to disaggregate the coefficients of total labor requirements (b) into 3 coefficients: direct labor requirements (l), material requirements (b^m) and final capital requirements (b^c). If A is a matrix of direct material and capital requirements and A^m is a matrix of direct material requirements, b and its components will be defined as follows:

$$b = 1(E - A)^{-1} \tag{8}$$

$$b^c = 1(E - A)^{-1} - 1(E - A^m)^{-1} \tag{9}$$

$$b^m = 1(E - A^m)^{-1} - 1 \tag{10}$$

$$b = 1 + b^m + b^c \tag{11}$$

There shares of labor, material and capital consumption in the total cost of product will be defined, respectively:

$$S_l = \sum_j l_j x_j / \sum_j b_j x_j \tag{12}$$

$$S_m = \sum_j b_j^m x_j / \sum_j b_j x_j \tag{13}$$

$$S_c = \sum_j b_j^c x_j / \sum_j b_j x_j \tag{14}$$

Consequently, in order to define the type of technological progress for a certain period, it is necessary to estimate the impacts of these three components on the total labor requirement reduction and to find the main one.

2. THREE TYPES OF TECHNOLOGICAL PROGRESS AND THEIR DYNAMICS

If the total labor requirements are disaggregated into three components - labor, material and fixed capital inputs,(see equations (12-14)) - the technological progress materialized in total cost reduction can be divided into three types: labor, material and capital savings.

By using the method described in paragraph 1 and the 7 input-output tables for the post-war Japanese economy we have got the data reflecting these three types of technological progress in dynamics (see Table 3, the names of the industries are given in Table 5).

It is obvious that at any time during the investigated post-war period the technological progress combined all the three types. But in each period one type usually dominated. The material-saving type took place in all periods playing a main role in 1955-1965. The labor-saving type of technological progress played a growing role and reached the biggest share in the total cost reduction in 1965-1970. The important impact of capital saving on total cost or labor requirements reduction took place in 1975-1980.

The first period 1951-1955 of technological progress belonged to the labor and material saving types. In 1955-1965 material saving dominated, but the role of labor saving was growing and in 1965-1970 labor saving took the first place among these types of cost reduction. In 1970-1975, when the first post-war energy crisis occured, material saving became more important again, and at last 1975-1980 was the only period when fixed capital saving dominated.

As a result (see Table 4), the labor share in total cost grew in the 1950's, was stable in the 1960's up to 1975 and then grew again. The

TABLE 3 Rate of cost elements changes, % (L-labor, M-material, C-fixed capital inputs,* maximum reduction).

No of industry	1951-1955			1955-1960			1960-1965			1965-1970			1970-1975			1975-1980		
	L	M	C	L	M	C	L	M	C	L	M	C	L	M	C	L	M	C
1	-24*	+44	+39	-20	-29	-36*	-25*	-24	+7	-19	-21*	-4	-32	-35*	-18	-17	-15	-20*
2	-12	-41*	-30	-22	-48*	+5	-52*	-49	-11	-61*	-42	-21	-39*	+13	-22	-29	-33	-39*
3	+24	+21	+57	-10*	+24	+43	-30	-40*	-12	-38*	-38	-12	0	-18*	-8	-4	-31	-48*
4	-35*	+58	+75	-20	-32*	-31	-6	-34*	+2	-27	-31*	-17	-9	-31*	-5	-20	-35	-45*
5	-26	-37*	-10	-28	-57*	-45	-17	-33*	+3	-27	-34*	-24	-19	-39*	-18	-10	-34	-46*
6	-28	-36*	-8	-34	-50*	-22	-32	-40*	+5	-42	-44*	-40	-13	-60*	-45	-23*	+26	0
7	-41	-44*	-27	-41	-54*	-8	-43	-48*	-11	-47	-51*	-45	-11	-24*	+4	-25	-37	-51*
8	-33	-71*	-60	-4	-28*	+20	-37	-40*	-13	-47*	-47	-33	-22	-35*	-13	-14	-31	-52*
9	+12	-44	-54*	-24	-25*	+11	-43*	-42	-12	-39*	-37	-26	-6	-25*	-6	-28	-34	-38*
10	-20	-34*	-11	-39*	-17	+8	-17	-37*	-17	-55*	-43	-34	-15	-21*	-10	-45	-47	-53*
11	-24	-48	-52*	-63*	-29	+45	-22	-43*	-23	-46*	-46	-40	-21	-37*	-10	-47	-55	-61*
12	-24	-55*	-54	-48*	-25	+66	-41*	-38	-13	-38	-41*	-32	-13	-22*	-18	-43	-45*	-31
13	-10*	+68	+68	-15	-41*	-33	-35	-42*	-3	-42*	-42	-31	0	-40*	-21	-27*	-24	-26
14	-11	-43*	+5	-3	-41*	+17	-37*	-25	-22	-46*	-45	-27	-13*	-3	-11	-23	-40*	-38
15	-34*	+25	+46	-32	-63*	-50	0	-2*	+21	-24*	-16	-17	-38*	+31	-6	+13	-50*	-21
16	-22	-36*	+2	-27	-49*	-18	-24	-38*	-12	-34	-42*	-35	-44*	+36	-32	-8	-26	-42*
17	-24*	-12	+8	-41	-59*	+3	-26	-30*	-4	-39	-42*	-41	-18	+6	-24*	-22	-24	-54*
18	-25	-71*	-51	+14	-13*	+2	-10	-22*	+17	-25*	-22	-11	+2	+1	+6	-24	-33	-50*
number of asterisks	5	10	2	4	13	1	5	13	0	10	8	0	4	12	1	2	3	13
average	-27	-27	-9	-23	-32	-10	-30	-36	0	-40	-38	-22	-19	-26	-14	-19	-35	-50

material share decreased during the whole period but with different rates and the capital share in total cost increased up to 1975 and decreased afterwards.

TABLE 4 Structure of total cost of production, %.

Cost Element	1951	1955	1960	1965	1970	1975	1980	1980/1951
Labor cost	44.7	44.5	46.5	47.3	46.2	47.4	53.3	119
Material cost	51.7	50.9	47.8	44.6	44.1	41.4	37.8	73
Fixed capital cost	3.6	4.6	5.7	8.1	9.7	11.2	8.9	245
Total	100	100	100	100	100	100	100	

There were certain correlations between three types of technological progress in the industries. The comparison of the change rates (1951-1980) in labor (LR), material (MR) and capital (CR) savings is shown in Table 5.

TABLE 5 1951-1980 reductions in L, M and C (%) for 18 industries.

Industries	LR		MR		CR		Sum of ranks
	Value	Rank	Value	Rank	Value	Rank	
1. Agriculture	21	11	35	18	61	17	46
2. Mining	6	2	7	7	25	10	19
3. Construction	46	18	32	17	84	18	53
4. Food	26	16	22	15	54	15	46
5. Textile	23	14	5	4	17	4	22
6. Paper	13	6	5	5	25	9	20
7. Chemicals	7	3	3	3	17	3	9
8. Primary metals	14	8	3	1	11	2	11
9. Fabricated metal products	20	10	8	8	20	6	24
10. Nonelectric machinery	9	5	8	10	22	8	23
11. Electrical machinery	5	1	3	2	11	1	4
12. Transportation equipment	7	4	5	6	25	11	21
13. Other manufacturing	21	13	15	14	44	14	41
14. Trade	21	12	8	9	39	13	34
15. Finance and real estate	24	15	25	16	55	16	47
16. Transportation and communication	15	9	12	13	19	5	27
17. Public utilities	13	7	12	12	22	7	26
18. Services	44	17	10	11	28	12	40

For instance, the value of a direct labor requirement coefficient in agriculture in 1980 equals 21% of its value in 1951, the value of a material input coefficient in construction in 1980 equals 32% of its initial value, etc.

From the viewpoint of labor saving, the best three industries were electrical machinery, mining and chemicals, while the worst were food, services, construction. From the material saving viewpoint, the best ones were primary metals, electrical machinery and chemicals, and the worst ones were finance (plus real estate), construction and agriculture. And finally, from the capital saving viewpoint the best industries were electrical machinery, primary metals and chemicals. Finance, agriculture and construction can be regarded as the worst three.

On the whole the most progressive industries (minimum rank sum) in the Japanese economy were electrical machinery and chemicals; construction and agriculture can be regarded as smokestack industries.

The theoretical discussion about the relationships between labor-material-capital savings (either they compete or coincide in dynamics) might be added with our estimates based on the rank data shown in Table 5. The coefficients of the rank correlation are the following:

0.83 - between material and capital savings,
0.64 - between labor and material savings,
0.62 - between labor and capital savings.

This means that a growing saving of one element usually leads to the same tendency in other cost elements and coincidence in this process is much stronger that competition.

And the final topic is what the reasons or determinants of the process are when one of the types of technological progress is going ahead. Of course, from the long-term viewpoint the relative prices of the three factors (labor, materials and fixed capital) as well as national availability of the resources are the important determinants of one or another way of technological progress.

In 1960-1980 labor prices increased in Japan by 2 times, prices of materials by 2.5 times, and for capital goods by 1.6 times. This led to higher savings of material input and lower savings of capital input (see Table 4). The first real capital saving period took place in the second half of the 1970's. One of the reasons was that capital goods prices began to grow practically only in the 1970's and had been very stable before.

The resources supply influenced these processes too. For example, material saving dominated during the periods of the post-war reconstruction of the Japanese economy when it lost the traditional sources of raw materials abroad and in 1970-1975 - the period of a first severe energy crisis. The 1965-1970 period was of a labor-saving type. At that time the rural labor resources were exhausted, the wage rate growth accelerated by 2 times and the labor-saving type of technological progress became mostly preferable.

The first results show that the approaches based on input-output techniques are able to discover important tendencies and interrelationships inside of technological progress.

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INFORUM-TYPE MODEL FOR CZECHOSLOVAKIA

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1. INTRODUCTION

The data base given by the input-output tables of the Czechoslovak economy and current statistics represents a convenient basis for an INFORUM-type model construction.

The Czechoslovak economy is a type of centrally planned economy, where questions about the dominating role of supply or demand in several spheres of the reproduction process are still under development.

Generally known applications of the "classical" INFORUM approach (e.g. in the USA, Italy, Belgium, West Germany, Japan, etc.) are typically demand oriented. The adaptation of this approach for modeling a type of the economy such as the Czechoslovak economy is possible in several ways. One of the possibilities is based on the direct use of the "classical" INFORUM approach with the application of suitable types of behavioral functions, which are more typical of centrally planned economies.

The aim of this contribution is a description of the main spheres connected with the INFORUM-type model for Czechoslovakia based on the application of the above mentioned approach.

2. A GENERAL DESCRIPTION OF THE MODEL

Any model is based on a description of the economy. For our purposes this description is given by the general structure of the Czechoslovak input-output tables. Figure 1 gives a schematic representation of the table used for the Czechoslovak model. The output of the economy, as other investigated indicators, is divided into 28 branches (see Appendix 1). The sales of any one of these branches in a given year are shown in the table represented in Figure 1 across one row in the column corresponding to the buyer. The sum of all the final demand elements minus imports is the gross domestic (social) product[1].

The forecasts consist of tables of this type. The basic logic is to forecast final demand by columns in total and for those branches which are

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[1] Differences in the SWA and NMP concepts are widely known so that the reader is not surprised about the absence of nonproductive services in the 28 industries shown in Appendix 1 on the supply side.

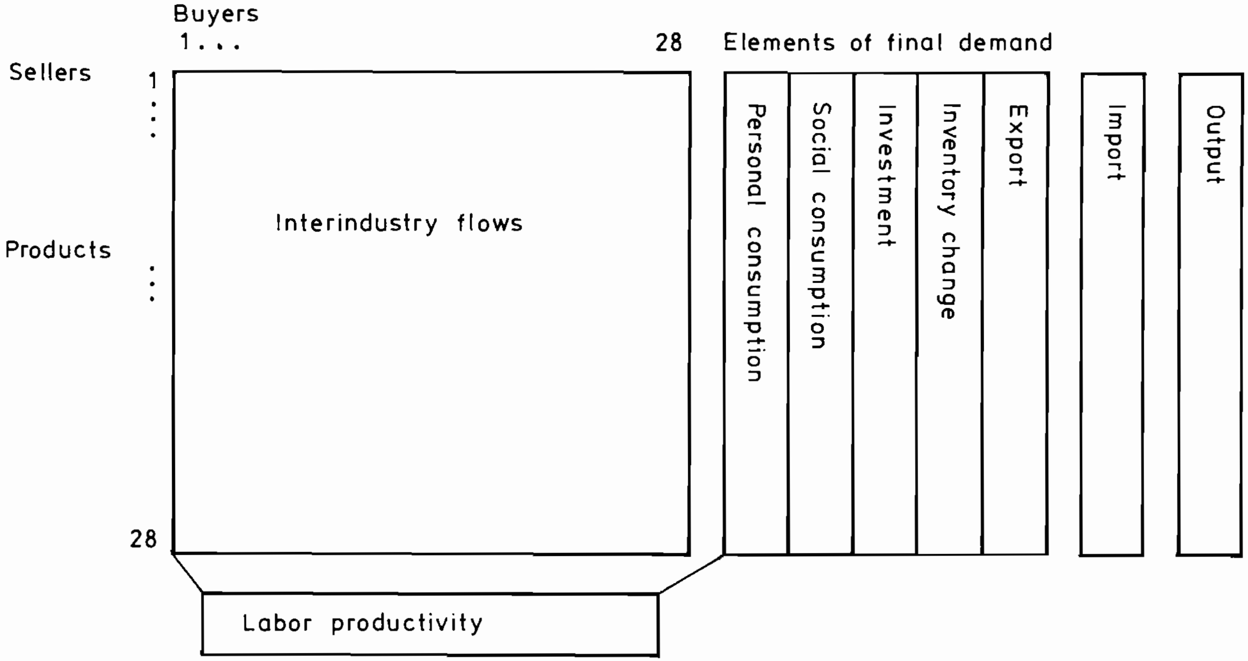

FIGURE 1 What the Czechoslovak model shows for each year.

essential from the point of view of the given column of final demand (see Appendix 2). For the rest of the branches the column totals can be distributed by a convenient percentage structure derived from the base year. Also in the case of imports the same approach is used. By applying the sum of all final demand columns to the known Leontief linear model adapted for our needs we obtain the outputs which are necessary to yield final demand. With the help of these outputs it is possible to compute the forecasted level of labor productivity and compare the obtained characteristics with the target level of labor productivity given for the investigated years.

Forecasted interindustry flows as well as each column of final demand express domestic plus imported production. All indicators investigated in the model are given in constant prices of the year 1977 (except for disposable income) in million Czechoslovak crowns (Kcs).

Several types of behavioral functions are used for forecasting final demand elements as well as imports.

3. THE TYPES OF BEHAVIORAL FUNCTIONS USED

3.1. Personal Consumption

In the sphere of modeling of personal consumption we have proceeded from the assumption that personal consumption in year t is a function of:

(i) disposable income in year t, or

(ii) disposable income in year t and personal consumption in year t-1.

The validity of these assumptions was repeatedly verified under the conditions of Czechoslovakia just as for several other centrally planned economies.

The forms of these demand functions are:

(i) $$C_i^t = \alpha_i + \beta_i Y^t \text{ , or}$$

(ii) $$C_i^t = \alpha_i + \beta_i C_i^{t-1} + \gamma_i Y^t \text{ ,}$$

where

C_i^t - value of personal consumption of good i in constant prices in year t;

Y^t - value of total disposable income in current prices in year t;

C_i^{t-1} - value of personal consumption of good i in constant prices in year t-1.

Disposable income (expressed in current prices) is taken from current statistical data and is equal to income minus personal financial payments.

The concrete use of the above described types of functions (i)or(ii) depends first of all on the character of a given good (branch). For example, in the case of the clothing industry function type (i) was chosen. The functions of personal consumption were estimated by industrial breakdown without further division in commodity groups. For illustration it is possible to describe the demand function for the total personal consumption as follows:

$$P^t = 51.05 + \underset{(0.04)}{0.51}\, y^t$$

Income elasticities for goods produced by major branches from the point of view of personal consumption are described below:

- agriculture	0.02
- food industry	0.13
- trade	0.13
- transportation	0.01
- production of electrical machinery and appliances	0.02
- power industry	0.03
- fuel industry	0.11
- textile industry	0.03
- machine building	0.02
- chemical and rubber industry	0.02
- wood industry	0.03
- clothing industry	0.01
- leather industry	0.01

3.2. Social Consumption

The second type of consumption contains all that amount of production which is necessary to cover the needs of the society in several fields (education, health care, civil service, etc.). The level of social consumption is regulated by tools of central planning. Therefore, it is possible to assume that social consumption in year t is just a function of social consumption in year t-1. For our needs we used the form

$$S_i^t = a_i S_i^{t-1} ,$$

where

S_i^t - value of social consumption of good i in constant prices in year t.

3.3. Inventory Change

The actual level of inventory change is centrally regulated by the requirements of the production process. Then we can assume that inventory change is a function of the production process. From this fact follows the application of our approach, which is based on the description of total investment as a linear function of production split by shares with positive or negative signs into the competent branches. Then the form of the function for inventory changes is:

$$C_i^t = a_i \left(\alpha + \beta X^t \right) , \qquad (1)$$

where

C_i^t - value of inventory change of good i in constant prices in year t;

X^t - value of production in constant prices in year t.

Parameters α , β are statistically estimated and a_i is derived from the structure of inventory change in the base year.

For total inventory change we obtain the function:

$$C^t = 10\,844.31 + \underset{(0.0079)}{0.028}\, X^t .$$

3.4. Investments

Usually the modeling of investments in INFORUM-type models in a given year is divided into investments for replacement and investments for expansion. In our approach investments are not divided. They are treated as a whole depending on two factors: sources and capacities. The sources are expressed by the value of accumulation (inventory change plus investment) of the previous year. On the one hand, these values describe the time effect in the production process (in investments), and, on the other hand, the unfinished investment activities (in inventory change) of the previous year. The capacities are represented by values of production in the current year. Then, investment in year t is dependent on inventory change in investment in year t-1, and on the actual production level. The form of investment function is given by:

$$V^t = \gamma + \delta \left(V^{t-1} + C^{t-1} \right) = \sigma X^t . \qquad (2)$$

Substituting the function for total inventory change from (1) to (2) gave the final form of the investment function:

$$V^t = a + bV^{t-1} + cX^{t-1} + dX^t ,$$

where

V^t - value of investments in constant prices in year t.

The meaning of X^t and C^{t-1} is the same as for inventory change. For the parameters we take: $a = \gamma + \delta\alpha$, $b = \delta$, $c + \delta\beta$, $d = \sigma$.

From the point of the relationship between sources and capacities, on the one hand, and investment, on the other hand, it is significant if the coefficient d is negative. In this case, an increase in production corresponds to a decrease of investment and vice versa, i.e. a decrease of production entails an increase in the level of investment. Then, it is possible to understand the given function as a simple regulating tool which describes the proportions between the necessary investment level and the dynamics of production under the conditions degree of development of the investigated economic system.

The concrete form of the function for total investment is:

$$V^t = 72\,326.76 + \underset{(0.08)}{1.0075}\, V^{t-1} + \underset{(0.0006)}{0.0282}\, X^{t-1} - \underset{(0.024)}{0.0662}\, X^t ,$$

The total investment (not divided into equipment and construction) is only split into the relevant branches by shares derived from the base year.

3.5. Exports

The modeling of exports in the centrally planned economies is mostly a combination of the supply- and demand-oriented approach. Usually the supply factor is represented by production and the demand factor by world imports. Our experience confirms the validity of this approach also under the conditions of the Czechoslovak economy. From this fact follows the form for export functions

$$E_i^t = a_i + b_i X_i^t + c_i D^t$$

where

E_i^t - value of exports of good i in constant prices in year t;

X_i^t - value of production of good i in constant prices in year t;

D^t - value of world imports in current prices (in million franco crowns (fco kcs) to the boundary of the seller's country).

From the analytical point of view the values and signs of coefficients b_i and c_i play an important role. The values correspond to the shares of the production of branch i and world imports with respect to exports of goods produced by branch i. The signs give information on the role of supply and demand in the export functions. This means, on the one hand, that a positive value of b_i corresponds to supply conditions from the importer's position (more production - more exports) and a positive value of c_i corresponds to demand orientation of the producer's position (more world imports - more exports). On the other hand, a negative value of b_i corresponds to nonsupply conditions from the importer's position and a negative value of c_i corresponds to non-demand conditions of foreign markets for good i from the producer's position.

The coefficients of export functions for essential branches are given below Table 1 :

TABLE 1 Coefficients of the export functions

Branches	a_i	b_i	c_i
Fuel industry	3 229.6	-0.09 (0.00)	0.08 (0.00)
Ferrous metallurgy	-870.2	0.1 (0.00)	-0.03 (0.00)
Chemical and rubber industry	11.9	0.09 (0.00)	0.05 (0.00)
Engineering industry	-27 137.4	0.75 (0.17)	-0.36 (0.46)
Production of electrical machinery and equipment	419	0.11 (0.00)	0.03 (0.00)
Production of building components	-1 719.6	0.19 (0.00)	-0.02 (0.00)
Wood industry	4 350.6	-0.19 (0.01)	0.07 (0.00)
Paper and cellulose industry	317.7	0.03 (0.00)	0.01 (0.00)

Glass, ceramics, and porcelain	-933.7	0.59	-0.01
		(0.02)	(0.00)
Textile industry	-296.1	0.11	0.03
		(0.02)	(0.00)
Clothing industry	160.9	0.11	0.03
		(0.07)	(0.00)
Leather industry	-1 117	0.34	0.006
		(0.05)	(0.000)
Food industry	8 173.1	-0.06	0.04
		(0.00)	(0.00)
Transportation	-8 111.1	0.28	0.03
		(0.01)	(0.00)
Trade	-4 772.9	0.4	0.13
		(0.04)	(0.03)

The above coefficients show that only in the fuel industry, the wood industry, and the food industry there are non-supply conditions from the importer's position. This fact is due, first of all, to the character of goods manufactured by the above branches, and also to the role of these goods within the Czechoslovak economy. The non-demand conditions from the producer's position in ferrous metallurgy, engineering, production of building components, and glass, ceramics, and porcelain mainly result from the level of competitive goods with respect to the situation on foreign markets.

3.6. Imports

In the sphere of import modeling, the pure supply approach was given preference. This was prompted, first of all, by the character of the Czechoslovak foreign trade. More than 70% of the Czechoslovak imports are from the socialist countries, and in this area the dominating aspects are, in general, the needs of the buyer country. Then, for the import functions the form is given by

$$M_i^t = a_i + b_i X_i^t ,$$

where

M_i^t - value of import of good i in constant prices in year t.

The meaning of X_i^t is the same for both types of functions of foreign trade.

The import function for branch i expresses the amount of imports of good i necessary to cover the needs of the production of branch i in a given year. This fact explains the meaning of coefficient b_i, which directly gives an import input for the given value of production. Therefore, under our conditions, these are always positive values smaller than 1 (except for the fuel industry, where imports (oil, gas) are bigger than production). Information about the complementary or substitute character of imports is given by the value a_i. If domestic substitution does not exist, $a_i \geqslant 0$. In the opposite case a_i is negative. It should be noted that a positive value of a_i was only obtained for ferrous metallurgy and for the chemical and rubber industry.

For the most essential branches, the competent coefficients of the import functions are given below (Table 2):

TABLE 2 Coefficients of the import functions

Branches	a_i	b_i
Fuel industry	-65 650.5	1.66 (0.08)
Ferrous metallurgy	1 482.8	0.05 (0.00)
Nonferrous metallurgy	-4 219.4	0.56 (0.02)
Chemical and rubber industry	408.2	0.24 (0.00)
Engineering industry	-4 044.6	0.33 (0.01)
Production of electrical machinery and appliances	-1 390.2	0.15 (0.00)
Textile industry	-2 401.9	0.18 (0.00)
Transportation	-5 939.3	0.30 (0.00)

3.7. Labor Productivity

The starting point for the investigation of labor productivity is given by the assumption of full employment (which is typical of the Czechoslovak economy as well as of other centrally planned economies). It, thus, follows that in the sphere of labor force the "mechanism" of the labor market is not functioning. The disposable labor force in the national economy is practically equal to employment. This is one of the most essential factors, which plays an important role in the level and character of labor productivity.

Let's assume that the evolution of labor productivity is determined by the character of the economic system's development. Then, we can assume that labor productivity is a function of time. The form of this function for each branch is given by

$$\log \frac{X_i^t}{L_i^t} = a_i + b_i t ,$$

where

L_i^t - number of employees (in thousands) in branch i and year t.

The meaning of X_i^t is the same as in the case of the export and import functions. The determination of t has the form of, e.g., 77, 80, 81, ..., etc.

The concrete form of the total labor productivity function is given by

$$\log \frac{X^t}{L_t} = \underset{}{2.7044} + \underset{(0.0000)}{0.0335}\, t .$$

4. CHANGES IN COEFFICIENTS

Changes in input-output coefficients are decisive for any meaningful investigation of structural changes in an economy. The method chosen here is based on the well known INFORUM logistic curve approach.

A logistic curve id defined by the differential equation

$$\frac{1}{c}\frac{dc}{dt} = b\,(a - c),$$

where "c" denotes the coefficient, "a" its asymptome, and "b" a constant.

The solution of this differential equation is

$$c_t = \frac{a}{(1 + Ae)^{-bt}} ,$$

where A is a constant of integration.

To apply ordinary least squares, the equation is rearranged as follows:

$$\log\left(\frac{a}{c_t} - a\right) = \log A - bat , \quad \text{if } \frac{a}{c_t} \geqslant 1 ,$$

or

$$\log\left(1 - \frac{a}{c_t}\right) = \log(-A) - bat , \quad \text{if } \frac{a}{c_t} < 1 .$$

The first equation is used for rising coefficients, and the second for declining coefficients.

The above equations have been applied only for the essential coefficients (see Appendix 3). For the remaining coefficients the structure derived from the base year has been used.

Changes in input-output coefficients may arise from changes in technologies, modernization, substitution between several kinds of inputs, etc. A global characterization of the movement of coefficients for a given period is possible by applying ratios of intermediate use. These ratios are given below for a selected group of branches.

TABLE 3 Ratios of intermediate use (1967 = 1)

Branches	1973	1977	1982
Agriculture	1.12	1.32	1.33
Fuel industry	1.21	1.75	1.64
Power industry	1.25	1.44	1.46
Ferrous metallurgy	1.32	1.64	1.70
Chemical and rubber industry	1.65	2.32	2.71
Engineering industry	1.42	2.06	2.42
Production of electrical machinery and appliances	1.68	2.25	2.56
Textile industry	1.20	1.30	1.50
Food industry	1.25	1.41	1.46
Building industries	1.67	2.68	3.12
Transportation	1.28	1.48	1.50

5 SOME QUESTIONS AND REMARKS ON FURTHER DEVELOPMENT

The information given in the previous parts of this contribution represents some description of the real side of the model. In its further development there are two principal directions.

The first one is a further improvement of the current form of the model, mainly in the sphere of:

- extension of final demand categories in the area of personal consumption; and
- explicit expression of centrally planned economies, market economies and developing countries in the foreign trade equations.

The second one is an extension of the real side of the model by price considerations and its integration into the international system of INFORUM-type models linked in the sphere of foreign trade.

The basic contribution of the real side of the model to price considerations essentially consists in the improvement of the analytical usefulness of the model. This fact can play an important role in the sphere of analytical utilizations, connected first of all with the aspects given by the value added structure.

In the sphere of linkage we must start from an obvious fact, which is established by a well-functioning foreign trade among the socialist countries and by the large similarities in their export and import mechanisms. It seems to be reasonable to start with the linkage of the Czechoslovak model to the models of the other socialist countries and gradually develop a convenient trade model for the centrally planned economies. This trade model can then be linked with the trade models of the market economies.

It is also possible to envisage an extension of the model from the point of view of regional input-output models. Such an extension allows for an economic policy simulation to cover the needs of regional planning in the sphere of structural changes.

The IIASA international system of INFORUM models and its data base offer a large number of possibilities for investigation of many problems in the field of economic growth, equilibrium, and structural changes. A set of these problems is connected with questions concerning the absorption of new technologies by several types of economies. Connections and disconnections in these spheres between the highly developed centrally planned economies and the post-industrial types of the market economies can be interesting for both parties. It can be said that for these purposes the Japanese and the Czechoslovak models should represent an ideal background.

APPENDIX 1 Branches figuring in the INFORUM Model of Czechoslovakia.

1. Agriculture; 2. Forestry; 3. Fuel industry; 4. Power industry; 5. Ferrous metallurgy; 6. Non-ferrous metallurgy; 7. Chemical and rubber industry; 8. Machine building; 9. Production of electrical machinery and appliances; 10. Production of building components; 11. Wood industry; 12. Paper and cellulose industry; 13. Glass, ceramics and porcelain production; 14. Textile industry; 15. Clothing industry; 16. Leather industry; 17. Printing industry; 18. Food industry; 19. Cooling and tobacco industry; 20. Other industries; 21. Building industries; 22. Geological activities; 23. Designing for construction; 24. Transportation; 25. Telecommunication; 26. Trade; 27. Material stocking; 28. Purchase of agricultural products.

APPENDIX 2 Essential branches (x).

Branches	Pers. cons.	Soc. cons.	Invest.	Invest. change	Exp.	Imp.
1	x			x		
2						
3		x		x	x	x
4		x				
5				x	x	x
6						x
7	x	x			x	x
8	x		x		x	x
9	x				x	x
10					x	
11	x				x	
12					x	
13					x	
14	x				x	x
15	x				x	
16	x				x	
17	x					
18	x			x	x	
19						
20	x				x	x
21		x	x			
22						
23						
24	x	x			x	x
25		x				
26	x				x	
27						
28						

APPENDIX 3 Essential input-output coefficients.

Branches

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1	x													x				x	x	x								
2		x									x	x																
3	x	x	x	x	x		x			x			x				x				x	x		x	x		x	x
4			x	x		x	x	x	x	x	x	x	x	x				x	x	x				x	x	x	x	x
5					x			x	x	x										x	x	x						
6					x	x	x	x	x				x							x								
7	x					x	x		x		x	x	x	x		x	x		x	x								
8	x	x	x					x	x	x			x							x	x	x	x				x	x
9							x	x	x	x	x								x	x	x				x			x
10		x			x	x				x			x							x	x	x						
11								x	x	x	x	x	x							x	x	x	x				x	
12							x		x	x	x	x	x			x	x	x	x				x					
13									x		x		x					x	x		x					x		x
14							x				x	x		x	x	x	x		x									x
15		x								x	x				x	x				x	x	x		x	x	x	x	x
16		x						x	x	x		x		x	x	x	x			x		x		x			x	
17									x		x	x	x				x	x	x				x	x		x	x	x
18	x						x				x	x	x		x	x		x	x	x								
19							x											x	x									x
20	x		x	x	x	x	x	x	x	x		x	x							x				x				x
21		x								x			x				x			x	x		x	x			x	x
22										x												x	x				x	x
23			x				x	x		x											x		x	x	x			x
24		x	x				x			x	x	x	x					x	x		x	x		x	x	x	x	x
25										x			x				x				x	x	x	x	x	x	x	x
26	x														x		x			x	x					x	x	
27	x		x	x				x	x							x	x	x		x	x	x		x				
28	x																	x		x								

AN EASY ECONOMETRIC WAY OF CONSTRUCTING INPUT-OUTPUT TABLES

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The idea underlying the method is to go directly from micro-economic data of firms over to branch macroeconomic coefficients. When all firms are "pure", that is to say when each of them produces a single commodity, this is not difficult to do since their mere aggregation by commodity gives the different branchs. Generally, firms are diversified and accounting records only furnish inputs and outputs relating to them, without detailing how each of the inputs is allocated to each output.

The problem raised is, therefore, the following: how to use the information provided by each firm accounting record in order to perform this allocation at the macroeconomic level? How can inputs be allocated to the proper outputs?

It has long been considered how to realize it with the help of a probabilistic model. When allocating an input to its different productive uses, each firm in the economy or in a representative sample fits statistically to an average technical structure, according to Leontief's assumption of a fixed technical coefficient for each branch. The stochastic framework for computing an input-output table actually offers several advantages. It gives a measure of the dispersion of the coefficients. It considers the fact that firms at best conform imperfectly to technological hypotheses.

It also recognizes the stochastic nature of sample data based on accounting records.

1. THE MODEL

As for the algebraic method, two polar assumptions will be confronted as concerns technology.

(i) Firm technology: A commodity has no specific technology but has the technology of the firm producing it.

(ii) Commodity technology: Technology is linked to the commodity in a specific way, no matter what the producing firm is.

These two assumptions are similar to those of the algebraic method, when the rationale bears on firms and not on industries. The firm technology assumption will be introduced here in an accessory way to solve certain problems raised by the application of the method. From now on, the productive system only admits of a commodity technology.

Let us add the following assumption: for each product, the production functions of the firms are of the zero substitution between factors and constant returns to scale type.

In the commodity technology, the firm which produces a particular commodity has to comply with a certain structure of costs depending on the commodity and not on the firm. Its specific feature is a certain random term which makes it deviate from this fixed structure of costs. When the firm produces several commodities, its global structure of inputs will be a compound of the inputs required for the production of each of these commodities, always allowing for a small random divergence.

For a firm k, the technological assumption implies for the amount of input i used:

$$x_i^k = a_{i1}\, y_1^k + \ldots + a_{iJ}\, y_J^k + u_i^k \tag{1}$$

in which:

x_i^k is the value of input "i" used by firm "k",

y_i^k is the value of commodity "j" produced by firm "k",

a_{ij} is the value of input "i" included in one unit of commodity "j",

u_i^k is a random residual linked to the use of input "i" by firm "k".

An input i (resp. factor g) will, consequently, give K equation of the type (K number of firms in the sample) which permit writing the basic relations for all inputs and factors:

$$x_i = Ya_i + u_i \qquad i = 1,\ldots,I \tag{2}$$

$$x_g = Yb_g + v_g \qquad g = 1,\ldots,G \tag{3}$$

with obvious vector notations and where $Y = \left[y_i^k \right]$ is the matrix (K, J) of the productions of the K firms for the J commodities.

If the model is written jointly for all inputs, grouping equations (2) gives:

$$\begin{bmatrix} x_i \\ x_2 \\ \cdot \\ \cdot \\ \cdot \\ x_I \end{bmatrix}_{(KI,1)} = \begin{bmatrix} Y & 0 & \ldots & 0 \\ 0 & Y & & \\ \cdot & & & \\ \cdot & & & \\ \cdot & & & \\ 0 & & & Y \end{bmatrix}_{(KI,IJ)} \begin{bmatrix} a_1 \\ a_2 \\ \cdot \\ \cdot \\ \cdot \\ a_I \end{bmatrix}_{(IJ,1)} + \begin{bmatrix} u_1 \\ u_2 \\ \cdot \\ \cdot \\ \cdot \\ u_I \end{bmatrix}_{(KI,1)} \tag{4}$$

or, in a more condensed way:

$$\mathfrak{X} = \mathfrak{Y}\, a + u \tag{5}$$

where $\mathfrak{Y} = I_I \otimes Y$ using Kronecker product between the dimension I unit matrix and matrix of firm productions Y.

We obtain similarly for production factors, through a superposition of the G models (3) :

$$\mathfrak{G} = \mathfrak{Y}\, b + u \tag{6}$$

When the number K of firm excedes the number J of outputs, the least squares method can be applied to models (5) and (6). The estimates obtained for a and b are unbiased if

$$E(u) = 0 \qquad \text{and} \qquad E(w) = 0 \tag{7}$$

similarly, if we have for the second order moments of the disturbances

$$E(uu') = V \quad \text{and} \quad E(ww') = W \tag{8}$$

are positive definite matrices the estimators of technical coefficients and factors are of minimum variance and given by:

$$\begin{aligned} \bar{a} &= (\mathfrak{Y} V^{-1} \mathfrak{Y})^{-1} \mathfrak{Y} V^{-1} \mathfrak{X} \\ \bar{b} &= (\mathfrak{Y} W^{-1} \mathfrak{Y})^{-1} \mathfrak{Y} W^{-1} \mathfrak{G} \end{aligned} \tag{9}$$

with variances respectively equal to $(\mathfrak{Y} V^{-1} \mathfrak{Y})^{-1}$ and $(\mathfrak{Y} W^{-1} \mathfrak{Y})^{-1}$.

Let us note that the coefficients of equations (2) are the rows of the input-output table and not columns as one could expect. The explained variables here are inputs and not outputs. The point is not to estimate functions of production, either on an assumption of complementarity (of the Leontief type) or admitting of a certain substitution. Precisely, equations (2) give the quantities of inputs required by firms if they all conform to Leontief's functions of production, with complementary inputs and constant returns to scale.

Here appears the twofold character of the linear model as it is set in equations (2) and (3).

From the economist's point of view, its object is to test this assumption on the firm's economic behaviour: a demand for production factors, or for intermediate inputs, which is proportionate to the produced value, whatever is the price system; so to say, an assumption on the firms' behaviour which is extremely elementary. To be valid, it implies that the entire firm verifies Leontief technology for each of its products. Weakening this assumption by admitting substitution between factors amounts to the assumptions of the non-substitution theorem (constant return to scales, a single rare primary factor and no joint production). However, we can scarcely go further and propose the model as a formalization of the firm's demand for intermediary commodities.

It is also possible to adopt the philosophy of national accountants when they construct the input-output table. For them, there are very few economic assumptions, but merely the objective of summing up all production flows without prejudice on the variety of individual behaviours they cover. In other words, a framework which is descriptive and not explanatory. The problem boils down to this: on the basis of a certain system of prices and demand for goods and factors of production, each firm verifies a relation between inputs and outputs which is given by the a^k_{ij} and depends on the firms. How is the macroeconomic a_{ij} to be determined when transactors and commodities are aggregated simultaneously?

In this empirical view, the only problem which has to be solved is that of the aggregation. And the linear model only intervenes as a statistically controlled way of determining this "aggregated" technology.

Naturally, the conclusions are not the same in both approaches. If the first one can be used for the verification of assumptions on the productive system (complementarity or substitutability of inputs, constant productivity of factors according to size), it is the second approach which interests us here.

2. THE ACCOUNTING CONSTRAINT AND THE MODEL

Here we focus our attention on the model of branch technical coefficients - Equation (5). Let the covariance linking the use of inputs i and i' by firms k and k' be:

$$\sigma_{ii'}^{kk'} = E(u_i^k u_{i'}^{k'})$$

The fact is that the I grouped models are not independant: the disturbances peculiar to a firm are linearly dependant due to the accounting constraint on firms' operating account. Formally, Euu' = V is no longer invertible and the vector a of the technical coefficients is no longer obtained through formula (5).

Each firm in the population is such as:

$$\sum_{j=1}^{J} y_j^k = \sum_{i=1}^{I} x_i^k \tag{10}$$

when value-added elements are incorporated into the model.

Then if we add the I equations relating to one firm, we have:

$$\sum_{i=1}^{I} x_i^k = \sum_{i=1}^{I} \sum_{j=1}^{J} a_{ij} y_j^k + \sum_{i=1}^{J} u_i^k$$

and thus: $\sum_{i=1}^{I} u_i^k = \sum_{j=1}^{J} \left(1 - \sum_{i=1}^{I} a_{ij}\right) y_j^k$ knowing (10).

The right hand side of this equality is non random so that $\sum_i u_i^k$ is equal to its expectation which is zero, $\forall k = 1,\dots,K$.

From that we first derive:

$$\sum_{j=1}^{J} 1 - \sum_{i=1}^{I} a_{ij} \quad y_j^k = 0 \qquad k = 1,\dots,K. \tag{11}$$

The relation being true for all firms with $y_j^k \geqslant 0$, we obtain:

$$\sum_{i=1}^{I} a_{ij} = 1 \qquad \forall_j = 1,\dots,J.$$

This result removes the risk of an anarchical - and therefore uneven - dispersion of coefficients on one branch as compared with another when breaking down firms into their productive components. When going from firms over to branches, the operating accounts remain balanced[1].

On the other hand, premultiplying $\sum_i u_i^k = 0$ par $u_{i'}^{k'}$ and taking expectations, we obtain:

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[1] This result only holds true when there is no constraint on the coefficients other than that given by the accounting constraint. Thus, in a more general model with constraints on the coefficients, we must reintroduce the equilibrium constraint into the operating accounts of the branches.
The balance of operating accounts by branch does not imply that the inputs estimated by the model on all the firms are equal to the actual amounts of inputs observed. If we want to allow for such a constraint, it becomes necessary to restore the balance of the coefficient table by use of RAS-type procedures.

$$\sigma^{kk'}_{1i'} + \sigma^{kk'}_{2i'} + \ldots + \sigma^{kk'}_{Ii'} = 0 \qquad \forall k', \ \forall i' \tag{12}$$

These K.I. relations (12) define a set of K linear constraints between the vectors in matrix V, which is then of rank (I - 1) and not invertible.

In this particular problem, it may be noted that, being aware of constraint (10) and the I - 1 equations relating to the I - 1 inputs, the last equation is obtained through

$$x^k_I = \sum_{j=1}^{J} y^k_j \left(1 - \sum_{i=1}^{I-1} a_{ij}\right) + \sum_{i=1}^{I-1} u^k_i. \tag{13}$$

The data relating to this last input - let us call it the entrepreneurial income - give no information to estimate the technical coefficients. It can be shown that it suffices to apply the generalized least squares (GLS) on the first I - 1 equations and obtain the technical coefficients of the last input through:

$$\bar{a}_{IJ} = 1 - \sum_{i=1}^{I-1} \bar{a}_{ij} \tag{14}$$

In the following, the symbols adopted relate to the first I - 1 inputs.

3. ASSUMPTIONS ABOUT THE COVARIANCES OF DISTURBANCES

To conduct the estimation of model (5) in a practical way, some restrictive assumptions are to be made about the second order moments.

The first assumption seems reasonable: that is supposing there no "external effects" between the production processes of different firms:

$$\sigma^{kk'}_{ii} = 0 \quad \text{if} \quad k \neq k' \quad \text{and} \quad \forall i, i' = 1,\ldots,I-1. \tag{15}$$

But such a restriction is not sufficient to allow an estimation of the technical coefficients. We must, therefore, introduce assumptions about the nature of the "internal effects" specific to the production process of individual firms.

In particular, the set of variances/covariances is not independent of firms. Some heteroscedasticity is introduced as much on account of the size of the firm as of its sectoral or geographical origin.

The following assumption will be made for this heteroscedasticity:

$$\sigma^k_{ii'} = \sigma_{ii'} \lambda_k.$$

The covariance associated with the entry of two inputs i and i' in the production process of firms is proportional to a variable λ_k proper to each firm ("size effect"). With (15) and (16), the model may, thus, be given its general form:

$$\mathfrak{X} = \mathfrak{Y}a + u \tag{17}$$

with $E(u) = 0$

$Vu = \Sigma \otimes \Lambda$

in which:

$\Sigma = [\sigma_{ii}]$ having the format (I - 1, I - 1);

Λ = diagonal matrix (K,K) whose k - th diagonal term is λ_k ;

I_{I-1} = unit matrix of domension I - 1;
$Y = I_{I-1} \otimes Y$.

In the model (17) we recognize a case where the GLS on the grouped model are identical with the GLS on each regression. Practically, model (17) consists in applying the ordinary least squares method (OLS) independantly to the I - 1 equations after reducing the inputs and outputs of each firm by the factor $1/\sqrt{\lambda_k}$.

The estimators of the technical coefficients are:

$$\bar{a}_i = (Y' \Lambda^{-1} Y)^{-1} Y' \Lambda^{-1} x_i \qquad (18)$$

for a given input i and juxtaposing (and transposing) each of the equations (17), instead of grouping them:

$$\hat{A} = X' \Lambda^{-1} Y (Y' \Lambda^{-1} Y)^{-1} \qquad (19)$$

a formula[2] in which the usual input-output coefficients may be recognized and which, in columns, gives the costs structure of a branch (including the operating accounts by branch).

The variance of $\bar{a}$ is given by:

$$V(\bar{a}) = \sum \otimes (Y' \Lambda^{-1} Y)^{-1}$$

and the estimations of the covariances in matrix $\sum$ are calculated through:

$$\sigma_{ii'} = \frac{1}{K-J} \sum_{k=1}^{I} \frac{\bar{u}_i^k \bar{u}_{i'}^k}{\lambda_k}.$$

The major characteristic of the model is that the first order properties of the estimators do not depend on the nature of the interdependances between the users of inputs, that is matrix $\sum$.

But we must acknowledge the importance that the analysis of such variance matrix would have for the study of the productive system and the production functions of branches. A positive $\sigma_{ii'}$ (resp. negative) is an indication of complementarity (resp. substitutability) in the use of the inputs or factors i and i' on the whole population of firms. This way, however, was not followed here. To estimate the statistics associated with coefficients, we assumed that $\sum = \sigma^2 I$.

4. WHICH HETEROSCEDASTICITY CORRECTION?

Various corrections of heteroscedasticity have been successively tested for model (17).

(a) Homoscedasticity. Firms are not corrected by any size effect $\Lambda = I$.

(b) The variable λ proportional to the variance is made of firms' turnover:

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[2] In this formula, the technical coefficients relating to the last input are obtained according to (14) and added as the ultimate row in the input-output table.

$$\lambda_k = \sum_{j=1}^{J} y_j^k$$

(c) The variable λ is equal to the square of firms' turnover:

$$\lambda_k = \left(\sum_{j=1}^{J} y_j^k\right)^2 .$$

Each input and each output is then reduced by: $\sqrt{\lambda_k}$. Thus, we focus on firms' ratios and not on amounts.

The best results - as far as the accuracy of the estimation is concerned - are obtained with (b). It is possible to explain this by supposing that one industry of the economy is only made of "pure" firms producing nothing but the specific commodity of that industry, which is, furthermore, not produced by any firm in any other industry.

For a given input, the natural input coefficient for the branch is:

$$a = \sum x / \sum y \tag{20}$$

that is to say the average technology (the ratio of the total input to the total output) in which firms intervene in proportion to their production:

$$a = \left[\sum (x/y) \quad y\right] / \sum y .$$

Now, applying the least squares to our example, the results are as follows, depending on the various assumption made for heteroscedasticity:

Correction (a): $\bar{a} = \sum xy / \sum y^2$

Correction (c): $\bar{a} = \frac{1}{K} \sum x/y$

Correction (b): $\bar{a} = \sum \frac{x}{\sqrt{y}} \circ \frac{y}{\sqrt{y}} / \sum \left(\frac{y}{\sqrt{y}}\right)^2 = \sum x / \sum y$.

Through (a), each input coefficient of a firm is weighted by the square of the firm's production: $\bar{a} = \sum a^k y^2 / \sum y^2$, and large-sized firms have a prevailing importance. In the case of (c), the estimation is valid only when the firms have the same importance. Then, we have: $\frac{1}{K} \sum x/y = \sum x / \sum y$. Otherwise, this way of removing the size effect lends too heavy a weight to small firms and introduces a heteroscedasticity of opposite direction.

Thus an intermediary reduction - correction (b) - is necessary, at least in this trivial case where aggregate of firms stands for the branch.

5. PROBLEMS AND LIMITATIONS

5.1. Increase in stocks and errors on explanatory variables

Errors made by firms when they answer questions concerning their sales, the non-inclusion of integrated production into their sales and, lastly, the way adopted for dealing with the increase in stocks or work in process, may bring in errors on the explanatory variables.

It is a case where applying GLS to model (17) gives biased and non-consistent estimators for the technical coefficients.

Removing this bias, by choosing the double least square estimator rather than the GLS, was not applied here. As a matter of fact:

a. The new estimated outputs do not verify the constraints on the operating accounts of firms. The column sum of the branch technical coefficients is no longer equal to 1;

b. Above all the instrumental variables retained are only slightly correlated with each of the outputs taken individually. The gain on the bias of estimators is obtained at a price of a heavy loss of information on the firm's technical data.

5.2. A priori constraints on the coefficients

Another deficiency of the method lies in its blindness when the statistician may have good reasons to think (through mere common sense or use of other statistical sources) that a technical coefficient should have a determined value.

The general framework which makes possible to integrate such a priori information is the regression with linear constraints on the coefficients. Equality constraints for predetermined coefficients, inequality constraints for non-negative coefficients.

But solving becomes difficult and it may be profitable to look for a simpler integration of a priori information,

Let us assume the case of a coefficient we know to be zero but which is, nevertheless, given as positive when applying the model. This appears in two cases:

(i) When there are vertically integrated firms: such is the case for foundry - very often integrated into mechanical or automobile construction. The foundry inputs then show up necessarily in the mecanical products made from foundry products.

(ii) When firms are too diversified. If too many firms produce both milk products and flat glass, the coefficients obtained by adjusting the models for the milk and for the inputs will be sort of quadratic means of the amounts appearing as inputs and outputs. It then seems unavoidable that a fraction of the milk will be allotted to the "glass" branch and that, at least econometrically, various minerals will be retrieved in the yoghurts produced.

To conduct the estimation one then uses the result according to which it is equivalent either to apply the GLS with constraints $a_{ij} = 0$ on one or several coefficients, or to apply the GLS on the models from which there are removed the variables associated with the coefficients desired to be equal to zero.

For a coefficient $a_{ij} = \bar{a}_{ij} > 0$, the result is the same: a constraint is introduced in the model by fixing the coefficient and estimating the equations associated with the firm k:

$$x_i^k - \bar{a}_{ij}\, y_j^k = \sum_{l \neq j} a_{il}\, y_l^k + u_i^k \qquad k = 1,\ldots,K . \qquad (21)$$

The problems raised by this procedure are the following:

- the cause of the non-zero coefficient, i.e. the joint production or vertical integration, is carried over into the other coefficients;
- the equation-by-equation estimation of the model, valid within assumption (15), holds no longer true; the set of explanatory variables is no longer common to all the equations;
- the accounting constraint is no longer respected and then the column sum of the branch coefficients is no longer equal to 1. Rigorously, the equation of the branches' operating account is to be integrated into the regression model without constraints. Practically, if the coefficient to be constrained is small in the model without constraint, it may be sufficient to distribute the difference with 1 of the branch coefficients over the whole branch.

5.3. The negative coefficients

As it is the case with the algebraic method, the calculations systematically give negative results for certain entries.

Let us limit their importance at once: when the model is specified at best, certain outputs being dealt with by a firm technology (cf. infra) and the elimination of heteroscedasticity, the results give no significant negative coefficient. The largest of these amounts to - 1.58% for "transportation equipment" in the branch "rubber and plastic" with student statistics equal to - 1.1.

Formally, the question may be dealt with as previously, introducing this time inequality constraints on the coefficients ($a_{ij} > 0$), and estimating the a_{ij} as the solution of a quadratic programme under linear constraints.

But these automatic methods should be considered with suspicion in that they artificially settle errors in the specification of the model and in the firm sample, as well as data incoherences.

This is why it is necessary to understand the origin of such negative coefficients.

Here are, for instance (Table 1) the results of the adjusted model for input N° 1 "Solid Mineral Fuels" (SMF), concerning the four main user branches one of which is the "Foundry" branch.

TABLE 1 "Coal and cokefaction". Estimated coefficients of input N°1 (t of Student between brackets).

	Solid mineral fuels N° 1	Electricity gas N° 3	Ferrous metals N° 4	Working of metals foundry N° 9
Model a without correction of size	82.40 (15.4)	5.34 (39.9)	13.01 (39.5)	-6.07 (-3.98)
Model b with correction	76.84 (27.7)	3.05 (8.2)	11.08 (28.7)	-1.41 (-1.64)
Model "Hybrid technology"	76.16	3.34	10.84	-0.93

How can $a_{19} = -1.41\%$ be explained for "coal" in "foundry", in the model corrected for size effects?

The following considerations appeal to inter-relations between input and outputs.

(i) Certain outputs have no part to play in the reasoning: they are outputs "orthogonal" to the "foundry" branch, and to the branch with which the latter is correlated, i.e. such as $C_{ij} = 0$ where $C_{ij} = \sum_k y_i^k y_j^k$ stands for the uncentered second order moment[3]. They do not appear in the determination of the technical coefficients[4].

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[3] Let us denote as C_{jx} the second order moment linking output j to the input; $V_j = \sum (y_j^k)^2$ the squared moment. As the model does not contain any constant term, it is not possible to reason directly in terms of non-partial correlation coefficients.

[4] This line of reasoning does make it possible to justify the application of the method to firms belonging to diversified industries. When industries

The analysis of the matrix of the non-centered moments or the principal components analysis on non-centered variables appearing on table $[X, Y]$ shows that, in our example, the outputs correlated with "foundry" are "Coal and coke", "Electricity and gas", and to a lesser extent "Ferrous metals".

The other outputs are insignificantly correlated with "foundry" and have a rather small impact on the coefficients in our example. These remarks made it possible to reason an a reduced number of variables when examining each negative coefficient. In practice never more than 3 or 4.

(ii) Let us suppose that the model has only two outputs, y_1 and y_2[5]. And let $\bar{a}_1 < 0$.

The calculation of the coefficient gives:

$$\bar{a}_1 = \frac{1}{V_1 V_2 - 2C_{12}} \left[V_2 C_{1x} - C_{12} C_{2x} \right] . \tag{22}$$

The determinant being always positive, $\bar{a}_1$ can be negative only if $V_2 C_{1x} < C_{12} C_{2x}$.

If y_2 is the main output, C_{2x} is rather large. It is then sufficient that y_1 be little correlated with the input but, on the other hand, rather well correlated with the main output so that the coefficient $\bar{a}_1$ becomes very small.

If, furthermore, the main output is of little importance in the economy (small V_2)$_1$ $\bar{a}_1$ can assume negative values.

(iii) The case with 3 inputs is analysed in an identical way; we then have:

$$\bar{a}_1 = \frac{1}{\Delta} [C_{1x} (V_2V_3 - C_{23}^2) + C_{2x}(C_{23}C_{13} - V_3C_{12}) + C_{3x}(C_{12}C_{23} - V_2C_{13})]. \tag{23}$$

Then, if the input is not natural for output 1 but it is used a great deal for outputs 2 and 3 (small C_{1x}, large C_{2x} and C_{3x}), if, furthermore, output 1 is rather closely correlated with one or the other of the remaining two outputs, being little correlated with each other, then the only relatively important terms become:

$$C_{1x} V_2V_3 - C_{2x}V_3C_{12} - C_{3x}V_2C_{13}.$$

As they consume a great part of the input, outputs 2 and 3 draw the coefficients to them and the result may well be negative for $\bar{a}_1$.

(iv) We then can use the previous remarks to explain the negative coefficient of the input SMF in "foundry". The initial problem is actually one of industry diversification: "foundry" is a small user of SMF but its activity is generally associated with other ones, mainly "ferrous metals", which are

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[4] continuation
are disconnected the model is separable or quasi-separable. For industries whose activities are closest one to another the argument no longer holds. It appears that an error would be made, when estimating the technology of a branch. If only firms of the industry in that branch were taken, the commodity technology would, thus, be left out when the commodity is used by industries in which it is not the main production. The advantage of the method lies in the aggregation of various activities of firms.

[5] In a one-output model, there can be no negative coefficient.

large consumers of them. The primary cause, therefore, lies in the existence of associated activities (coking and ferrous metals) in which there is a strong component of SMF and which draw coefficients to them (thus the coefficient of the SMF in "Mechanical" construction" is also negative - 0.25%; t = 0.5).

A review of data shows moreover that firms having a joint production of "foundry" and "ferrous metals" are not all, as a rule, users of "coal". The opposite case would have given - between "coal" and "foundry" - a second order moment large enough to make the coefficient positive the(term $C_{1x} V_2 V_3$ becoming very large).

The condition requiring C_{1x} to be small is, therefore, essential. This explains why negative coefficients are only met with in models integrating infrequent input; in practice, besides "coal", the "land transport equipment" and the "aeronautical and aeronaval equipment".

The diagnosis is therefore the same in both methods. And it is not by chance that the two major negative coefficients are found for the same entries; as in the algebraic method a reexamination of data or a different technology assumption make it possible to eliminate such coefficients[6].

5.4. Commodity-technology or firm-technology

Certain commodities, with which it is impossible to associate one particular input, are relatively correlated with all the other inputs.

That is the case for "production of a firm for its use", "margins" and the "non-industrial commodities" item. The preceding diagnosis is confirmed: for these commodities, we find values of technical coefficients which are residuals often strongly negative.

For these commodities, the commodity-technology assumption underlying the method is inadequate. It would be more convenient for them to make the firm-technology assumption according to which they have the average costs structure of their firm.

In practice, the technological assumption made on these secondary commodities insignificantly influences the results concerning coefficient of industrial commodities.

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[6] Along these lines, one might then think of incorporating as an observation in the allocation model of on input only those firms which use that input in a quantity differing from zero. But this solution - which has been tested - is bad: while it does not change Y'_x, it generally reduces Y'Y and then raises the order of the variance $(Y'Y)^{-1}$. This result is natural: the firms which produce a given output while not using the input supply a piece of information referring to the exclusivity of the input and the output. They cannot, therefore, be rejected without prejudicing the estimator's accuracy.

FINANCIAL RESTRICTIONS IN OPTIMIZING DYNAMIC INPUT-OUTPUT MODEL

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In this paper we will consider an input-output model with investment restrictions. The model discussed here appeared in the course of development of a linear optimizing input-output model (Itskovich 1976).

The input-output models at the present time balance interindustries flows, output levels and volumes of fixed assets, amount of goods produced and available labor forces (Aganbegian, Granberg 1968) accumulation and consumption funds in the national income (Itskovich 1976, Planirovanie... 1970) . The model described in this paper permits us to balance the level of production of sectors producing capital goods with the amounts of financial resources available for these sectors.

1. THE MODEL

The capital investment in a model is divided according to its origin into two parts. One is self-financing, the other is centrally planned investment. We will call them centralized investments. The self-financing may come from the sector's profit, depreciation, from resources in the development of production fund and from others sources. Here we assume that sectors have enough financial resources for replacement, and their surplus is used for net investment. The amount of self-financing in each sector is given in the model by a share of the sector's profit which in its turn is computed in the model.

The centralized investments are instrumental variables.

The centralized investment and a surplus of own financial resources of a sector are used to enhance the sector's fixed assets.

For every time period t the following parameters are exogenous[1]:

$z_{oi} \geqslant 0$ - numbers which give the structure of consumption ($1 \leqslant i \leqslant n$); $a_{ij} \geqslant 0$ - technological coefficients ($1 \leqslant i \leqslant n$; $1 \leqslant j \leqslant n$) ; $b_{ij} > 0$ - the input or utilization of fixed assets stock i ($1 \leqslant i \leqslant s$) per unit value of output of the sector j ($1 \leqslant j \leqslant n$) ; $\gamma_j > 0$ - direct labor input coefficient of the sector i ($1 \leqslant i \leqslant n$) ; $L > 0$ - the available amount of labor; $w_j > 0$

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[1] The index t attached to exogenous parametrs is omitted for simplicity sake.

- wage rate of the sector j $(1 \leqslant j \leqslant n)$; $F_{ij} > 0$ - fixed assets stock in value terms of kind i $(1 \leqslant i \leqslant s)$ employed in the sector j $(1 \leqslant j \leqslant n)$ at the beginning of time period; $\alpha_j \geqslant 0$ - the ratio of self-financing in the sector j $(1 \leqslant j \leqslant n)$ used for capital formation in this sector; g_i - foreign trade balance.

With all these parameters given we are searching for non-negative values x_j^t, z_j^t $(1 \leqslant j \leqslant n)$, u_{ij}^t $(1 \leqslant i \leqslant s,\ 1 \leqslant j \leqslant n)$, λ^t maximizing function:

$$f = \max \lambda^t \sum_i z_{oi} \qquad (1)$$

subject to

$$\sum_j a_{ij} x_j^t - x_i^t + z_i^t + \sum_j u_{ij} \leqslant g_i, \quad 1 \leqslant i \leqslant n \qquad (\xi_i)^2 \qquad (2)$$

$$b_{ij} x_j^t - u_{ij}^t \leqslant F_{ij} \quad 1 \leqslant i \leqslant s; \quad 1 \leqslant j \leqslant n \qquad (\eta_{ij}) \qquad (3)$$

$$\sum_j \gamma_j^t x_j^t \leqslant L \qquad (\Theta) \qquad (4)$$

$$\lambda^t z_{oi} - z_i^t \leqslant 0, \quad 1 \leqslant i \leqslant n \qquad (\omega_i) \qquad (5)$$

$$x_j^t - \sum_j a_{ij} x_i^t - \gamma_j x_j^t w_j - p_j^t = 0 \qquad (6)$$

$$\max \left\{0, \alpha_j p_j^t\right\} - \sum_{i=1}^{s} u_{ij}^t \leqslant - I_j, \quad 1 \leqslant j \leqslant n \qquad (7)$$

Here

$x_i^t \geqslant 0$ - is total output of the sector i $(1 \leqslant i \leqslant n)$;

$z_i^t \geqslant 0$ - the amount of production (in value terms) of the sector i $(1 \leqslant i \leqslant n)$ consumed in nonproductive activities;

$u_{ij}^t \geqslant 0$ - means of production (in value terms) produced in the sector i $(1 \leqslant i \leqslant s)$ which are used for net accumulation in the sector j $(1 \leqslant j \leqslant n)$;

p_j^t - the value of profit (if $p_j^t > 0$) or losses (if $p_j^t < 0$) in the sector j $(1 \leqslant j \leqslant n)$,

$\lambda^t \geqslant 0$ - a scalar.

The problem (1) - (7) maximizes consumption in a given structure for every time period of consumption (relations (1), (5)).

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[2] There is notation of dual variable in the parantheses.

Constraints (2) show that the volume of production in each sector, which may be used in the economy for productive and nonproductive needs, is not greater than the total output of this sector.

Inequalities (3) require the demand for productive fixed assets to be not greater than the available stock of fixed assets. The rule of fixed assets stock change is given by the equation.

$$F_{ij}^{t} = F_{ij}^{t-1} + u_{ij}^{t-1}$$

Constraint (4) gives a labor restriction. Inequalities (5) fix the structure of the vector of consumption. The equations (6) determine profits and inequalities (7) mean that all centralized investment must be used.

When the problem (1) - (7) is solved we use the well known national accounting relations to compute the volume of replacement of productive fixed assets, productive investment, national income produced, cost price, wage fund.

2. MODEL'S ANALYSIS

To simplify the analysis of the problem (1) - (7) let us convert equations (6) and (7) into an inequality

$$h_j^t x_j^t - \sum_{i=1}^{s} u_{ij}^t \leqslant - I_j, \qquad 1 \leqslant j \leqslant n \qquad (\varphi_j) \qquad (8)$$

where

$$h_j^t = \begin{cases} 0, \text{ if } 1 - \sum_i a_{ij} - \gamma_j w_j \leqslant 0 \\ \alpha_j \left(1 - \sum_i a_{ij} - \gamma_j w_j\right), \text{ otherwise.} \end{cases}$$

Let us assume that the exogenous parameters are such that the problem has a feasible solution where $\lambda > 0$. Then the problem has an optimal solution with $\lambda^* > 0$[3].

The investigation of the model (1) - (5), (8) proved the following[4]:

1. Parameters x_i are positive when the values of foreign trade balance are relatively small in comparison with the volumes of outputs.

2. Dual variables of balance constraints (2) are positive.

3. All $z_i^* > 0$, and all α_i^* are equal to ξ_i^*.

4. For an optimal plan constraints (2) and (3) are equalities.

5. In an optimal plan, there are indices i such as $\omega_i^* > 0$ and there are i such as $\omega_i^* < 1$. Theoretically the case when all $\omega_i^* = 1$ is also possible.

6. Let us assume $s = 2$. Then for every sector j

$$u_{1j}^t + u_{2j}^t \geqslant h_j^t x_j^t + I_j \geqslant I_j \geqslant 0.$$

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[3] The star denotes that this parameter belongs to the optimal solution.

[4] The analysis was made by Itskovich (1976).

It means that for each sector j $u_{1j} > 0$, or $u_{2j} > 0$, or both u_{1j} and u_{2j} are positive.

7. If an accumulation of productive fixed assets in a sector exceeds the volume of centralized investment (dual variable φ_j equals zero) for this sector there is no excess of productive fixed assets in (3) at least for one i. In a sector in which $\varphi_j > 0$ there may be excess of one or both kinds of productive fixed assets.

8. If there is a sector j where u_{1j} and u_{2j} are positive but

$$\eta_{1j} = \eta_{2j} = 0 \quad \text{then} \quad \xi_1 = \varphi_j = \xi_2.$$

3. COMPUTATIONS

Using the dual variables of right-hand side of constraints (3) and (8) we may divide all sectors in the model into three groups.

I. Sectors for which constraints on fixed assets and financial constraints turn into equalities in an optimal plan. The dual variables of right-hand sides of constraints (3) and (8) are positive.

II. Sectors for which constraints on fixed assets turn into equalities in an optimal plan but there are strict inequalities in financial constraints. The dual variables of the right-hand sides of constraints (3) for these sectors are positive, the dual variables of the right-hand sides of constraints (8) are equal to zero.

III. Sectors in which there is an excess of productive fixed assets in (3) but financial constraints turn into equalities in an optimal plan. The dual variables of the right-hand sides of constraints (8) for these sectors are positive and one of two η_{ij} $(i = 1,2)$ is zero.

An enhancement of volume of centralized investment in sectors of the first group increases the outputs of all sectors but decreases the objective function f. Reduction of centralized investment in these sectors reduces the demand for centralized investment by sectors of group II.

The strict inequality in financial constraints(8) - dual variable φ_j equals zero - in sectors of group II means that the amount of investment which a sector possesses is not sufficient for the production of an optimal output. Additional investment may be reallocated to these sectors from sectors of the group I and III.

On the other hand, there is an excess of centralized investment distributed among sectors of group III. When we decrease this excess the objective function f will grow. That is a good reason to take centralized investments from sectors of group III and to allocate them to sectors of group II.

Thus, the dual variables help to anticipate the effect of redistribution of centralized investment among sectors.

Different volumes of centralized investment introduced into the model and different structures of a given amount of centralized investment yield different paths of economic growth. We shall illustrate this statement by the result of computations which are given in Table 1. The table shows the results of different distributions of a given amount of centralized investments among 18 sectors. The patterns of distributions are shown in Table 2.

TABLE 1 Change in total values of national economy indicators in variants 2-5 in percent to variant 1.

Variants	GNP	National income	Consumption fund	Profit	Own cost
2	100.4	100.4	102.7	101.3	100.1
3	82.7	80.0	84.1	79.5	82.4
4	100.1	100.6	103.5	101.6	99.9
5	100.1	100.6	103.5	101.6	99.9

It can be noted that there is no guarantee that in an optimal plan all inequalities (8) will turn into equalities. The left-hand and right-hand sides of these inequalities are not equal in variants 1 and 2. The total accumulation of productive fixed assets$\left(\sum_{i=1}^{s} u_{ij}^{t}\right)$ in the variant 1 is larger by 0 - 25.8% than total investment $\left(h_j^t x_j^t + I_j\right)$ in the sector $j(1 \leqslant j \leqslant n)$, in the variant 2 the excess ranges from 2.5% to 6.5%.

From the economic point of view, such excess means that the investment is not sufficient for the fulfillment of the production program. A credit may become a source of financing this excess.

There is a possibility in the model of equalizing the volume of accumulation of productive fixed assets and the capital investment. In other words, one may have in the optimal solution only two groups of sector - group I and group III. To do this, it is enough to rewrite constraints (8) as the equalities. Variant 3 presents the results of computation for the model in which inequalities (8) are substituted by equalities (see Table 1). The distribution of centralized investment in this variant coincides with that in variant 1 (see Table 2).

It appeared that the expansion path in variant 3 is worse than in variants 1 and 2. Thus, the total profit for the whole period of computation is less by 20.6% than in variant 1, the total national income - by 20%, and the total consumption is smaller by 15.9% than in variant 1.

Changing the structure of distribution of centralized investment among different sectors we managed to improve the path of economic growth without rewriting constraints (8) as equalities. Variant 4 shows this (see Tables 1 and 2). In the optimal solution all constraints (8) are fulfilled in variant 4 as equalities.

Thus, a change of the pattern of distribution of centralized investment not only yields different growth paths but also permits us to equalise the amounts of accumulation of production fixed assets and total investment. But one cannot be sure that rearrangement of distribution of centralized investment among different sectors will give an equality in equations (8). Experience with computations shows that the difficulty of balancing the accumulation and investment in the model increases as the period of computation moves away from the starting point.

It seems natural to put a question to ascertain which pattern of distribution of a given sum of centralized investment yields the largest increase in consumption. The way in which this problem may be solved in the optimizing model (1) - (5), (8) is a successive recomputation of various structures of centralized investment distribution. Evidently, this way is not efficient. That is why another approach was suggested.

The basic idea of this approach is very simple to follow. It is necessary to fix only the total sum of centralized investment and compute

TABLE 2 The structure of distribution of centralized investments among sectors in different variants of the experiment, %.

Sectors Variants	1	2	3	4			5		
	t=1,2,3	t=1,2,3	t=1,2,3	t=1	t=2	t=3	t=1	t=2	t=3
Machine-building and metalworking	11.0	11.0	11.0	10.4	11.0	8.3	6.7	7.8	2.1
Construction	12.4	12.4	12.4	2.9	4.4	0.1	0	0	0
Electricity	5.2	1.0	5.2	7.0	2.6	6.9	6.9	36.2	26.3
Ferrous metallurgy	3.9	7.6	3.9	6.8	7.7	6.7	2.4	0	0
Non-ferrous metallurgy	2.3	6.2	2.3	6.2	6.2	5.0	4.9	2.9	2.6
Fuel industry	7.0	36.8	7.0	37.3	36.9	35.8	37.3	33.9	36.1
Repair of machines and equipment	6.0	1.2	6.0	+	+	+	0	0	0
Chemical industry	2.6	0.5	2.6	+	+	+	0	0	0
Timber industry	1.5	0.3	1.5	+	+	+	0	0	0
Construction materials	3.5	8.6	3.5	8.7	8.6	7.4	0.5	0	2.8
Light industry	0.9	0.2	0.9	+	+	+	0	0	0
Food industry	2.7	0.5	2.7	5.3	0.5	1.2	5.3	0.5	1.2
Other branches of industry	1.4	0.3	1.4	0.3	0.3	1.0	0	0.2	1.0
Capital repair	0.2	5.4	0.2	5.4	5.4	4.6	5.3	3.7	4.3
Agriculture	4.0	4.7	4.0	7.2	13.4	20.8	7.1	13.3	21.3
Transportation	11.1	0.2	11.1	1.1	1.4	+	22.6	0	0
Trade and distribution	4.1	0.8	4.1	0.8	1.0	2.3	0.4	1.5	2.3
Other branches of material production	0.2	0.4	0.2	0.6	0.4	+	0.6	0	0

"+" - less than 0.1

their optimal distribution among sectors in the model.

To construct such a model we only have to restate constraints (8) and introduce one new constraint. More precisely, we substitute (8) by

$$h_j^t x_j^t + I_j^t - \sum_{i=1}^{s} u_{ij}^t \leqslant 0, \qquad 1 \leqslant j \leqslant n \qquad (\varphi_j) \qquad (9)$$

and introduce an additional inequality

$$-\sum_j I_j^t \leqslant -I \qquad (\varphi) \qquad (10)$$

where I denotes the total amount of centralized investment.

The solution of a revised model (1) - (5), (9), (10) gives us the volumes of centralized investment in each sector I_j. It is proved for the revised model that if a given sum of centralized investment I is sufficient to produce an optimal output, i.e. constraint (10) is an equality in an optimal plan, constraints (9) are carried out as equalities. If under these conditions there is at least one sector with no excess of fixed assets all sectors with the excess of fixed assets will not receive centralized investment ($I_j = 0$).

The computations on the revised model with the same initial information as in variant 1 gave practically the same values of national economy indicators as in variant (see variant 5 in Table 1). Nevertheless, the structure of centralized investment distribution in this variant differs from that in variant 4 (see Table 2). It shows that the same values of global national economy indicators may be reached with different structures of centralized investments distribution among sectors.

At the end of the analysis, it is worth noting that the discussed optimizing inter-industry models may be useful for an estimation at the consequences of various investment policies. Such policies in the model are presented by various total values of investment and their inter-industry distribution. These models permit to coordinate the level of accumulation of productive fixed assets and the amounts of available financial resources to be used for such an accumulation.

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CHANGES OF OUTPUT CAPACITY UTILIZATION CAUSED BY STRUCTURAL CHANGES OF MATERIAL INPUTS

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1. INTRODUCTION

The paper deals with the problem of relations between the output of particular branches (sectors) of the national economy, and the output capacity of these branches, i.e. with the relations between the production volume, really achieved, and the possibility of producing. The index of the capacity utilization belongs to the most important parameters characterising the state of the national economy.

The main problem is: how do the changes in the structure of inputs influence the output level in particular branches? It is hardly possible to answer this question when the capacity utilization is estimated on the basis of production functions, even if we considered the functions which include more than two classical explanatory variables, i.e. capital stock and labor. The reason for it is that the production functions do not explain influence of all material inputs. The shortage of supplies or changes in the structure of supplies (e.g. substitution of inputs, increased use of domestic materials instead of restricted imports etc.) can hardly be included in the typical production function for an obvious reason that econometric models with many explanatory variables are difficult to estimate.

The other way of computing the capacity utilization indices consist in the solving of some optimization model, where the Leontief's input-output model is used as a set of restrictions (see Dubla and Lipińska 1982, Lipiński 1983). In this case we need a relatively great volume of statistical data, which is often difficult to gather. The static character of the solution is the second disadvantage. The proposed simulation method belongs also to this group, but it is relatively simple.

The method consists in the solving of a simple optomization problem, maximizing the final production volume. Instead of production functions we have the only criterium: to maximize the intensity, with which the final demand, with a given structure, should be satisfied. To the restrictions of the model belong:
- output capacity of particular branches,
- balance equation of the national economy.

2. MODEL AND ITS SOLUTION

Let us denote by:
x - vector of global outputs of branches,
m - vector of output capacities,

y - vector with components describing the desired structure of the final production,
A - matrix of input-output coefficients,
λ - the intensity of satisfaction of the final demand realization of the final production with a given structure.

Then, the proposed model can be written as follows (Factor... 1983, Lipiński and Rogalska 1984):

$$\lambda \rightarrow \max \tag{1}$$

$$x \leqslant m \tag{2}$$

$$x = A x + \lambda \cdot y \tag{3}$$

$$x \geqslant 0 . \tag{4}$$

If A is a productive matrix, then there exist an optimal solution(λ^*, x^*) for the given m, y, A. To obtain this solution, we can apply the following algorithm:

Step 1. Compute

$$x_D = (I - A)^{-1} y$$

Step 2. The restriction (2) can be now written as $\lambda x_D \leqslant m$.
Compute

$$l_j = m_j / x_{jD}$$

where m_j, x_{jD} - elements of proper vectors. Then, because of (2), there exists

$$\lambda^* = \min_j l_j$$

Step 3. Using the obtained value of the intensity coefficient λ compute

$$x^* = \lambda^* x_D$$

Analysis of the solution allows us to examine:
- which industries are "bottle-necks" obviously these, for which there occurs $l_j = \lambda^*$;
- in which branches the output capacity utilization index is near to 1(100%) - such branches must be carefully treated by the planning of restitution strategies for the right macroeconomic proportions;
- which industries (sectors) have significant overcapacities.

The above described simple optimization model can be applied for simulation experiments, which should give the values of output capacity utilization indices depending on changes in parameters m, y and A. The solution (λ^*, x^*) can be found for any combination of given vectors and any combination of changing input-output coefficients.

The vectors m and y can be obtained e.g. as forecasts on basis of lassical econometric models or planned quantities. The same occurs with input-output coefficients a_{ij}, but unlike with the above mentioned vectors, there is usually no need to estimate all of these elements. It is practically enough to concentrate the forecasts only on important input-output coefficients, assuming that the other coefficients will save their values from a basic oeriod. The importance of the input-output coefficients can be estimated by (Lipiński and Tomaszewicz 1983):

- measuring the influence of changes of these coefficients on the volume of final (global) production,
- analyses of the changeability in time (a coefficient will be treated as important, if its value changes significantly or is assumed to change).

The values of chosen important input-output coefficients can be computed as random numbers from intervals

$$(a_{ij} - \sigma_{ij},\ a_{ij} + \sigma_{ij})$$

where

a_{ij} - an average value or forecast of the coefficient a_{ij} for a given time period,

σ_{ij} - standard deviation (in case of average values) or forecast's error (otherwise).

These numbers can be easily obtained by applying a random number generator, with the probability distribution which seems to be the most proper for the changeability tendencies.

3. SIMULATION EXPERIMENTS FOR THE POLISH ECONOMY

3.1. General description of data

The simulation experiments based on the model (1)-(4) were performed using statistical data concerning the period 1982-1985 and available forecasts for the vectors m, y and the matrix A. All the computations were done in comparable constant prices from the year 1982. The national economy is divided into 7 sectors: electroengineering industry, other manufacturing industries, construction, agriculture and forestry, transportation and communications, trade, other sectors. The data for the year 1982 were taken from the published input-output table for Poland. The lack of tables for the following years made it necessary to use the published indices for the final demand y (1982-1984) and forecasts for other variables. The proper data are given in Tables 1-3.

TABLE 1 Output capacities - estimates and forecasts for the period 1982-1985 (constant prices from 1982 - billions of zlotys)

Short symbol	Sector	1982	1983	1984	1985
QE	Electroengineering industry	1898.6	1950.3	1981.7	2041.9
QP	Other industries	6234.1	6410.1	6557.9	6721.5
B	Construction	1493.0	1548.2	1597.7	1648.9
RL	Agriculture and forestry	2029.0	1994.2	2002.9	2022.7
T	Transportation and communications	863.0	926.8	997.3	1061.1
H	Trade	938.9	984.9	1000.6	1036.7
PO	Other sectors	308.6	312.5	315.4	319.1

Source: Juszczak and Stańczyk (1984).

TABLE 2 Structure of the final demand in 1982 (billions of zlotys)

Sector	C	G	J	R	E	Total
QE	199.5	62.9	317.7	58.1	419.8	1058.0
QP	1600.0	228.1	1.1	410.2	426.7	2666.1
B	19.6	71.0	793.4	-37.3	67.5	914.2
RL	417.5	15.3	-10.9	-3.8	30.2	448.3
T	83.3	47.3	1.1	0.0	125.7	257.4
H	532.2	15.6	15.0	-0.2	6.7	569.3
PO	61.8	36.6	0.0	6.1	1.3	105.8
Total	2913.9	476.8	1117.4	433.1	1077.9	6019.1

Source: aggregated data from the Rocznik Statystyczny 1984.

C - consumption from personal incomes,
G - other consumption,
J - investments,
R - increase of inventories,
E - exports.

TABLE 3 Dynamics of the final demand components (previous year = 1.000, constant prices)

Component	1983	1984	1985
C/QE	1.065	1.059	1.067
C/QP		1.051	1.042
C/B	1.075	1.043	1.020
C/RL	1.002		
C/T	1.094		
C/H	0.966		
C/PO	1.064		
G	1.000	1.043	1.023
J/QE	1.061	0.985	1.057
J/B	1.113		
R	1.307	1.718	1.012
E	1.090	1.076	1.060

Source: Juszczak and Welfe (1984), Lipiński and Rogalska (1985).

3.2. Values of input-output coefficients

The 49 series of input-output coefficients were divided into several groups:

- coefficients with constant value (quotient of standard deviation to average value below 10%) - a_{12}, a_{13}, a_{22}, a_{23}, a_{27}, a_{42}, a_{44}, a_{51}, a_{52}, a_{55};
- coefficients with increasing value - a_{15}, a_{17}, a_{25}, a_{31}, a_{32}, a_{35}, a_{37}, a_{57}, a_{71}, a_{72};

- coefficients with decreasing value - a_{21}, a_{22}, a_{42}, a_{44};
- other(unimportant) coefficients, whose values were assumed arbitrarily according to tendencies from the 70's and actual changes of these tendencies.

TABLE 4 Input-output coefficients (values for the year 1982 and forecasts for the period 1983-1985 in constant prices from 1982)

Year	Sector	QE	QP	B	RL	T	H	PO
1982	QE	.2311	.0351	.0990	.0198	.1204	.0226	.0949
	QP	.2311	.4020	.2457	.1158	.3072	.0677	.3371
	B	.0106	.0122	.0498	.0122	.0243	.0157	.0425
	RL	.0002	.1513	.0016	.3998	.0007	.0028	.0080
	T	.0206	.0337	.0755	.0077	.0884	.0839	.0493
	H	.0247	.0262	.0124	.0164	.0375	.0062	.0143
	PO	.0172	.0086	.0134	.0018	.0151	.0139	.0557
1983	QE	.2425	.0380	.1197	.0199	.1301	.0238	.1028
	QP	.2277	.4048	.2513	.0989	.3013	.0708	.3174
	B	.0106	.0128	.0580	.0121	.0248	.0173	.0446
	RL	.0002	.1484	.0014	.3978	.0006	.0028	.0080
	T	.0201	.0384	.0792	.0047	.0829	.0860	.0498
	H	.0229	.0261	.0105	.0167	.0443	.0083	.0147
	PO	.0165	.0090	.0150	.0017	.0166	.0146	.0594
1984	QE	.2539	.0410	.1395	.0200	.1399	.0250	.1107
	QP	.2243	.4076	.2569	.0820	.2953	.0760	.2972
	B	.0106	.0134	.0661	.0121	.0252	.0188	.0467
	RL	.0002	.1455	.0135	.3957	.0006	.0027	.0080
	T	.0196	.0430	.0830	.0018	.0774	.0880	.0504
	H	.0210	.0260	.0870	.0171	.0510	.0105	.0150
	PO	.0159	.0095	.0165	.0016	.0182	.0153	.0630
1985	QE	.2480	.0420	.1500	.0200	.1500	.0250	.1200
	QP	.2600	.4140	.2600	.0800	.2900	.0770	.2900
	B	.0110	.0140	.0840	.0120	.0260	.0200	.0490
	RL	.0002	.1510	.0130	.3900	.0010	.0030	.0080
	T	.0190	.0470	.0870	.0050	.0720	.0080	.0510
	H	.0190	.0260	.0700	.0180	.0590	.0130	.0160
	PO	.0170	.0100	.0180	.0020	.0200	.0160	.0670

Source: Rocznik Statystyczny (Statistical Yearbook) for 1982, own forecasts for 1983-1985 (Lipiński and Rogalska 1985).

All the forecasted values (in constant prices from the year 1982) are shown in Table 4, whereas the mean relative errors (in %) of the most important coefficients are given in Table 5.

The values of output capacity utilization indices for the given vectors m and y, and the matrices A as shown in Table 4, can be found in Table 6.

TABLE 5 Mean relative errors (in %) of the forecasts for the important input-output coefficients.

Sector	QE	QP	B	RL	T	H	PO
QE	2.1	9.6	-	-	7.7	-	-
QP	4.4	2.8	6.3	3.7	3.4	-	-
B	8.1	5.0	6.4	-	7.4	-	-
RL	-	9.1	-	2.8	-	-	-
T	7.8	-	10.5	-	9.2	-	-
H	-	-	-	-	-	-	-
PO	10.3	10.1	-	-	-	-	-

Source: Lipiński and Rogalska (1985).

TABLE 6 Output capacity utilizatio indices related to the sector RL - agriculture/forestry - basic version.

Sector	1982	1983	1984	1985
QE	.894	.922	.957	.932
QP	.898	.886	.908	.893
B	.628	.668	.626	.613
RL	1.000	1.000	1.000	1.000
T	.751	.730	.712	.694
H	.776	.684	.744	.692
PO	.684	.695	.724	.735

Source: Simulation results.

3.3. Results of experiments

The first experiment consisted in solving the problem (1)-(4) with the changes in single important elements of the matrix A, describing the cooperative links between industry and agriculture/forestry (using the random number generator, computing the random numbers distributed rectangularly on the intervals $(a_{ij} - \sigma_{ij}, a_{ij} + \sigma_{ij})$). It was obtained as a result of the fact that changes of the following coefficients had influenced the output capacity utilization to the highest degree:

a_{22} - input of own products in the sector QP,

a_{42} - input of agriculture/forestry products to the sector QP,

a_{44} - input of own products in the sector RL.

The comprehensive data are shown in Table 7.

As it can be seen from these data, an increase of input of own products in the sector QP (industry except electroengineering) increases the output capacity utilization in this sector, with simultaneous decrease of the utilization indices in other sectors (except agriculture/forestry). The decrease of the utilization indices when increasing the own input in the sector RL, and input of sector RL to QP, is, however, an unexpected result. Probably, it would be an evidence of the fact that products of the sector

RL are processed as raw materials in the industries which produce mainly consumer goods (e.g. textile industry, wood and paper industry, food industries). The intermediate demand in these sectors seems to be relatively smaller than in other ones.

There were also prepared experiments with simultaneous changes in more than one input-output coefficients - pairs (a_{22}, a_{42}), (a_{22}, a_{44}), (a_{42}, a_{44}) and triplet (a_{22}, a_{42}, a_{44}).
However, the obtained results are hardly comparable in this case, because it is impossible to standarize the results in the way applied for single input-output coefficients.

TABLE 7 Increase of output capacity utilization indices connected with 1% relative increase of the proper input-output coefficient (results of simulation experiments).

Year	Sector	a_{22}	a_{42}	a_{44}
1982	QE	-.00336	-.00629	-.00592
	QP	+.00224	-.00607	-.00571
	B	-.00280	-.00447	-.00423
	RL	.0	.0	.0
	T	-.00168	-.00519	-.00487
	H	-.00261	-.00536	-.00529
	PO	-.00206	-.00480	-.00444
1983	QE	-.00329	-.00653	-.00617
	QP	+.00213	-.00613	-.00574
	B	-.00310	-.00481	-.00447
	RL	.0	.0	.0
	T	-.00155	-.00516	-.00489
	H	-.00213	-.00498	-.00447
	PO	-.00194	-.00487	-.00468
1984	QE	-.00348	-.00630	-.00677
	QP	+.00212	-.00592	-.00571
	B	-.00290	-.00422	-.00402
	RL	.0	+.00139	.0
	T	-.00058	-.00472	-.00465
	H	-.00077	-.00479	-.00487
	PO	-.00058	-.00479	-.00465
1985	QE	-.00347	-.00683	-.00579
	QP	+.00193	-.00649	-.00579
	B	-.00308	-.00455	-.00401
	RL	.0	.0	.0
	T	-.00135	-.00511	-.00446
	H	-.00231	-.00499	-.00401
	PO	-.00212	-.00278	-.00468

Source: Lipiński and Rogalska (1985).

4. CONCLUSIONS

The application of the presented method of analysing the output capacity utilization indices can be helpful for macroeconomic decision makers. The simplicity of the method, and the possibility to employ it at any level of aggregation, seem to be advantageous. The output capacity utilization indices, obtained in the above described way, could suggest the proper structure of material inputs, if we aimed at maximal utilization of output capacities. The other possibility consists in computing the utilization indices for a given structure of inputs.

However, attention should be paid to the fact that more reliable results need precise statistical data or forecasts, describing tendencies of changes in the vectors of final demand, output capacities and input-output coefficients. The proper system of price indices (deflators), which could ensure the comparability of results from different periods, would be also appreciated.

It seems also worth experimenting with the other assumptions concerning the stochastic structure of the problem (i.e. the type of probability distribution of the elements to be randomly changed), as well as with the deeper disaggregation of the model.

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EXCHANGE RATES: HOW THEY EFFECT PRICES AND QUANTITIES IN THE INFORUM-ERI INTERNATIONAL SYSTEM OF MACROECONOMIC INPUT-OUTPUT MODELS

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This section describes the effects of exchange rates on prices and quantities in each of the national input-output models that are a part of the INFORUM linked system of models, and then how these national effects interact in the entire system. An alternative projection of exchange rates where the rates are fixed at their June 1985 values is used in the entire system and the results interpreted. The seven countries for whom we have models are the USA, Canada, Japan, West Germany, France, Italy and Belgium.

An exchange rate is the price of one currency in terms of another. In our seven linked macroeconometric input-output models, the exchange rate directly affects two quantities on the real side and the calculation of prices on the price side. For expositional purposes let us take the case of a currency devaluation and trace its effects through a typical model of our system. (Please note all of the national models will differ in some details from the "typical" model described below.) By the term real side we are referring to the calculations of volumes or quantities. On the other hand, the term price or income side refers to the calculation of prices and nominal values.

1. DIRECT REAL SIDE EFFECTS

Exchange rates affect the levels of prices used in the calculation of exports and imports. Exports, by sector, are primarily a function of the levels of domestic activity in the corresponding foreign sector and the level of the ratio of domestic to foreign competitors prices. We except a positive relationship between foreign activity and export volume. We except a negative relationship between the price ratio and export volume. A devaluation has the effect of raising the prices of foreign competitors in terms of the domestic currency. Thus, the direct effect of a devaluation is to raise the level of the volume of exports. Similarly, imports are functions of the level of domestic activity and of the ratio of the import to domestic price. Since a devaluation raises the import price directly, we should expect the volume of imports to fall because of the prices effect. Domestic activity, however, has been increased, because of the increase in exports, and so the volume of imports may go up or down depending on the relative strengths of the price and demand terms.

2. DIRECT PRICE SIDE EFFECTS

Import prices enter directly into the calculation of domestic prices. The domestic price identity is:

$$P_d = P_d D + P_m M + V \qquad (1)$$

where:

P_d is a vector of domestic prices;

P_m is a vector of import prices;

D is a matrix of input-output coefficients of domestically produced goods;

M is a matrix of input-output coefficients of imported goods; and,

V is a vector of value added per unit of real output.

From equation (1) we see that the devaluation will directly raise the level of domestic prices through the increase in the cost of imported materials. In general, the vector, V, will also be affected. V consists of labor compensation and return to capital. The table below describes some of the terms in the calculation of V.

TABLE 1 Factors affecting value added per unit of output.

Factor	Item affected	Expected sign/comments
Foreign competitors' prices	Profits (return to capital)	+, since a rise in foreign prices allows domestic producers some relief from foreign competition
Wage rate	Labor compensation	+
Unemployment rate	Labor compensation, Profits	-, high levels reduce labor's bargaining position, profits are reduced as firms seek to retain weak domestic markets and also look abroad for sales; low levels, on the other hand, allow firms to raise prices with relative impunity

3. REAL AND PRICE SIDE INTERACTIONS

The increased real side volume of domestic activity produced by the devaluation may or may not affect the price side. If the economy begins with a significant amount of slack the increased activity will probably not lead to more domestic inflation. On the other hand, an already fully-employed economy will see large price increases. The increased domestic prices from the price side will reduce the gains derived in exports (assuming the domestic price increase is less than the devaluation) and reduce the increased level of the import to domestic price ratio used in the import equation. Thus, the first round real side stimulus of the devaluation is reduced once the devaluation effects on domestic prices are considered.

4. INTERNATIONAL INTERACTIONS

Assuming that a devaluation effectively lowers the prices of that country in terms of other countries' currencies (that is the rate of devaluation is greater than the rate of induced domestic price increase), the effects on other countries are of an opposite nature but to a much smaller degree. The exact degree will depend in the case of imports on the relative sectorial import dependence between the countries and in the case of exports on the overall importance of the devaluing country in the world trade in the commodity in question. Thus, the Canadian exchange rate change will have a large effect on U.S. import prices (since about 25% of American imports are of Canadian origin) but only a small effect on export competitors' prices (with the exception of grains and some nonferrous ores where the Canadians have a large proportion of the world trade). Conversely, the Canadian exchange rate change will hardly affect Italian import prices since the proportion of Italian imports coming from Canada is small.

5. A STORY OF FIXED EXCHANGE RATES

The above presentation has all been in terms of changing one country's exchange rate and analyzing the domestic and international implications of that change. For the period one year considered the exchange rate was treated as exogenously determined. What would be the implications for output, employment, and prices if exchange rates remain unchanged for a much longer period, say fifteen years? Let us give the answer to our question in context of the countries in our system and of the effects that fixed exchange rates would have on them. The exchange rates chosen were those prevailing in June 1985.

Japan is representative of the case of a country with an undervalued currency and with currently high employment. The Japanese response is summarized in Table 2 below.

TABLE 2 Comparison of Japanese results: changing vs fixed exchange rates

	1985		1986		1990		2000	
	Base	Fix	Base	Fix	Base	Fix	Base	Fix
Yen/$	225	225	206	225	180	225	140	225
Unemployment rate	3.0	3.0	2.1	1.9	3.6	1.8	1.5	1.6
			exponential growth rates					
	1985-1986		1986-1990		1990-2000		1985-2000	
	Base	Fix	Base	Fix	Base	Fix	Base	Fix
GNP	4.9	5.2	3.3	3.6	3.8	3.7	3.8	3.8
Exports (1975 prices)	0.2	1.0	2.9	3.8	4.0	3.6	3.4	3.4
GNP Deflator	0.5	2.6	3.0	7.7	5.3	9.0	4.3	8.2

Base: changing exchange rates.
Fix: fixed exchange rates.

In the base forecast, the yen is projected to be revalued against the dollar. Keeping the yen at the 1985 level for the year 1986 causes exports (in real terms) to grow .8% per year faster then under the base run. Under fixed rates. total GNP grows slightly faster, unemployment is a little lower, but prices rise significantly faster since Japan in initially at full employment and, further, import prices rise faster because in the base case the revaluing yen held them down. Thus, Japanese firms can only marginally increase output but they can increase profit margins by taking advantage of the cheap yen and raising their prices. If we keep the fixed rate assumption going on to 1990 we see the effects noted in 1986 continuing but in an exaggerated form. Prices are now rising at twice the rate of base run, export volume in nearly 1% faster, and GNP continues to rise a little faster. However, between 1990 and 2000 we see a reversal in fortunes as the higher inflation rate robs the Japanese of their favorable international price position. Hence, growth finally slows and unemployment returns to a position more in line with the base. For the entire 1985 to 2000 period, we have no appreciable difference in growth or employment. The only change is in the rate of inflation.

West Germany represents a case where the country begins with an undervalued currency but, in contrast to Japan, with high unemployment. Table 3 summarizes the West German results.

TABLE 3 Comparision of German results: changing vs fixed exchange rates.

	1985		1986		1990		2000	
	Base	Fix	Base	Fix	Base	Fix	Base	Fix
DM/$	2.65	2.65	2.30	2.65	2.10	2.65	1.60	2.65
Unemployment rate	9.0	9.0	9.9	9.0	9.7	5.4	5.7	5.2
	exponential growth rates							
	1985-1986		1986-1990		1990-2000		1985-2000	
	Base	Fix	Base	Fix	Base	Fix	Base	Fix
GNP	1.5	3.4	2.9	4.1	3.0	2.4	2.9	2.9
Exports (1975 prices)	3.3	5.0	2.7	4.4	3.0	3.2	2.9	3.6
GNP Deflator	0.8	2.9	2.9	5.7	4.3	11.2	3.7	9.2

Base: changing exchange rates.
Fix: fixed exchange rates.

Like the yen, the Deutsche Mark is projected to be revalued against the dollar. Constant exchange rates have the effect of substantially increasing exports, output and employment at only a moderate cost in inflation. The main source of the increased inflation is the increased cost of imported materials and not in value added costs. Overall, the first compared to the base run, the 1986-1990 period shows the following: a modest increase in inflation; GNP growth more than 1% faster per year; and unemployment a full 4 percentage points lower. In the 1990's, with the economy approaching full employment, inflation takes hold, thus reducing export growth, GNP growth and employment. Comparisons for the entire fifteen year experiment show almost no gain in output growth, small increases in employment(most likely cyclical in nature), and huge increases in inflation.

What can we say to summarize these country's results? At least three broad statements can be made. The first is that, in the long run, exchange rates do not affect the economy's overall level of output. The second conclusion modifies the first by giving 10-15 years as the time frame for the long run. The third is that our exchange rate assumptions have substantial long run affects on the rate of inflation in each country. Since exchange rates are exogenous in the system and prices are endogenous, we could infer that exchange rates influence prices. That is true, but it is also very true that relative rates of inflation influence long run exchange rates. Hence, while exchange rates are technically exogenous to the system, they are subject to revision based on the forecast results of the models.

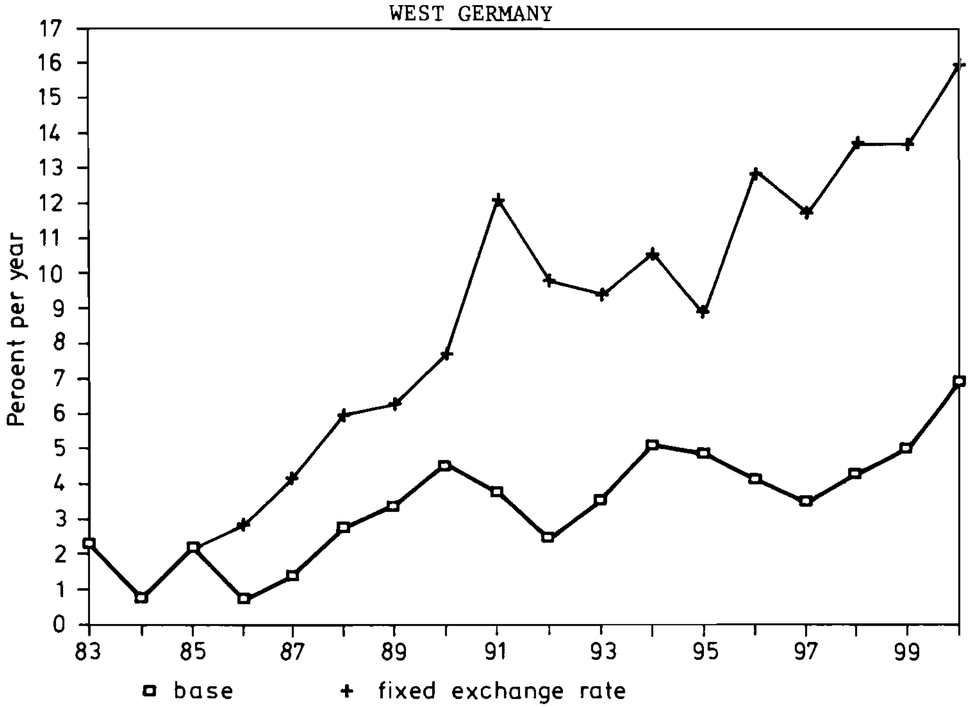

FIGURE 1 GNP deflator growth.

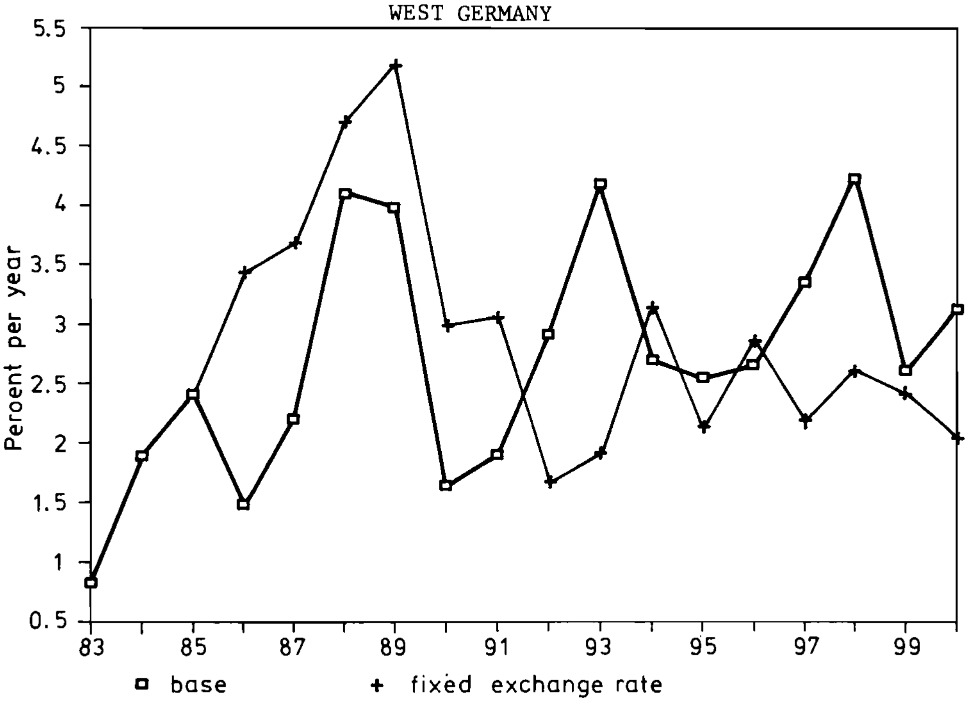

FIGURE 2 GNP growth rates.

INTRA-CMEA TRADE SHARE MATRICES. RECONSTRUCTION AND ANALYSIS FOR 1971-1980.

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1. INTRODUCTION

In the construction of the linked system of the national INFORUM-type input-output models of the CMEA countries the trade share matrix approach seems to be superior to other methods (see Czyżewski and Tomaszewicz 1984). However, using this approach, several problems must be solved.

This paper presents an attempt to overcome empirical difficulties resulting from constraints in publishing statistics concerning foreign trade of the CMEA countries. The method of reconstruction of intra-CMEA trade share matrices for the years 1971-1980 combines the limited statistical information and a set of a priori assumptions about the allocation of particular country exports (imports) shares to get the preliminary matrices. Then, the RAS method is used for biproportional adjustment of the preliminary matrices. The analysis of obtained time series is presented in the Appendix. Finally, a proposition concerning forecasting of exports imports shares is put forward.

2. DATA

Empirical difficulties result from constraints in publishing adopted in foreign trade statistics in the CMEA countries. Having no statistical information about the intra-CMEA trade flows, various formal methods for "guessing" can be used. Each of them usually combines the limited statistical information and a set a priori assumptions about the allocation of particular country exports/imports shares.

As a result of the first step of our calculations (see Czyżewski and Tomaszewicz (1984)) we obtained the intra-CMEA trade share matrices for 1980. The computations were carried out for 7 European CMEA countries: Bulgaria, Czechoslovakia, the GDR, Poland, Rumania, Hungary and the Soviet Union using 1980 global data (presented in 1980 US dollars) about the intra-CMEA exports and imports for 4 CTN groups of commodities:

CTN 1 - industrial machinery and equipment (including spare parts),
CTN 2+3+4+5 - fuels and non-food raw-materials,
CTN 6+7+8 - food and raw materials for production of foodstuffs,
CTN 9 - industrial consumer goods (excluding food).

The estimates of these matrices were based on the a priori assumptions concerning the same aspects within each commodity group:

1) the share of each country exports to the Soviet Union,
2) shares of Czechoslovakia, Poland and the GDR in exports of these countries,
3) the geographical structure of the Soviet Union's exports.

Then the RAS method was used for biproportional adjustment of the preliminary matrices.

Overcoming the data problems enables us to use the trade share matrix but does not solve the question how to use it in modelling transmission of economic activity among the CMEA countries. The possible solutions of this problem were discussed in Czyżewski and Tomaszewicz (1984).

The most important question lies in the identification of factors which cause changes in the trade shares. Because of no operational theory of the intra-CMEA trade behaviour we decided to identify these factors in an empirical way.

Therefore, the next step of our calculations was to reconstruct time series data on the elements of the trade share matrices in order to follow their changes and make assumptions about their future behaviour. The matrices for the period 1971-1981 were obtained by the RAS method using base matrix for 1980 and the global intra-CMEA exports and imports for 4 commodity groups expressed in 1980 US dollars. This simple method has some disadvantages, but after introducing a priori information about some flows[1] such calculations are now being carried out - this method seems to be very useful for generating trade share matrices.

3. CHANGES IN TIME

Analysing estimated trade share matrices we have to take into account the impact of the applied estimation method on the obtained time series. Despite possible errors of estimation the generated matrices give information about the historical picture of economic activity among the CMEA countries, which is helpful for further studies.

Due to the fact that the intra-CMEA exports and imports are covered by long and medium bilateral agreements, smooth changes (trends) in the trade share matrices were expected. On the basis of the generated data we obtained an opposite picture. Despite a few shares (exports and imports as well) they did not generally vary smoothly in time for several reasons.

1. A certain part of demand for "hard" goods supply of which is constrained on the CMEA markets must be converted to the non-CMEA market where rapid and dynamic changes are observed. If one unexpected change on this market has a serious impact on one CMEA country market other countries, mostly the Soviet Union, will act to relieve the distortion.
2. Because of the high level of the SU imports/exports shares any changes in patterns of transactions with the SU will change the shares of other countries, even though intra-trade flows among these countries remain unchanged.
3. Shares of exports of different countries (excluding the SU) to any given country (except the SU) have very similar patterns of changes, as well as the shares of imports from a given country to the other countries as the changes of imports (exports) shares do not depend so much on transactions within these countries but rather on transactions with the SU.
4. Trade flows and consequently imports/exports shares seem to be smoother

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[1] Especially for row and column concerning the SU exports to and imports from other countries. These shares have the highest level in the matrices.

for commodity groups CTN1 (machinery and eguipment) and CTN9 (industrial consumer goods) than for the two other groups which are mostly "hard" goods (CTN2+3+4+5 - fuels and non-food raw materials, CTN6+7+8 - food and raw materials for food).

5. The much more rapid changes of flows are observed for food and raw materials for food production because of fluctuations in weather conditions and crops.

For some more detailed information about imports/exports shares and flows - see Appendix 1.

4. PROPOSITION CONCERNING FORECASTING OF EXPORTS/IMPORTS SHARES

The changeability of shares in time does not make forecasting process an easy task. It seems that direct methods which attempt to capture changes in each share separately are not very fruitful. Unlike with the non-CMEA market where the foreign trade price movement describes well the trade flows movement a lot of factors which have an impact on the intra-CMEA flows are difficult to quantify.

We suggest to use a two-stage indirect procedure. Let us take into account the Link-type model in which imports are supply determined by using exports shares.

1. During the first step, the exports share matrix $\left[\lambda^{o}_{ij}\right]$ for the basic year is used to make provisional calculations of import M^{o}_{j} (i, j)- indices of countries on the basis of exports of each country E^{t}_{i}.

For a given country j, we have

$$M^{o}_{j} = \sum_{i} \lambda^{o}_{ij} E^{t}_{i} = \sum_{i} v^{o}_{ij}$$

and

$$\sum_{j} M^{o}_{j} = \sum_{j} \sum_{i} \lambda^{o}_{ij} E^{t}_{i} \; . \qquad (1)$$

2. During the second step, the provisional calculations are adjusted by the so called "residual" method. The residuals (e_{j}) are the values of differences between the real level of flows in the year t (v^{t}_{ij})and the one provisionally calculated as $\lambda^{o}_{ij} E^{t}_{i} = V^{o}_{ij}$, so

$$v^{t}_{ij} = \lambda^{o}_{ij} E^{t}_{i} + e^{t}_{ij} .$$

Adding to each value of imports M_{j} the residuals we obtain

$$M^{t}_{j} = \sum_{i} \lambda^{o}_{ij} E^{t}_{i} + \sum_{i} e^{t}_{ij}$$

and

$$\sum_{j} M^{t}_{j} = \sum_{j} \sum_{i} \lambda^{o}_{ij} E_{i} + \sum_{j} e^{t}_{j}$$

$$\sum_i e_{ij}^t = e_j^t .$$

To fulfill condition (1) the sum of residuals was to be equal to zero, i.e.

$$\sum_j \sum_i e_{ij}^t = \sum_j e_j^t . \qquad (2)$$

The residuals (e_j) should be modelled on the basis of econometric equations, but because of no operational theory any further suggestions concerning the specification of these equations have to be prerequisited by detailed empirical studies. There are estimation and forecasting procedures which quarantee that condition (2) is fulfilled. If ordinary forecasting methods are implemented adjustment procedure must be used additionally (for example the procedure minimizing the sum of squares of differences between forecasted and adjusted resuduals).

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APPENDIX Some more detailed information on exports/imports shares.

Fuel, raw materials - CTN2-5.

Exports/imports totals. Mutual transactions between Bulgaria, Czechoslovakia, the GDR and Poland show an upward trend with the collapse at the end of seventies in the observed period 1971-1981. The collapse was also observed for two other countries: Rumania and Hungary. In Hungary, there was another collapse in 1976 after an upward trend of transactions in 1975 (this situation was observed in Hungary for each commodity group). There were smooth tendencies of transactions with Rumania either collapse (in 1978).

A different situation was observed for the Soviet Union. Imports from the SU (excluding Hungary in 1976) as well as exports to the SU (excluding Poland at the end of the 70's) have a smooth upward trend especially sfter 1974.

1. Exports shares.

Downward trends are observed after 1979 for Bulgaria, Czechoslovakia, the GDR and Poland. All the countries (excluding collapses in the above mentioned years for Rumania and Hungary) show the increase in the ratios of their exports to the SU. The shares of the SU exports to the other countries tended to oscillate. A systematic increase of the ratio of the SU exports to Bulgaria was observed.

2. Imports shares.

The decrease in the shares of imports from each country excluding the SU can be observed. Generally, the shares of imports from Bulgaria decreased after 1977 and from the other countries after 1973/1974 (excluding Hungary, see comments above).

After 1974, the upward trend in the SU imports shares was observed in all the countries. Considerable oscillations were recorded in the shares of imports from the other countries to the SU.

The data point out that especially after 1974 the increase of transactions between all the countries and the SU took place. This increase had a great impact on the downward trend in each country's exports/imports shares (it does not concern the SU). The downward trend in imports shares from some countries was already observed after 1974 despite the upward trend of total imports flows.

Machinery and equipment: CTN1.

Exports/imports totals. Mutual transactions show the upward trend. The exceptions are Poland and Rumania - their exports to the countries start to decrease (or oscillate) at the end of the seventies. The imports from the other countries (including the SU to Poland and Rumania) also collapsed.

1. Exports shares.
Similarly to other groups of commodities, the shares of exports from every country to a given country (excluding the SU) are not much different. The shares of exports to Bulgaria are characterized by a downward trend to Czechoslovakia by an upward trend after 1974, to Poland and the GDR - after 1976. The exports shares to Rumania and Hungary have considerable oscillations, especially for the years 1977/1978 - in the case of Rumania and, as it can be seen, for every commodity group between 1975 and 1976 - in Hungary.

The shares of exports to the SU show an upward trend. On the other hand, the shares of the SU exports to the other countries are differentiated among the countries and are rather unstable.

2. Import shares.
The shares of imports from a given country (excluding the SU) do not differ very much according to the receiver-country.

Shares of imports
- from Bulgaria - a clearly upward trend,
- from Czechoslovakia - oscillations are observed,
- from the GDR - a downward trend up to 1979, then an increase was observed,
- from Poland - an upward trend up to 1979, then a decrease,
- from Hungary and Rumania after oscillations between 1975/1976 and 1978/1979 respectively some stabilization is observed.

The shares of imports from the SU are differentiated among receiver-countries. Generally, however, the shares have a downward trend after 1976 with the stabilization (or a decrease - for Poland) in the last two considered years of the sample.

Industrial consumer goods - CTN9.

Exports/imports totals. Transactions within this group of commodities generally show an upward trend with collapses at the end of the seventies. Among others, collapses can be observed in the exports to the GDR, in the exports to and the imports from Poland, as well as a decrease of the supplies from the SU to Czachoslovakia in 1980.

Exports and imports shares. The shares of exports to Bulgaria have considerable oscillations - an increase up to 1974 then a decrease to 1978, and then an increase once again.

The shares of exports to Czechoslovakia and the GDR have a downward trend after 1974, while to Poland after 1977. The collapse for Hungary is observed in 1975. The relative increase of export transactions with the SU is observed after 1974. The shares of imports from Bulgaria and Poland show a downward trend after 1977/1978, unlike with Rumania and the GDR where a downward trend was observed up to 1975, and then an upward trend prevailed.

Such a change in the shares of imports from the SU was already observed since 1974.

Food and raw materials for food - CTN6+7+8.

Exports/imports totals. Unlike with the above analysed markets of goods, on this particular market considerable oscillations can be seen. They concern, first of all, Bulgaria - the main exporter in this group of commodities. Its shares of exports to Czechoslovakia and the GDR are characterized by an oscillating upward trend with the collapse in 1978/1979, the decrease of deliveries to Hungary is observed after 1976, and an upward trend in deliveries to the SU.

The exports of the other countries have the following trends

- the Polish exports collapsed after 1978,
- the generally increasing tendency for Bulgarian and Rumanian export is observed,
- the exports from Czechoslovakia and the GDR are more or less stable, a general upward trend with quite big oscillations is displayed by the SU exports to Czechoslovakia and Rumania.

1. Exports shares.

Generally downward trends are observed after 1978 excluding the shares of exports from the SU which increased in 1979 both for Poland and Rumania. The shares of exports to the SU increased after 1978. On the basis of the above mentioned remarks a general conclusion can be drawn: after 1978/1979 the relative exports in this group of commodities concern mainly the transactions between the SU and the group of the other countries. Within the group of other countries relative transactions decreased.

2. Imports shares.

The decrease in the shares of imports from Bulgaria to every country is observed after 1976. The same picture can be observed for imports from Czechoslovakia. Relative imports flows from Rumania show a rather upward trend. The shares of imports from other (including the SU) countries oscillated considerably, which especially concerned Poland and Czachoslovakia.

INDUSTRIAL USE OF INPUT-OUTPUT MODELS - AUSTRIAN EXPERIENCES

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1. INTRODUCTION

Detailed economic scenarios based on an input-output model of the INFORUM type have been used by Austrian entrepreneurs and managers since 1973. In quite a number of large-scale and medium-size enterprises such results are considered as a highly important background information for medium-term corporate planning. Most of the users of the present model AUSTRIA III are engaged in the manufacturing sector, especially in the production of semi-manufactured intermediate commodities. Other users come from the banking, the wholesale and the transportation sector. During the last 12 years about 60-70% of the firms in manufacturing (taking total output or employment as indicators) have made use of the model results to a certain extent. Based on the Austrian experience gained during this period, this paper will concentrate on three aspects, that have proved to be of high relevance for the industrial use of the input-output models results.

2. INSTITUTIONAL BACKGROUND

About 15 years ago the Federal Economic Chamber started to put resources into establishing a medium-term input-output model. The basic idea behind this decision was to create an instrument which might help decision makers to base their planning on a consistent and detailed overall economic framework.

This type of activity can be explained by the special role of the Chambers in Austria and the Chamber of Commerce in particular.

In most Western European countries, institutions like the Chamber of Commerce or the Chamber of Trade are rather loose voluntary associations. In Austria, the Economic Chamber, Chamber of Labour, Chamber of Agriculture, etc. are organisations under public law, which have been created by special acts of the parliament to serve the interests of certain groups of people. In spite of this specific legal basic, the Chambers are independent bodies with legally defined rights and obligations. Their main task is to promote the interests of their members.

In general, the Chambers play an important role in nearly all fields of the economic policy. A good example of the way in which Austria mediates and cooperates in settling economic problems, is through the Joint Commission for Wages and Prices. In this Commission the Economic Chamber represents the interests of entrepreneurs.

Another major task of the Economic Chamber is to provide help and advice to its members. Among the various services which are offered are promotion of foreign trade, arrangements for special exhibitions and international fairs and educational training. The Statistical Division of the Economic Chamber encourages firms to use the available statistical data and provides technical and methodological assistance.

The results of the Austrian input-output model play an important role among the "products" of the Statistical Division. On the average the equivalent of two to three man-years of work go into the development and re-estimation of the model annually.

The institutional background of the input-output modeling work has a number of advantages. As a semi-governmental organisation the Chamber has easy access to statistical data of all kinds and can even carry out its own statistical surveys. In the various sub-organisations, all kinds of engineering information are available which is essential in many respects. Last but not least, the special climate of confidence between members and their organisation facilitates the flow of information.

3. DISSEMINATION OF RESULTS

A manager who wants to use model results at least as a general background for some of his decisions should have a certain insight into the methods and assumptions on which these scenarios are based. Therefore much attention was and is paid to establishing a kind of common language among model builders and potential users. Results are not distributed in printed or xeroxed form but presented as working papers to the participants of "forecasting seminars". Such seminars are usually organised twice a year and cover introductions into the principles of national accounting, input-output analysis and the most relevant sources of information. Much time (usually one day) is devoted to the description and discussion of the characteristics of the underlying model, its possibilities and limits. A rather detailed documentation of the various assumptions is also made available. Managers who have already gained some experience in the use of input-output-based scenarios and who have already attended previous seminars are invited to special "advanced seminars". Seminars of the second type concentrate on new developments in the model structure and in the empirical basis and put more emphasis on the evaluation of certain assumptions. In order to underline the conditional character of all the simulations at least two alternative scenarios are presented at each seminar. In addition, participants are encouraged to ask for special runs under their own specific assumptions. Quite a number of enterprises have already made use of this opportunity.

The efforts to establish a common language between model builders and users has led to a number of important by-products. Users see the necessity to integrate exogenous information in many respects (for example in the field of future technological development, big investment decisions) and are, therefore, often willing to make this kind of data available. Users also check model results against their own planning figures and against long term contracts. The feedback to the model has probably helped significantly to improve the reliability of the model output.

The model structure, as it stands now, is also, to some extent, the result of the needs and preferences of the users. Because most of the users are primarily interested in results in constant prices, emphasis has been laid on modeling the real side of the economy. Since most of them are convinced or have been convicted that it is not the model builder's duty to make "plausible judgements" on forthcoming political decisions in Austria (for example concerning big investment in the nationalised part of the industry) or abroad (for example concerning the oil price or the political situation in the Middle East in 1995) they have agreed to accept alternative scenarios. According to this "philosophy behind" AUSTRIA III, it, therefore, can be considered as an open accounting framework to quantify the impacts of different sets of assumptions in a consistent way.

Another outcome of the close cooperation with the users of the model results is the priority given to flexibility, on the one hand, and to simple solutions, on the other hand. Many users have pointed out that one of the most attractive properties of the model for them lies in the absence of formulations that have no meaningful economic counterpart. Austria III is by no means a "black box model" and any user who is willing to spend a few hours of close examination can understand how the instrument operates.

4. INSUFFICIENT DISAGGREGATION

Input-output models, such as the ones of the INFORUM type, proved to be almost ideal instruments for many aspects of corporate planning. Regardless of the degree of sophistication and complexity of the model many users are - although fascinated by the analytical opportunities of such an instrument - not satisfied as far as disaggregation is concerned. Even the most detailed model always provides aggregates only. Therefore in many cases a bridge has to be built between the aggregates of the model and the specific products and markets.

The following paragraphs try - in the light of the Austrian experiences and examples - to outline some of the possibilities to overcome the problem of insufficient disaggregation.

4.1. Partial disaggregation

A well established technique is to add additional rows to the input-output table and to treat the demand for the commodities of the sub-sector like the demand for non-competitive imports. The term "partial disaggregation" indicates that such a procedure requires data on the use of the commodities of the sub-sector by the various industries and final demand categories, while the data on the specific input structures are not essential.

The basic assumption of such a partial disaggregation is that the share of the commodities treated separately is small. In this case one can hope, that the demand for the commodities within the sub-group is determined by all the other sectors, and that the sub-sector does not affect the other industries in a different way than the "rest of the sector".

In the simplest form the demand for the commodities in the "skirt" or "fringe" (see Almon, 1974) can be linked by fixed coefficients to total output of the receiving sectors. In order to ascertain a maximum degree of consistency, one should check whether the coefficients in the row of the "home sector" were subject to changes in the model. In this case analogous modifications have to be made for the linkage coefficients. This problem can be avoided by a direct link to specific matrix elements.

In Austria, there are a number of examples for the application of such partial disaggregation techniques. One example is the breakdown of an extremely inhomogenous sector such as the branch "Quarrying Stone Stone products", which produces typical intermediate products like sand and bricks as well as typical consumer items like golden decorated coffee cups made of porcelain. Other applications attempted to get more details about comparable homogenous groups of commodities. An example for the latter case is the steel industry, which distinguished more than 10 types of steel by linking the demand for these specific products to the elements of the row "Steel industry" by means of fixed coefficients.

4.2. More advanced linkage approaches

The reliability of the results of further disaggregation can easily be improved by adopting more advanced linkage methods than stable coefficients. On the basis of sufficient data "linkage equations" of all kinds of specification can be estimated to link the demand for a certain commodity to a matrix element or to total output of the receiving sector. A very illustrative example for the US is given in Almon (1974). Similar techniques have also been used to a large extent, to evaluate the impacts of economic activities on "non-commodities" such as the environment. The application of all sorts of linear and non-linear linkage approaches is only limited by the obvious trade-off between more details and the loss of consistency.

The Austrian model users have applied linkage techniques in a number of cases where time series on inputs were available for some of the industries from the annual survey in manufacturing. One of the big problems with this type of information is that the annual data are neither complete as regards the number of inputs nor complete as regards the number of receiving units.

Full and more consistent data are only available for a few years. The parameters of many of the linkage equations must, therefore, be interpreted very carefully. At least, they should be compatible with the technological assumptions in the model, which are quite often estimated on the basis of engineering information. The consistency checks carried out in connection with attempts to achieve a greater level of disaggregation proved to be an important source of information. For example "skirts" for the sector "Nonferrous metals" provided very useful material on probable changes in the product-mix of the sector, which in turn affects the input structure quite considerably.

Another major example for the application of a linkage approach was a study on the growth patterns of printing in Austria (Richter, 1977). At this stage of the model (AUSTRIA II), printing was included in a sector which also comprised paper products of all kinds like packing materials,office supplies, hygenic paper, and so on. The data situation was extremely poor and direct observations on the use of the services of printers were even lacking in the years for which 10 tables are available.

Therefore, the first step was to estimate linkage equations for the identifiable part of the aggregate (primarily packing materials) treating "printing" as a part of the remaining residual.

Starting from this upper limit of demand for printing services direct linkage equations were estimated on a more or less pure judgemental basis. In most cases excluding the old "main diagonal" a log linear relationship for the demand of printing services with the output of the various industries was assumed. A better empirical basis was available for the deliveries to final users. Foreign trade statistics provided detailed data on exports and imports, some material on private consumer expenditures was taken from national accounts, which was sufficiently reliable to estimate consumption functions. For the important category of public consumption, also including public expenditures for free school books, demographic projections on the number of pupils and exogenously given plans on future expenditures were integrated.

The emerging scenarios of development patterns of the printing industry were, thus, the results of a mixed approach combining all kinds of information and techniques. As everybody expected, the first simulations were obviously incompatible with the underlying base scenario of the input-output model. Most of the major inconsistencies were eliminated in an iterative procedure of reconciliation.

As many other linkage exercises the benefit for the model builder was at least as important as the benefits for those, who asked for the investigation.

4.3. Integration of quantity data, stepwise disaggregation

For many applications users would prefer quantities instead of forecasts in constant price volume terms. Such information is of special relevance for the transportation sector. The next few paragraphs give an example of the use of input-output model results as a starting point for quite enterprise-specific considerations.

The problem was raised by one of the leading forwarding agents in Austria who wanted to evaluate the overall risk of building a new terminal for incoming freight. The enterprise has a high market share as regards imported goods in general, but its role differs significantly by type of commodities and by transportation mode.

In the first step, import equations in quantity terms in(100 kilos) were estimated on the basis of time series and linked to the input-output model. The resulting import vector M was further disaggregated by modes of transportation by means of the matrix T.

$$TM^t = T^t \cdot \hat{M}^t$$

T is a "transportation mode coefficient matrix" of dimension t x n, the sum over t equals one for each of the commodity groups n. Highly reliable empirical material for calculating T was available from the Austrian foreign trade statistics. Since the mode of transportation is one of the characteristics in the basic material, special tabulations allowed to compile a time series of matrices consistent with the classification of the input-output model. Simple trends led to estimates for T for the forecasting period.

This still overall economic import demand by transportation modes TM^t was then transformed to an enterprise-specific estimate by applying a market share matrix MS^t. The elements of MS differ quite significantly both across the rows and across the colums and range between 0.7 and 0.0. Data for MS were taken from direct observations by the marketing department of the enterprise. The integration of this type of information was faciliated by the fact that much of the internal statistical material was already collected in input-output classification, because input-output model results had been used as background material for many years. Term-by-term multiplication of the estimated MS matrix for year t by TM^t finally resulted in an estimate in the enterprise-specific transportation volumes of imported goods by commodities and by transportation mode.

Within this framework a number of sensitivity studies were carried out to quantify the impacts of alternative assumptions. Besides the application of the formalised disaggregation and weighting scheme to different sets of overall economic assumptions (primarily different growth rates in different export markets) changes in the following parameters were analysed more carefully:

- an increase in the market shares of imported goods in domestic markets relative to the reference scenario,
- modofications in the transportation mode coefficients matrix in favour of

transportation modes for which the enterprise has a stronger position in the market,

- changes in the enterprise specific market share matrix.

These investigations led to the conclusion that a positive return to the planned investment can only be envisaged in the case of a combination of the most optimistic assumptions. Scenarios with one or two "moderate assumptions" would lead to an underutilization of the new capacity. Bacause of this high degree of vulnerability the decision was taken not to execute the project.

This conclusion was a little bit in contrast to the results of more aggregate investigations carried out prior to the analyses within an input-output framework. Based on an examination of the past trends of imports by groups of commodities and another one of trends in transportation modes, planners were quite optimistic about the chances of an economic success of the new investment.

However, the details of the transportation mode matrix indicated that many of the past increases concerned groups of commodities and transportation modes for which the enterprise was in a weak market position. The other and even more relevant contribution of the input-output model was the possibility to address issues like changes in Austria's competitive position in a consistent way. Another unexpected finding was the high degree of sensitivity of the import volumes of the most relevant commodities to changes in some of the export markets. The opportunity to assess even a part of the political risk of a decision was highly appreciated by the users and demonstrated the superiority of a detailed input-output framework over any aggregate approach for the needs of corporate planners.

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INDUSTRIAL MODELING WITH INPUT-OUTPUT. AN APPLICATION TO THE ITALIAN METAL MECHANICAL INDUSTRY

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Input-output is a form of industrial modeling. The traditional Leontief input-output format represents a way to link industrial outputs, the vector of sector output (X), with the vector of final demands disaggregated by sector (F) through the input-output inverse

$$X = (I - A)^{-1} F.$$

Modern techniques have integrated this system into the comprehensive macro model, and have given it a substantial degree of flexibility. This means that:

1. The input-output system has been fully integrated into the macro model. It represents links, the one between final demands and industrial activities, and the one between prices and costs in a larger system, which encompasses labor demand, investment, and price determination on the sectoral level. (Preston 1972).
2. Bridge equation mechanisms have been introduced to disaggregate final demands from the final purchaser classification appropriate in demand determination to the sector classification required in the input-output system.
3. Mechanisms have been introduced to update the input-output tables in recognition of relative prices and technological trends.
4. In principle, such approaches can also recognize the impact of industrial import and export flows; some of them do (Nyhus 1975) but the majority of the larger systems do not.

These approaches produce aggregate economic models with a consistent comprehensive view of the industrial system. These systems have at least a resemblance of flexibility. They are useful for national forecasting and simulation. We will question below whether they are sufficiently flexible to capture in a realistic fashion the underlying forces which influence competitiveness of inputs and technological development.

Once the concern narrows from national industrial structures to the level of particular industries and firms, the input-output information remains extremely useful, but lacks specificity as compared with other informational sources which are frequently available at the industry level. In particular, the assumptions of proportionality and fixity which are so important in providing a basis for the input-output coefficient data and which are

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Roberto Santarelli (Federmeccanica), Massimo Tivegna (Confindustria) and Carlo Bianchi (IBM, Italy), collaborated on this project.

necessary for the consistency of the aggregate solution, often produce information which lacks correspondence to what is observed at the industry level. Moreover, the specific industry may represent only a narrow share of one input-output sector and model linkages may only be available for broad sectoral categories. This calls for introduction of extraneous information for data disaggregation or additional linkage modeling.

1. THE ROLE OF INPUT-OUTPUT INDUSTRIAL MODELS

Input-output plays a multiple role in the industry model. In Figure 1, we show the conventional input-output matrix. In the horizontal direction the disposal identity-available product is allocated between indirect and final use. From the perspective of the industry, the horizontal axis looks different. It represents the market for the industry's product.

The vertical axis represents the production process, the inputs into production which are related to output. The production structure also influences the process of price formation as prices are formed as a markup over input costs.

Models of industries range widely in form and size[1]. Some are complex systems such as those used for optimal refinery scheduling or for disaggreated corporate planning. Others are simple but useful descriptive models for industrial forecasting and simulation. This article deserves the role of input-output in a simple econometric industrial model which can serve as a prototype for more detailed, though not necessarily much more complex, industrial modeling studies.

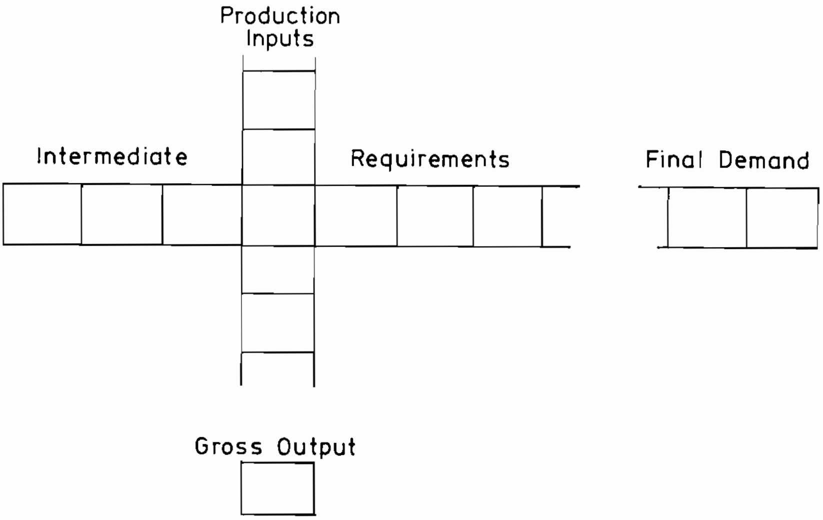

FIGURE 1. Vertical and horizontal identities of the input-output system.

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[1] For discussion of industry models see Adams (1973), Adams and others (1982), Naylor (ed.)(1979), Labys (1975), Klein (ed.)(1969, 1969b, 1971).

2. THE OBJECTIVE

The Italian Federation of Metal and Mechanical Industries (Federmeccanica) is a grouping of private manufacturing enterprises comprising firms in production of ferrous and non-ferrous metals, machinery, household durable goods, computers, etc. It encompasses a comprehensive but also heterogenous slice of Italian industry. In common with many other industrial federations, a primary concern of this organization is with sales, wages, prices, costs and employment. For example, wage negotiations call for recognition of the impact of higher wages on prices, demand, and employment. Public sector decisions with regard to the wage escalator mechanism and social charges must be evaluated in the light of their impact on costs, prices, and competitiveness. Exchange rates affect exports to foreign markets and imports from abroad. On the other hand, at this time the Federation did not place priority on detailed information on particular products (or their costs) which are comprised in the broad metal-mechanical products category. A prototype model could be used as a basis for other more detailed systems.

3. MODEL STRUCTURE

The structure of the model is shown graphically in Figure 2. The focus on explanation of the cost-price-employment interaction is clearly apparent.

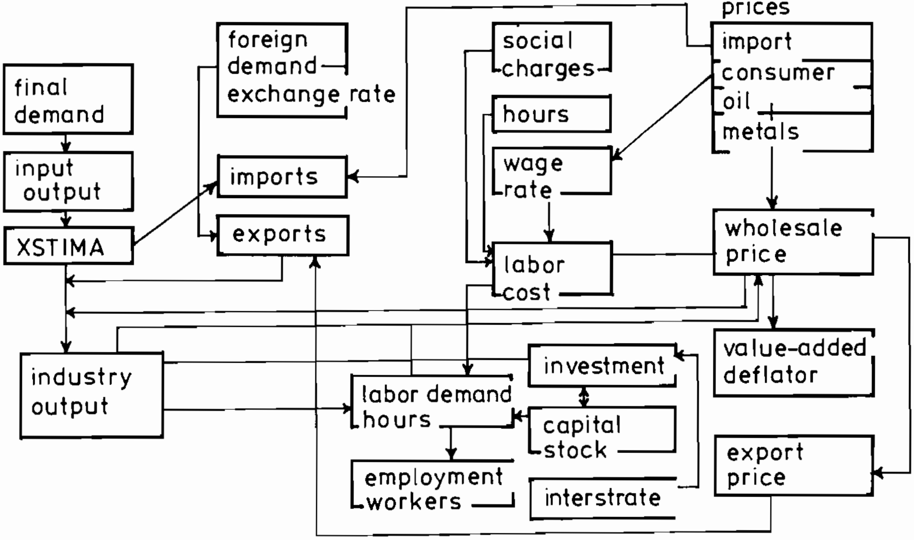

FIGURE 2. Schematic diagram of the model.

On the left side of the diagram the step from final demand to industry-specific demand is by way of an input-output translation. In the center is wage determination and the labor cost variable critical in price setting. On the right side of the diagram is the price mechanism which feeds back to the demand system on the left. The exogenous variables in the system are domestic economic activity and inflation, foreign demand, import prices and the exchange rate, statutory hours of work, social charges, and the wage escalator, and the prices of metals and petroleum. (The model is annual and there is no equation for inventory accumulation, so that demand is directly translated into production activity.)[2]

The equations are as follows:

3.1. Output

$$\text{XSTIMA} = (I - A)^{-1}\, H\, G \qquad (1)$$

where XSTIMA is a synthetic variable, a proxy for domestic demand, measuring the size of the market for metal-mechanical products assuming constant input coefficients and constant industrial composition of final demand. $(I - A)^{-1}$ is the inverse of the 1975 domestic requirements matrix. H is a bridge matrix, breaking down each final demand into its industrial composition in the base year (1975) and G is the vector of final demands. The approach is derived from export market analysis in international trade which begins with a constant market share estimate and modifies that on the basis of competitiveness. XSTIMA is the equivalent of such a constant market share final demand estimate of the sales of the metal-mechanical industries (Adams et al. 1976).

Such a computation makes heroic assumptions about the stability of various coefficients: input coefficients, import coefficients, and industrial proportions of final output and exports. Output (VAPMMX) is linked to XSTIMA by the term VAPXST (the ratio of input VAPMMX to XSTIMA) - the latter is explained by regression. The input-output based XSTIMA variable focuses only on domestic demand so that an adjustment for export deviation from trend (EXMX/EXX) is necessary. Additionally, the impact of price on demand and supply is taken into account with price as a shift factor in the relationship.

$$\text{VAPMMX} = \text{XSTIMA} * \text{VAPXST} \qquad (2a)$$

$$\begin{aligned}\text{VAPXST} = {} & \underset{(3.2368)}{-0.0446} * \text{PINGM} + \underset{(1.1082)}{86.5369} * \text{EXMX/EXX} \qquad (2b) \\ & + \underset{(3.2368)}{93.1757}\ (\text{EXMX/EXX-EXMX}\ [-1])/\text{EXX}\ [-1] + \underset{(4.0912)}{170.323}\end{aligned}$$

Sum Sq	332.841	Std Err	6.0813	LHS Mean	203.383
R Sq	0.7283	R Bar Sq	0.6377	F 3, 9	8.0398
D.W. (1)	2.8242	D.W. (2)	2.5852		

3.2. Exports and Imports

An approach to international trade could be through input-output procedures (Nyhus 1975). On the export side, the exports could be determined on the basis of imports into market countries, and on the import side, a fixed import coefficient could be assumed. In both cases, the fixity of the

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[2] Adams (1973) has argued that production scheduled directly in response to quantity demanded is a frequent characteristic of manufacturing industry behavior.

coefficients is likely to produce an unrealistic result since elasticities are likely to differ from unity and since price factors must be taken into account.

The export equation, nevertheless, relies on an approximation of the input-output approach by using imports in the market countries (MOE59X) as an independent variable. The impact of relative prices (PEXM/PEXW591) is also taken into account.

$$\text{EXMX} = \underset{(14.5035)}{28.5077} * \text{MOE59X} - \underset{(2.8738)}{4595.63} * \text{PEXM}[-1]/\text{PEXW591}[-1] + \underset{(2.8259)}{8511.83} \qquad (3)$$

Sum Sq	829969	Std Err	288.092	LHS Mean	6133.37
R Sq	0.9554	R Bar Sq	0.9465	F 2, 10	107.06
D.W. (1)	1.7015	D.W. (2)	2.1926		

With respect to imports, a traditional import function is used:

$$\text{MMX} = \underset{(8.5464)}{230.615} * \text{XSTIMA} + \underset{(4.1143)}{8802.77} * \text{PINGM}/\text{PMM} - \underset{(4.4020)}{12627.5} \qquad (4)$$

Sum Sq	949912	Std Err	293.863	LHS Mean	4220.92
R Sq	0.9123	R Bar Sq	0.8964	F 2, 11	57.232
D.W. (1)	1.8448	D.W. (2)	2.4559		

Imports are a function of domestic demand (XSTIMA) and of relative prices (PINGM/PMM). We note that an adjustment for import supply is already part of XSTIMA (domestic requirements) but an inconsistency may remain between MMX and the imports implicit in the input-output computation of XSTIMA.

3.3. Employment

The central employment variable (HTM) represents total hours of work input. A formal production function would have called for meaningful capital stock data. Alternatively labor input could have been derived from the input-output relationship, but this would have forced proportionality and immediate adjustment and would have left no impact for labor cost.

A regression relation has been used instead: employment is linked to production activity by means of a labor requirements function.

$$\text{HTM} = \text{VAPMMX} * \text{HTMVAP} \qquad (5)$$

$$\text{HTMVAP} = -\underset{(3.7176)}{142.143} * (\text{VAPMMX}/\text{VAPMMX}[-1]) - 1 - \underset{(5.7616)}{0.0191} * \text{KNM}[-1]/1000$$

$$- \underset{(6.1187)}{11.2254} * \text{RLDOMX}/\text{HAEFFM} * 1000000 + \underset{(42.4855)}{824.114}$$

Sum Sq	799.189	Std Err	8.9397	LHS Mean	386.762
R Sq	0.9835	R Bar Sq	0.9785	F 3, 10	198.23
D.W. (1)	1.0236	D.W. (2)	2.0997		

where
HTM is total hours of work input required; HTMVAP is hours of work input required per unit of output; KNM is capital stock.
RLDOMX/HAEFFM is wage rate per effective hours of work (annual basis).
Equation (5) serves, thus, to determine labor requirements per unit of output, the inverse of productivity. Negative relationships with respect to growth of output, wages, and with respect to capital stock are reasonable.

3.4. Wages and Labor Cost

A number of alternative possibilities exist for a wage equation, depending on the purpose of the model[3]. A primary objective in the present context is to evaluate the effect of wage escalation.

$$\%WOM = \underset{(7.8989)}{9.0266} * D737677 + \underset{(7.5058)}{0.7442} * \%PC + \underset{(2.9890)}{4.6447} \qquad (6)$$

Sum Sq	30.1148	Std Err	1.7354	LHS Mean	17.6929
R Sq	0.9242	R Bar Sq	0.9091	F 2, 10	60.997
D.W. (1)	2.5287	D.W. (2)	1.8041		

The adjustment of wage rate (%WOM) to consumer prices (%PC) is with an elasticity of 0.7, a result which is often obtained in studies of the Italian scala mobile mechanism. The dummy (D737677) catches years of major wage negotiations when wage increases are typically somewhat larger than at other times. The constant of the equation indicates an annual trend productivity improvement factor of 4.6 percent.

This equation serves well for sample period simulation and for short term forecasting. In many applications one may, however, specify the wage increase exogenously since an important use of the model will be to evaluate the impact of alternative wage bargains. A different approach, for cyclical analysis and for long term projection might be to explain real wages in terms of labor market pressures and productivity but efforts to estimate such a function on the basis of available data were not successful.

An important element in labor cost in Italy are social charges (OSM) which are determined exogenously and have undergone significant changes as a result of policy decisions. The rate of these charges (OSM) has been applied exogenously to the wage rate to get labor costs per employee (RLDOM).

$$RLDOM = WOM\ (1 + OSM) \qquad (7)$$

Hours of work are another important issue in Europe. Legislated hours (HSCONM) have impact on actual hours per worker (HAEFFM) and, in turn, affect the producer's real wage cost.

$$HAEFFM = \underset{(6.2354)}{63.3441} * HSCONM - \underset{(5.4301)}{12.8044} * TREND \qquad (8)$$

$$+ \underset{(2.9443)}{0.0407} * \left(VAPMMX - VAPMMX\ [-1]\right) + \underset{(4.9171)}{24318.1}$$

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[3] The typical macromodel combines Leontief input functions for materials with Cobb Douglas or CES production functions for labor and capital.

Sum Sq	6233.06	Std Err	24.9661	LHS Mean	1579.49
R Sq	0.9631	R Bar Sq	0.9520	F 3, 10	87.024
D.W. (1)	1.4425	D.W. (2)	2.2827		

Total employment in terms of number of workers (OTM) is then computed by identity

$$OTM = HTM/HAEFFM \qquad (9)$$

3.5. Investment and Capital Stock

Investment and capital stock are essential linkages in the system. Yet, as is typical of industrial and macroeconomic modeling investment is a variable which can be predicted with difficulty. The variability of investment and its dependence on the cost of capital or alternatively on cash flow, make it difficult to explain in terms of a fixed coefficient input-output model. The basis for our investment equation is the neoclassical model of investment based on user cost of capital and the accelerator.

$$\begin{aligned} ILM = \underset{(3.7872)}{0.5459} * ILM\,[-1] - \underset{(3.8751)}{0.1512} * KNM\,[-1] - \underset{(1.0784)}{37432.4} * TSUCKM \\ + \underset{(4.1271)}{237.607} * VAPMMX + \underset{(1.0994)}{331292} \qquad (10) \end{aligned}$$

Sum Sq	NC	Std Err	86367.6	LHS Mean	1199200
R Sq	0.8441	R Bar Sq	0.7749	F 4, 6	12.186
D.W. (1)	1.9438	D.W. (2)	2.2285		

Investment (ILM) is a function of user cost of capital (TSUCKM) a variable dominated by the real long term rate of interest, and output (VAPMMX). A gradual adjustment from existing capital stock (KNM) to desired capital stock is postulated.

The capital stock computation involves an allowance for depreciation (AM).

$$AM = \underset{(11.5612)}{0.7136} * AM\,[-1] + \underset{(3.8952)}{0.0263} * KNM - \underset{(0.6783)}{19321.8} \qquad (11)$$

Sum Sq	903979776	Std Err	9065.32	LHS Mean	847812
R Sq	0.9969	R Bar Sq	0.9963	F 2, 11	1766.2
D.W. (1)	1.1474	D.W. (2)	2.2231		

Capital stock is then simply calculated by identity:

$$KNM = KNM\,[-1] + ILM - AM \qquad (12)$$

3.6. Prices

Three prices are considered endogenously in the model, the wholesale price index, the value added deflator, and the export price index. The wholesale price (PINGM) is the relevant price when considering the industry's competitiveness and the demand for its products. The value added deflator (VAPMM) is the appropriate measure to value production activity net of inputs of materials. The export price index (PEXM) is determined by cost conditions and serves to determine competitiveness in foreign markets.

A cost markup approach is used to explain the PINGM, central price in the model. The weights of the inputs going into this price determination mechanism might have been explained in terms of input-output coefficients. An alternate approach used here is to rely on a regression relationship to determine the appropriate weights.

$$\begin{aligned} \%PINGM = {} & \underset{(3.2011)}{0.1609} * PCH(PMETM) + \underset{(5.5640)}{0.0763} * PCH(POILM) \\ & - \underset{(1.7290)}{0.4355} * PCH(VAPMMX/HTM) + \underset{(2.467)}{0.4677} * \%RLDOM + \underset{(0.7770)}{2.3941} \end{aligned} \qquad (13)$$

```
Sum Sq   39.6469      Std Err     2.2262      LHS Mean   13.5848
R Sq      0.9494      R Bar Sq    0.9241      F 4, 8     37.549
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A percent change in wholesale price of metal mechanical products (%PINGM) is linked to wages and social charges (RLDOM) with an elasticity of approximately 0.5. There is an impact of metal prices (PMETM) and energy prices (POILM) approximately in line with their share of the value of total output. A productivity factor (VAPMMX/HTM) contributes negatively to price with an elasticity -0.4.

The value added deflator (VAPMM) is related primarily to the wholesale price index. In addition, there are impacts on VAPMM from productivity (VAPMMX/HTM) and from labor cost per hour (RLDOM/HAEFFM).

%DVAPMM
Annual data for 13 periods from 1971 to 1983
Date: 13 Aug, 1985

$$\begin{aligned} \%DVAPMM = {} & \underset{(4.2344)}{0.0035} * PCH(PINGM) + \underset{(4.9437)}{0.0069} * PCH(RLDOM/HAEFFM) \\ & - \underset{(2.6130)}{0.0040} * PCH(VAPMMX/HTM) - \underset{(0.6888)}{0.0185} \end{aligned} \qquad (14)$$

```
Sum Sq    0.0040      Std Err     0.0210      LHS Mean    0.1475
R Sq      0.8806      R Bar Sq    0.8409      F 3, 9     22.134
D.W. (1)  1.9945      D.W. (2)    1.9934
```

The export price (PEXM) is entirely explained on the basis of the wholesale index (PINGM) and import price (PMM).

$$PEXM = \underset{(3.0314)}{0.3704} * PEXM[-1] + \underset{(0.1665)}{0.0415} * PINGM + \underset{(3.4897)}{0.6568} * PMM - \underset{(0.6891)}{5.6112} \qquad (15)$$

```
Sum Sq   842.958      Std Err     9.1813      LHS Mean   291.051
R Sq       0.9980     R Bar Sq    0.9975      F 3, 10     1696.8
D.W. (1)   1.3840     D.W. (2)    1.9088
```

The feedbacks of the system are from wages to employment and from wages to prices and product sales[4].

---

[4] The identities necessary to complete the system involve only translation between rates of change and first differences and principal levels of some of the variables.

4. SAMPLE PERIOD SOLUTION RESULTS AND MULTIPLIERS

The performance of the model in sample period simulation is quite satisfactory.

Sample period performance of the model is summarized in Table 1 and Figure 3. Mean absolute percentage error (MAPE) ranges from variable to variable. The figures show that the model catches cyclical swings, though a substantial error remains in the employment (OTM) estimate as a result of a too strong labor cost response.

TABLE 1 Sample period performance of the metal mechanical industry model (solution period 1971-1983).

Variable	Mean absolute percentage error (%)
Real Value Added (VAPMMX)	2.2
Wholesale Price (PINGM)	2.1
Employment (HTM)	3.5
Exports (EXMX)	4.5
Imports (MMX)	6.2
Investment (ILM)	4.4

A variety of multipliers reflecting the potential applications of the model were computed and are summarized in Table 2. The multipliers in Table 2 are for continued disturbance from year 1 to year 5.

The multiplier calculations are shown here:

a. A 10 percent increase in demand. In this case, as anticipated, output expands closely with demand. There is some improvement in productivity and consequently some reduction in price. The capacity constraint is not effective. Employment increases, but less rapidly than the expansion of output and there is a substantial increase in imports. Investment responds sharply.

b. A 1 percent increase in the rate of inflation. The principal impact of inflation is on the wage cost and, consequently, on wholesale price. Output is slightly reduced and there is a small reduction in employment. Imports increase somewhat and exports show a small decline.

c. A 10 percent increase in import prices. The increase in import prices results in significant, though relatively small increase in the wholesale price. A sharp reduction in exports (though partially offset with a reduction in imports) results in a moderate reduction in production activity.

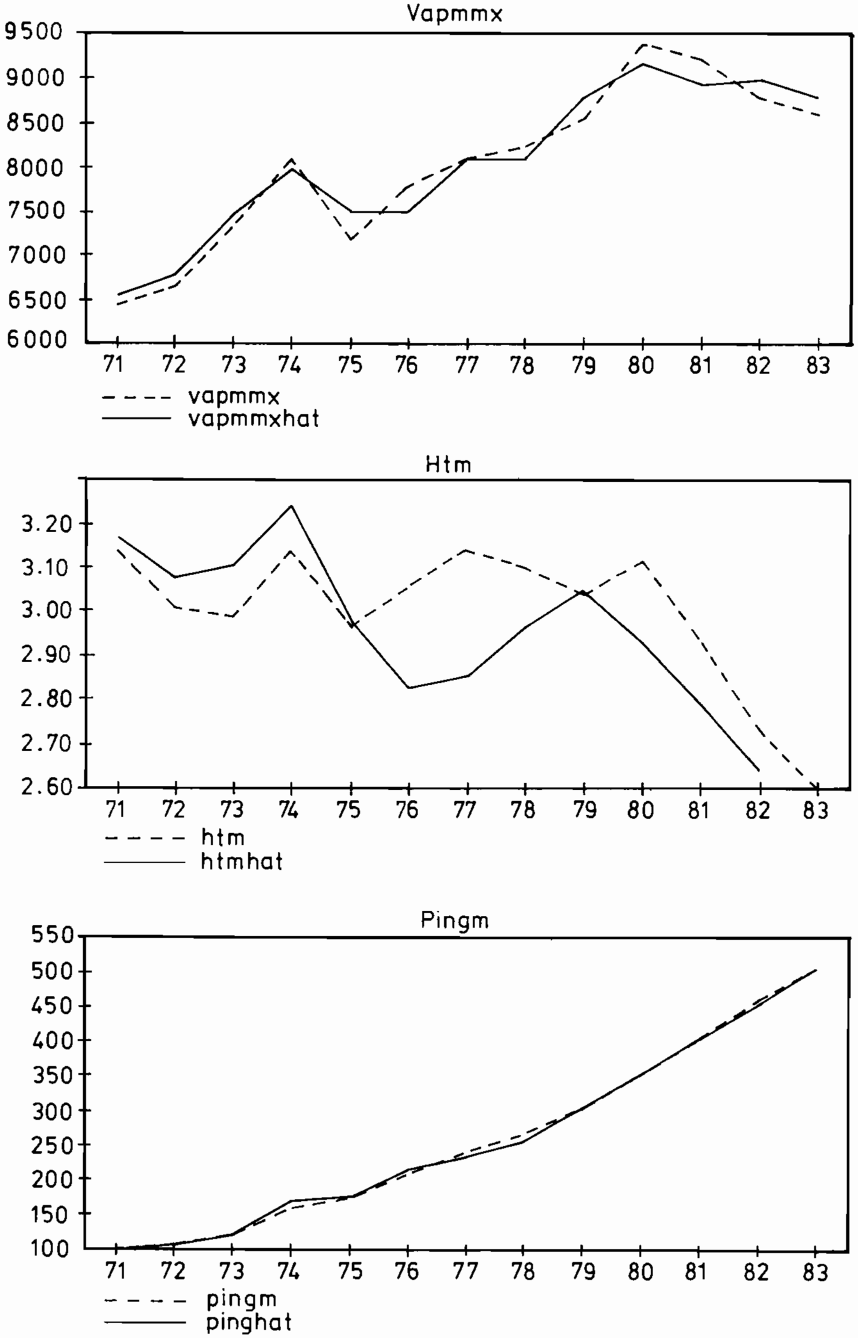

FIGURE 3. Sample period simulations.

TABLE 2 Multiplier effects in metal mechanical industry model (effects as % of baseline simulation).

	1	2	3	5
10% Increase in Demand (XSTIMA * 1.1)				
VAPMMX	10.03	10.06	10.03	10.13
PINGM	-1.30	-.35	-.90	-2.15
HTM	6.83	9.19	7.17	4.33
MMX	18.01	18.66	17.49	16.72
ILM	6.83	9.19	7.71	4.33
1% More Rapid Inflation (% PC + 1.0)				
VAPMMX	-0.01	-0.02	-0.04	-0.07
PINGM	0.30	0.60	0.83	1.31
HTM	-0.08	-0.18	-0.34	-0.63
EXMX	0.00	-0.02	-0.05	-0.08
MMX	0.82	1.41	1.77	3.02
ILM	-0.01	-0.03	-0.06	-0.13
PEXM	0.01	0.03	0.04	0.07
Increase in Import Prices (POILM, PMM, PMEM, * 1.1)				
VAPMMX	-0.05	-5.59	-4.64	-3.10
PINGM	2.23	3.04	2.37	3.02
HTM	0.16	-3.70	-4.27	-1.10
EXMX	0	-12.43	-15.78	-13.59
MMX	-18.97	-14,79	-15,01	-14.69
ILM	-0.06	-6.81	-8.39	-5.27
PEXM	6.63	9.02	9.82	10.02

On the whole, the multiplier simulations produce a reasonable picture of response, even though further refinement of the model structure may eliminate some remaining anomalies.

5. COMMENTS ON THE ROLE OF INPUT-OUTPUT IN INDUSTRIAL MODELING

The metal mechanical industries model demonstrates a relatively modest, though central application for input-output. In this section we comment on the potentials and limitations of input-output based modeling on the industrial level. Much depends, of course, on the purpose of the model, its time perspective, its degree of detail, the specific input-output application, etc.

Focusing first on demand side applications, the input-output approach for linking a specific sector to the national economy has considerable value, as demonstrated in the XSTIMA variable above. It provides a structured way to link national and sectoral performance. On the other hand, we noted the need to recognize price impacts, trends, and the role of the foreign sector (when that has not been fully integrated into the input-output system). More important perhaps is to recognize that coefficient shifts due to technological and commercial change drastically affect the results. The narrower the product category, the greater appears to be the risk of shifts in demand as a result of technological changes, foreign competition, or price[5].

The approach must thus be used with caution and even if procedures to allow for gradual shifts in the coefficients are incorporated in the analysis, the possibility of technological changes suggests the need to keep a watchful eye on prospective developments which cannot be captured by the input-output system itself or by technological trends.

Turning now to the input side of the input-output approach, it can serve effectively to determine inputs of materials and supplies (and in some cases labor) and to provide a framework for a cost markup pricing mechanism. Again the problem of coefficient shifts must be recognized. To some extent, models of coefficient adjustment on the basis of prices or of technological trends can be incorporated. Engineering information can be taken into account. In this case where the modeler is focusing on developments in one industry and in its sources of supply, significant changes in the production process which substitute one type of input for another or which greatly change the quantities of inputs required into a particular process can be predicted and adjusted for.

Finally, with respect to industrial modeling in general, the considerable advantages of input-output techniques must not obscure their substantial limitations. The growing recognition to the Schumpeterian view of industrial development and its role in economic development undermines the input-output assumption insofar as coefficients are assumed fixed and indeed exogenous. To deal with policy simulation questions (Adams 1985) it is necessary to consider what influences the structure of production and how that structure is determined by policy and other economic forces.

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[5] The author has encountered a number of such problems. For example, disaggregation of the seven industries making up the metal mechanical sector showed that some of these sectors could not be well explained with an XSTIMA type variable. Similarly in a study of the demand for office products, while the technique was effective for many categories, it simply did not have explanatory power in others. It is not surprising for example. that the demand for computers is not well explained with such an approach.

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SUPPLY RIGIDITIES IN INPUT-OUTPUT MODELING OF THE WOOD AND PAPER INDUSTRY DEVELOPMENT

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1. INTRODUCTION

A historical analysis of the development of the USSR wood and paper industry was undertaken in order to reflect some specific features of the distribution of resources in the structure of the IIASA global model for the forest sector.

Despite the high speed of substitution of wood products by other materials, the wood and paper industry is and will be an important one in the balance of materials used by the USSR economy.

An analysis of structural changes within and outside the wood and paper industry is a subject of the paper. Results of it may help to build an industrial submodel where technological parameters play an important role, expressing production of various end products (paper, panels, etc.) in terms of roundwood. Characteristics of the wood and paper industry are expressed here mainly in physical terms but can be converted to 1972 prices.

The data provided by various yearbooks have been compared against "engineering" data taken from numerous studies to analyze some important characteristics of the industry development in recent decades. Attention was paid to problems of efficient utilization of low-quality timber and by-products of different processes.

2. A MODEL OVERVIEW

The structure of the model is partly determined by the necessity to include it as a part of Global Trade Model designed by IIASA's Forestry project and by the availability of data required to get a comprehensive analysis of the wood and paper industry development in the last two decades. Technological transformations of the timber resources look very simple (Figure 1) and it seems possible to run the model from either the supply or the demand sides. Taking into account the variety of end users of wood and paper products and the uncertainty in their demands for specific products, we concentrated on those products whose end use is rather narrowly oriented. However, it seems that by analyzing demand for wood products by few activities one may cover the bulk of timber demand.

Our first efforts have been put into bridging the gap between qualitative structure of the resource development industrial roundwood, fuelwood with end-use structure in terms of paper, panels, plywood and sawnwood.

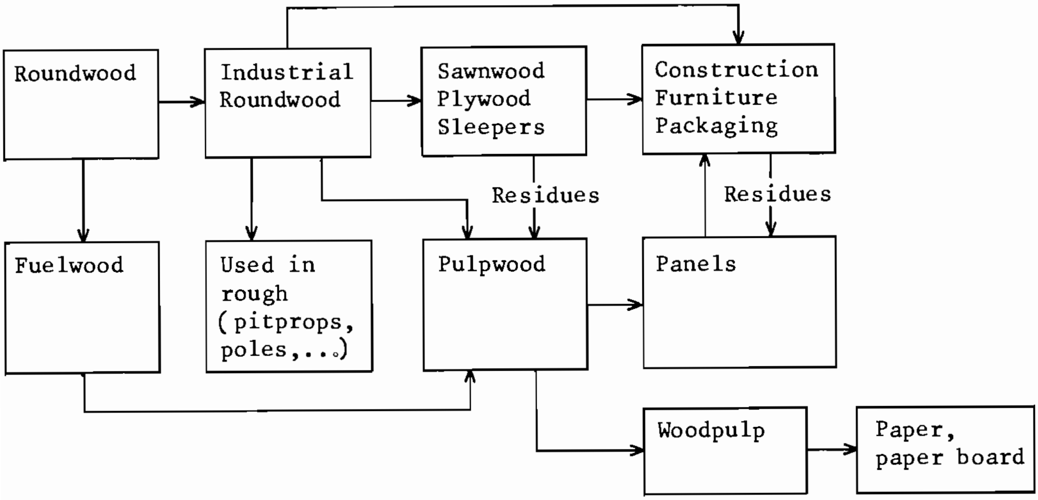

FIGURE 1 Flowchart of the timber products transactions.

From the very beginning, it was clear that technological processes (or intraindustry relationships) can be expressed by engineering input coefficients or "conversion factors" in very wide intervals if roundwood use by other industries is not determined. Therefore, the number of end-use industries has been extended to cover needs of transportation (sleepers), coal mining (pitprops), electricity and communications (poles).

According to the goal of the model development and the chart of technological transformations (Figure 1), we must consider at least four different sets of parameters. On the supply side it is necessary to analyze the qualitative structure of roundwood logged, for example, shares of fuelwood and industrial roundwood, shares of sawlogs, veneer logs, and pulpwood etc., which reflect the availability of resources and their change over time. A second set of parameters will refer to the scale of possible utilization of residues and fuelwood for technological purposes. The third set of parameters gives us an understanding of the input coefficients, i.e. how efficient was (and will be) the utilization of different types of timber by every process of the resource transformation until its end use. And the last set of parameters determines the scale of demand for wood products by different branches of the economy.

In a simplified algebra it is expressed as an input-output model where a_{ij} may be positive to reflect the use of product i in the j-th process (or in the end-use industry) or negative to determine the scale of byproduct (residues) produced by the j-th process (end-use industry). For example, if i-sawlogs and j-sawnwood, then a_{ij} might be 1.62 but for k-th input (particles) a_{kj} might be in the range of -.12 and the k-th product is used in panel production (say r-th process) with a_{kr} equal to 2.

The information represented in a Soviet input-output table is of great importance to get a first overview of industries' requirements for timber products, with some limitations on the wood and paper industry itself. Exports and imports performance is not considered in detail but is used only to make sure that apparent consumption figures are consistent with domestic requirements defined in terms of end-using industries. However, we refer to exports to emphasize some rigidities in the production of different kinds of timber products in the late 1970's and the developments in the secondary resource utilization.

3. SUPPLY SIDE: QUALITATIVE STRUCTURE

In the last two decades, one may observe a U-turn in the volume of roundwood, which is also obvious for industrial roundwood despite the fact that the share of fuelwood has decreased (Table 1). At the same time much more fuelwood is used for technological purposes and, therefore, might be classified as industrial roundwood. Technology developments proved to be efficient to involve low quality timber and residues in the production of panels and pulp. Some estimates show that in the foreseeable future roundwood resources cannot exceed 437 mln m^3 and the utilization of chips may reach 60-70 mln m^3 and those from the logging can be higher than 15 mln m^3. It gives the upper limits on the supply side when the lower limits are represented by the years 1979-1983 with total roundwood production figures at the level of the early sixties.

Under the observed constraints on the supply side in the late 1970's in terms of industrial roundwood (strictly round), exports of logs have declined after a lengthy period of continuous growth from 9.4 mln m^3 in 1978 to 6.2 mln m^3 in 1982 (sawlogs) and from 6.6 mln m^3 in 1977 to 5.4 mln m^3 in 1982 (pulpwood). The bulk of exports of roundwood goes to Japan (about 6 mln m^3) and Finland (2.7 mln m^3) while sawnwood export destination is much more dispersed across the CMEA and Western countries. The qualitative structure of the resources seems to be unchanged over time (Table 2). Thus, the observed decrease in the fuelwood volume (in 20 mln m^3) and in its share(from 29% to 22%) was not a result of the supply structure, i.e. the decrease of the share of low-quality timber classified as fuelwood is misleading, but rather it was a response of the industry to relatively modest growth of timber logging in 1960-1975 and its decline in the late 1970's - more and more fuelwood was used for technological purposes when about 28% of timber was classified (by quality) in the 1960's as fuelwood; if we add to this figure pulpwood of the IV grade quality, then the share of low-quality timber is almost 30% and it has increased (not decreased) in the last decade (compare 7th and 3rd lines in Table 2)[1].

	1960	1965	1970	1975	1978	1980
Share of pulpwood IV grade and fuelwood used for technology purposes in low quality resources	.02	.10	.24	.31	.27	.27

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[1] In total, exports of roundwood and sawnwood also show a U-turn:

Exports (mln m^3)	1960	1965	1970	1975	1980	1982
Roundwood	4.4	11.1	15.3	16.9	13.9	13.2
Sawnwood	5.0	8.0	8.0	7.8	7.2	7.2

One may consider causes of this export behavior from the demand for timber products in the world market but for us it is important to observe that this factor does not reverse the decline in absolute figures of the resources for domestic use in the last years. Thus, more than a quarter of low quality timber classified partly as "fuelwood" is now used for technological purposes.

TABLE 1 Roundwood production and industrial roundwood resources (mln m^3).

	1960	1965	1970	1975	1980
Roundwood	369.5	378.9	385.0	395.1	356.6
of which					
Industrial roundwood	263.1	282.7	298.7	312.0	277.7
of which					
fuelwood used for technological purposes	1.6	8.9	17.7	29.0	20.0[a]
strictly roundwood	261.5	273.8	281.0	183.9	257.0
Chips used for technological purposes	n.a.	8.6	13.5	21.0	26.5
of which from logging	0	0	.1	1.6	4.2

[a] Estimate based on 1977-1978 data.

These data show also that the supply of high quality roundwood has decreased substantially in the 1970's from 272 to 248.6 mln m^3 and the utilization of residues became an efficient and necessary technological step (not due to the goodwill of the users of residues or the producers of pulpwood products)[2].

TABLE 2 Qualitative structure of the timber resources.

	1960	1965	1970	1975	1978	1980
1. Roundwood production (mln m^3)	369.5	378.9	385.0	395.1	361.8	356.6
2. Fuelwood (mln m^3)	106.4	96.2	86.5	83.2	77.9	78.9
3. Share of fuelwood (2:1)	.29	.25	.22	.21	.22	.22
4. Fuelwood, total, including used for tech. purposes (mln m^3)	108.0	105.1	104.2	111.2	97.6	[98.9][a]
5. Share of fuelwood, total (4:1)	.29	.28	.27	.28	.27	[.28][a]
6. Fuelwood and pulpwood IV grade (mln m^3)	108.0	106.5	113.2	120.7	107.1	108.0
7. Share of low quality timber (6:1)	.29	.28	.29	.30	.30	.30

[a] Estimate based on 1977-1978 data.

Changes on the supply side were reflected in the production of sawnwood and sleepers when demand for wood sleepers was diminished by the production of concrete sleepers:

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[2] The use of residues for panel production increased from 1. mln m^3 in 1965 to 6.5 mln m^3 in 1980.

Production	1960	1965	1970	1975	1980	1982	1983
Sawnwood, mln m^3	105.6	111.0	116.4	116.2	98.2	97.5	97.0
Sleepers, mln units	56.6	46.9	40.9	41.4	34.9	34.3	36.6

Using reasonable conversion factor multipliers (0.19 for sleepers and 1.6 for sawnwood) and deducting pitprops and poles (where high quality roundwood is used) one gets a significant reduction of the domestic resources for other purposes and since as production of exported sawnwood requires higher (than domestic) inputs of sawlogs, what is left for domestic use in terms of high quality roundwood seems to be quite limited in the last years under the observed drop in 20 mln m^3 (4th row in Table 3).

Direct and indirect use of logs for exports is estimated in the range of 10% of high quality timber under the assumption of 1.7 m^3 of sawlog input per 1 m^3 of exported sawnwood when the peak of 12% was reached in 1978 (3rd row in Table 3).

TABLE 3 Resources and exports of high quality roundwood.

		1960	1965	1970	1975
1. Total exports in terms of roundwood	12.9	24.7	28.0	30.2	26.0
2. Industrial roundwood of high quality	261.5	272.0	271.8	274.4	248.6
3. Share of export requirements in total resources of high quality roundwood	.049	.091	.106	.110	.105
4. Domestic resources of high quality roundwood	248.6	247.7	243.8	244.2	222.6

The rigidities on the supply side are reflected also in a significant reduction of the use of unprocessed timber in construction when in 1970-1980 it "roughly halved". It is also observed that in 1970-1975 for the first time shipments of roundwood to construction decreased by 13% after a continuous growth until 1970 and at the same time consumption of sawnwood in this industry decreased slightly[3]. Therefore, the above mentioned decrease in the domestic use of high quality roundwood in the 1970's already began in the late 1960's.

All these facts on the supply side make it clear that significant changes on the end-use side might occur especially for industries using timber in rough and sawnwood. Some changes, for example, in the use of timber in transportation (sleepers), communications (poles), mining (pitprops), can be mainly treated as an impact of technological progress.

We conclude that the share of high quality timber (defined as sawlogs and veneer logs) does not exceed 40-45% when other types of roundwood may belong to one class or another with high uncertainty (Table 4). Comparability of these data is marginal in absolute terms when one source of data covers some regions or only the Ministry (Minlesbumprom), figures are found for the economy as a whole, or only for enterprises included in the plan.

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[3] Some authors state that in 1976-1980 use of unprocessed timber in construction decreased twofold.

TABLE 4 Qualitative structure of timber resources in volumes (mln m^3) and in percentage, in total roundwood.

	Sources			
	FAO	Yarmola (Planned volumes)	Yarmola (Industry as a total)	Moiseev (Ministry)
Total Roundwood	3851	347.8	404.1	306.8
in %	100	100	100	100
of which				
fuelwood	86.6	70.6	93.6	52.6
	22.5	20.3	23.2	28.9
Industrial roundwood	298.5	277.2	310.5	254.0
	77.5	79.7	76.8	82.8
of which sawlogs and veneer logs	167	140.1	173.8	139.0
	43.3	40.3	43.0	45.3
Pulpwood	33.0	26.5	26.5	22.0
	8.6	7.6	6.6	7.2
Piprops	13.6	18.0	18.0	16.0
Roundwood	3.5	5.2	4.5	5.2
for construction	86.5	75.4	94.8	76.8
and other	22.5	21.6	23.4	25.0

4. DEMAND SIDE: ROUNDWOOD IN ROUGH AND INTRAINDUSTRY DEMAND

A comprehensive picture of the technological use of roundwood is given by the 1972 input-output survey. These data compared against data in physical terms show us that despite the fact that the bulk of industrial roundwood is used within the wood and paper industry, about half of the timber in rough is dispersed between other branches and among them construction, transportation, and mining must be considered carefully while the rest of the industries can be aggregated to "other" industry (Table 5).

Unfortunately input-output data don't permit disaggregation of further inputs for specific products; the only way is to work out inputs in physical terms compiling data from various publications.

The same can be done for woodworking industry which covers sawnwood, plywood and panel production. Since in 1970 plywood and panels production in value terms was not big enough, it is possible to compare input-output data with the structure reported by other sources. Again, prices do not change very much the general picture of the end use of wood products as it clear from Table 6.

Some differences in figures in Table 6 between input-output and other sources are due to plywood and panel distribution, which is very different from the sawnwood (1/3 of plywood, 1/4 of fiberboard, and 3/4 of particleboard are now used in furniture production, corresponding figures for 1970 are 1/3, 2/3 and 2/5). A quarter of sawnwood is used within the industry for further processing. What is remarkable is that about a third of sawnwood is delivered for construction needs.

TABLE 5 Distribution of timber in rough by industries[a].

Industry	Sources 1972, I/O Value bln rubles	 output share (in %)		 1970, Yarmola volume mln m^3 (in %)	 output share
Metals	.055	1.0		8.4	3.1
Machinery	.077	1.7			
Energy, fuels	.281	5.0		22.7	8.4
Chemistry	.007	.1		.7	.2
Logging	.210	3.3	3.3		
Sawmilling	2.970	46.8	30.5		
Furniture	.057	.9	143.3	53.1	
Pulp and Paper	.571	9.0			
Others and chem.	.376	4.3			
Building mater.	.052	.8			
Textiles	.057	.9		4.7	1.7
Food and bever.	.023	.3			
Construction	.599	9.4		24.2	9.0
Agriculture, forestry	.181	2.9		11.0	4.1
Transportation	.05	0.9		2.5	1.0
Industry output	6.341	100%		269.0	100%

[a] The distribution of industrial roundwood between industries in Table 5 is given in consumer prices for the year 1972 in mln rubles (shares are shown in percentage of the logging industry output) as well as 1970 data in physical terms for a limited number of enterprises, covered by planning offices.

TABLE 6 Distribution of processed wood products by industries.

	Codes	Sources 1972 I/O $x_{48.j}$	 output share	 Glotov (1977) output share	 Yarmola (1972) (only for sawnwood) volume	 output share
Metals	1-4	.112	1.2		5.0	6.1
Machinery	12-36	.704	7.2	4.4		
Energy, fuels	5-11	.104	1.1		2.5	3.1
Chemistry	37-46	.122	1.3		.14	.2
Logging and sawmills	47-48	1.371	14.1			
Furniture	49	.665	6.8	5.0	19.9	24.5
Pulp, paper and other wood products	50-52	.400	4.1			
Building mat.	53-60	.207	2.1			
Textiles	61-68	.609	6.3		1.4	1.8
Food	69-78					
Construction	79	3.770	38.7	36.7	29.0	35.7
Agriculture, forestry	80,81	.278	2.9		1.9	2.4
Total output		9.744	100	100%	81.2	100%

After the above very general overview of the specificity of the timber use in the Soviet economy in the 1970's, we may consider product by product demands for timber to make conclusions on the possible structural changes of the wood and paper industry under given rigidities in timber resources, and on the use of its products which are partly perfect substitutes of one another. By doing it we will deduct step by step those products' requirements for roundwood, which make much more clear the necessity for a structural change within the industry, that took place in the late 1970's.

4.1. Sleepers

Sleeper production declined from 56.6 mln units in 1960 to 36.6 mln units in 1983, i.e. by 1.5 times[4]. Some substitution by concrete sleepers took place at the end of the 1960's and at the beginning of the 1970's, when there was a significant growth in railway, at the same time there was an increase in exports of sleepers. Production of sleepers due to historical reasons is located in logging enterprises, which partly explains low use of residues. (Average efficiency is very low, (i.e. 50-55%), 2.3-2.35 m^3 of roundwood is used for 1 m^3 of sleepers).

Thus, we may estimate the demand for roundwood for sleepers in the last decade in order of 10 mln m^3 [5].

Under this condition the extrapolation in the range of 10 to 8 mln m^3 of logs for sleeper production seems to be reasonable, especially if we take into account steady growth in the length of railways (they are increasing by 3-4 thousand km in five years with a total length of up to 1550 thousand km) and the substitution factors and only 70% of sleepers is used in transportation while 24% have been used in construction. Most probably a significant decrease in wood sleeper production was not a result of rigidities on the supply side, but came from substitution by concrete sleepers (at least until 1975 when exports of sleepers increased twofold) since the ratio of both wood and concrete sleepers to railway length was very stable over 1960-1975.

4.2. Poles

Production is estimated in the range of 4.1 mln m^3 for 1960 and 5.6 for 1970, and 3.9 mln m^3 for 1975. A significant reduction between 1965 and 1975 was due to substitution by concrete poles:

	1960	1965	1970	1975
Production of concrete poles (mln m^3)	.35	.81	1.36	1.54

Continuation of both trends gives us a figure of about 3 mln m^3 of high quality roundwood used for poles.

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[4] The production figure for the last years is estimated from these data in the range of 40 mln pieces.

[5] 10.6 mln m^3 is used for 47.2 mln sleepers and some other products.

4.3. Plywood

Industrial roundwood used for production of plywood is estimated now in the range of 7 mln m^3:

	1960	1965	1970	1975	1980
Veneer logs mln m^3	4.1	5.8	6.5	7.0	7.5

Roundwood used for veneer sheets can't be separated, but it makes the "technological parameter" too high when dividing input per plywood only - bigger than reported by different sources.

4.4. Pitprops

Demand for pitprops is determined by mining activities (mostly underground mining, especially coal). It was a significant part of timber use in the 1960's but in the last decade its production went down:

	1960	1965	1970	1975	1980
Production pitprops (mln m^3)	24.6	22.7	18.0	n.a.	
of which for coal	17.0	n.a.	15.0	13.0	n.a.
FAO estimate on pitprops production (mln m^3)	n.a.	20.7	13.6	12.0	10.7

The substitution by concrete and metal parts plays (as many authors state) an important role[6]. Their production grew significantly fast in the late 1960's but it is still negligible compared with timber pitprops:

	1960	1965	1970	1975
Production of concrete pitprops and panels for mining(mln m^3)	.18	.31	.49	.62

Summing up the two types of pitprops and dividing them by coal production figures mined underground, one gets a steady decline both in the production of pitprops and input coefficients:

	1960	1965	1970	1975	1980
1. Timber pitprops per coal, (m^3/ton)	.043	.037	.033	.027	.022
2. Total pitprops per coal, (m^3/ton)	.060	.051	.039	.035	.028

After estimation of requirements for high quality roundwood delivered to other branches of economy: poles, pitprops, sleepers and plywood (Table 7), we concentrate on the problems of sawnwood and the use of chips and residues inside wood, pulp and paper industry on the basis of data from Table 6.

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[6] Exports play a role in the calculation of domestic resources when they increased to 1.5 mln m^3 in 1965 and went down to 0.6 mln m^3 in 1980.

TABLE 7 Timber resources for different end-users.

	1960	1965	1970	1975	1980
Domestic resources of high-quality roundwood	248.6	247.7	143.8	244.2	222.6
Sleepers	12.4	12.0	11.0	12.0	10.0
Poles	4.1	5.0	5.0	4.0	3.0
Plywood	4.1	5.8	6.5	7.0	7.5
Pitprops	23.8	19.2	12.8	11.2	10.1
Total resources for further processing	204.2	205.7	208.5	210.0	192.0

The only significant decrease in the resources of high quality roundwood (Table 7) is observed in 1975-1980 which means that the demand-supply relationship was forced by the technological progress on the end-use side, and supply rigidities should not be overestimated when in 1960-1975 resources of high quality roundwood were almost constant. These figures in general correspond to the sawnwood apparent consumption figures.

	1960	1965	1970	1975	1980
Apparent consumption of sawnwood (mln m^3)	100.6	103.3	108.7	108.7	91.4

It seems that the ratio between two figures is sensible - it is close to some values observed for the USA and Canada but there are other than sawmills users of high quality roundwood which are considered below:

	1960	1965	1970	1975	1980
Resources of high quality per m^3 sawnwood - (technical coefficient)	2.03	2.0	1.92	1.93	2.10

4.5. Pulp

Resources for pulp production pulpwood consist of roundwood, chips and particles. There was recorded a fast increase in the use of chips and particles produced from residues or low quality roundwood. Data reported in Table 8 show radical changes in the structure of pulp, which is important when analyzing demand for inputs. They are different for mechanical and semi chemical pulp in two cases: 5 m^3 per ton of chemical pulp, 4.0 for semichemical and 2.6 for mechanical pulpwood in terms of roundwood. Share of mechanical woodpulp dropped from 30% in the 1960's to 20% in the 1980's.

TABLE 8 Pulp production in the USSR.

Production, mln tons	1963	1965	1980	1975	1975	1980
Total woodpulp	n.a.	3.907	4.252	6.679	8.545	8.88
of which						
a) mechanical	n.a.	1.150	1.286	1.569	1.770	1.71
b) semi-chemical	n.a.		.166	.163	.290	.3
c) chemical		2.538	2.546	4.404	5.725	5.94
d) dissolving		.220	.254	.542	.76	.75
Fiberpulp			.196	.275	.330	.335

Assuming that the share of semi-chemical woodpulp is negligible in terms of difference in input requirements one gets almost threefold growth in the demand for raw materials in pulp production:

	1960	1965	1970	1975	1980
Demand estimate (mln m^3)	14.0	18.8	29.6	39.0	40.6

Adding about 1.5 - 2.5 mln m^3 needed for other fiberpulp we come to 43 mln m^3 in 1980. With exception for 1980, data, in general, are consistent with resources' estimates and we may use conversion parameters in the analysis and in forecasting "average" technologies.

Technical details on inputs structure (Table 9) show clearly the demand for high quality timber (pulpwood) is still strong enough despite the fast increase in the use of residues, fuelwood and IV grade pulpwood: it was 13.5 mln m^3 in 1960 and about 10 mln m^3 in the 1970's. Another observation is that 75% of the fuelwood used for technological purposes goes to pulp production.

TABLE 9 Input structure for pulp production.

Inputs im mln m^3	1960	1965	1970	1975	1980
Total resources	14.7	20.2	33.0	42.7	44.7
of which					
residues[a]	0.2	.8	3.4	8.2	9.7
fuelwood[a]	1.0	5.2	10.4	17.4	12.0
Roundwood	13.5	14.2	19.2	17.1	23.0
of which					
pulpwood of IV grade	0.0	1.4	9.0	9.5	9.1

[a] Residues and fuelwood are converted to timber with a factor 0.7.

4.6. Panels

It is stated in various sources that panels must be produced only from residues, so that their production cannot be determined by the resource (roundwood itself) structure. However, analysis (Table 10) shows that a big part of chips is still produced from low quality roundwood (possibly fuelwood) which is a factor diminishing the industrial roundwood resources for other purposes and increasing the demand for logging.

TABLE 10 Input structure in panels production.

	1965	1970	1975	1980
Residues used (mln m^3)[7]				
for particleboard	.73	1.1	1.73	2.59
for fiberboard	.83	1.31	2.15	1.63
Total converted to roundwood		1.1	1.7	2.72
Production of				
particleboard	.8	2.0	4.0	5.45
fiberboard	130	208	409	477
Requirements for timber (estimate)	2.45	4.96	9.85	12.6
Rest od demand covered by (low-quality) roundwood	1.36	3.2	7.1	9.7

Thus, we can observe a strong growth in the demand for (low quality) roundwood in panels production which is not still substituted by chips production from residues in the range of 10 mln m^3, which can be a significant factor to increase use of residues under the continuous strong growth in panels production.

It is clear that a twofold increase in the production of fiberboards (222 mln m^2 in 1970 and 469 mln m^2 in 1980) and particle board (2.0 mln m^3 and 5.1 mln m^3, respectively) made a significant change in input structure for furniture production when sawnwood and plywood production did not increase.

4.7. Paper and Paperboard Production

Demand for raw materials in the late 1960's and early 1970's was oriented on pulp when the share of recycled materials was rather low. This structure is presented below in percentage:

Woodpulp chemical	-	58%
Woodpulp mechanical	-	22.5%
Recycled paper	-	16%
Textiles recycled	-	3.5%

These average values have been applied to the time series on paper and paperboard production, and summing derived "demand" with exports minus imports we found rather a small discrepancy between these values and production of both kinds of woodpulp over the years. Thus, on the average, these shares can be used for the analysis, taking into account in a forecast a possible increase of the use of recycled materials diminishing demand for pulp.

Demand for wood products in construction has also changed but the use of roundwood and sawnwood is still very big:

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[7] At the same time, exports of residues increased from almost zero in the 1960's to 0.5 mln m^3 in 1980.

	1960	1965	1970	1975
Sawnwood (mln m^3)	22.4	24.0	27.2	25.0
Roundwood (mln m^3)	13.1	13.9	12.1	n.a.
Fiberboard (mln m^2)	6.5	23.0	44.1	98.2

These trends have accelerated in the late 1970's, which led to a significant reduction in use of sawnwood and roundwood. In total construction it is still the biggest end-user of timber, but the input of timber per output of industry is decreasing by almost 50% over 5 years.

A minor part of timber is sold to households and its volume is declining in the last decade, for example 1.7 mln m^3 roundwood, 1.8 sawnwood in 1980.

Engineering paremeters (or conversion factors) on sawnwood production are rather confusing: they vary from 1.41 to 1.66, i.e. to produce 1 m^3 of sawnwood we need to use 1.41 - 1.66 m^3 of industrial roundwood (sawlogs).

One source states the sawnwood output for different kinds of sawlogs is in the range of 61.2%. Maximum efficiency is reported for South-West region when for the biggest producer - North-West - its value is only 57%, i.e. on the average 1 m^3 of sawnwood requires 1.62 m^3 of sawlogs. Another one gives a better efficiency for 1970 - 69.992 mln m^3 of sawlogs is used to produce 45 mln m^3 of sawnwood (i.e. input coefficient is 1.55), but it must be considered as planned figures, while the third one shows that the level of 45 mln m^3 of sawnwood actually reached by the Ministry only in 1975 required more than 70 mln m^3 of sawlogs. The technological pessimism - sawnwood production requires about 1.5 m^3 of sawlogs for 1 m^3 od sawnwood is better justified than an optimistic value of -1.4 which might be a good one for the early 60's and only for specialized enterprises[8].

These technological paremeters are essential ones when we consider production of sawnwood for 1970 as 81.2 mln m^3 from the resources in the range of 130 and to produce 100 mln m^3 of sawnwood required resources in the range of 165 mln m^3, which is more than 50% of industrial roundwood.

A comprehensive survey emphasizes the need for careful analysis of conversion factors: "Conversion factors ... may vary considerably with the quality of the raw material, methods and efficiency of processing, desired size and quality of the product and other operational, economic and technical exigences... The coefficients established at the national level are, therefore, average and apply to a given period..." Taking into account supply and demand definitions discrepancy, one must recognize difficulties in the bridging of the gap between end-users' demand expressed in terms of round and processed wood and technological supply-oriented structure of roundwood being logged.

Thus, the analysis of supply and demand structure proved to be useful to introduce a set of parameters into a model as well as to impose lower and upper limits on production and consumption levels.

A set of domestic prices being used in the 1960's and at the beginning of the 1970's was estimated by regression techniques with the help of data on the value of the total end product (sawnwood, plywood, particleboard, fiberboard, paper and paperboard) produced per 1000 m^3 in different countries and different regions of the USSR.

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[8] It is clear that step by step estimation of the resources used for sawnwood gives a reasonable result instead of low efficiency observed before.

Some consumer prices, at least in rough, can be estimated from the 1972 input-output table, for example, pitprops - 23 rubles per m^3 as well as pulpwood (round and particles) for paper production - 16.5 rubles per m^3 and for total roundwood - between 16.5 and 17.8 rubles.

The difference between producer and consumer prices was twofold for paper and paperboard and applying technical coefficients for roundwood processed into sawnwood 1.62, one gets producer price for industrial roundwood 12.4 rubles per m^3.

These prices derived from foreign trade statistics for 1971 and 1972 show that foreign trade prices correspond to consumer prices for intermediate products of the industry and they are two to three times lower for finished products.

TABLE 11 Comparison of price estimates.

	Producer prices	Consumer prices	Foreign trade prices
Sawnwood	20	n.a.	40
Plywood	152	n.a.	125
Particleboard	160	n.a.	46
Fiberboard	0.5	n.a.	0.2
Paper	280	580	136
Paperboard	204	416	125
Pitprops	n.a.	23	16
Pulpwood	n.a.	16.5	12
Sawlogs	12.5	17.8	19.2

An analysis of technological parameters and prices makes it clear that "norms" used in the planning in general are reflected in consumer prices imposing some severe constraints on those end-users which can't prove the efficient use of new products and these demands can be satisfied by roundwood instead of panels, paperboard, etc. It shows also that price changes over time must take into account supply-demand relationships at the global and industrial level.

It is also important that the above considered supply-demand relationships prove that the necessary inputs for panels and paper are not very limited, but the "minor" demands as sleepers, poles, packaging, construction for high quality timber under a quite stable qualitative structure of roundwood make modest forecasts for sawnwood.

THE INPUT-OUTPUT MODEL OF THE GDR FOREST SECTOR

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1. INTRODUCTION

The primary purpose of this paper is to present the input-output model of the GDR forest sector[1] which contains the wood utilization. In order to connect this model with the long-range reproduction of forest resources, on the one hand, and with the long-range development of the national economy as a whole on the other, the input-output model is included in a model system. The description of this model system is the starting point of this paper. Then the structure of the input-output model of the forest sector shall be described, and the use of this model in industrial planning will be discussed. It must be mentioned that non-wood products and ecological benefits will not be referred to in this paper, but need to be kept in mind whenever assessing the importance of forest for mankind.

2. THE MODEL SYSTEM FOR PLANNING THE FOREST SECTOR

The forestry and the forest industry are interacting with each other and are interrelated with the national economy. The interactions between the forestry and the forest industry occur via roundwood consumption. Both subsystems also interact with the general economy. This latter subsystem determines the supply of capital, labour, energy, and other required resources. Domestic consumption, export demand and import supply are also determined by the national economy subsystem.

The corresponding model system consists of three separate models:
a) the model which reflects the development of forest resources,
b) the model which describes wood utilization (input-output model),
c) the model of the national economy.

The model of the development of forest resources which was worked out by Kurth and Lucas (1980, 1984) reflects the development of annual growth, annual cut, and the annual accumulation per hectare in the period of one

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[1] According to the view of Andersson et al. (1984) the forest sector comprises two major components: forestry and forest industry. The forest sector concept includes all aspects connected with forests and their exploitation, i.e. activities ranging from timber growth to use of end products. Ecological, environmental, and socio-economic factors are included in this definition.

production cycle of 100 years[2]. In the focus of attention are the so-called "intensification measures" which may lead to an increasing organic production per hectare and time unit. Such intensification measures are the raising of the fertility of soil (e.g. through the use of fertilizer) and the raising of productivity of stands (e.g. through optimization of tree structure). The influence of such intensification measures on the annual growth per hectare was estimated under the consideration of the possible lowering of organic production at the expense of social functions rendered by the forest and unavoidable risks. Different developments of annual accumulation and annual cut, which are the dependent variables, are simulated under the condition of achieving the desirable forest stock (approximately 230 m^3 per hectare), on the one hand, and covering the domestic wood demand, on the other.

The input-output model concerns the main lines of the flow of wood within the national reproduction process, beginning with the raw wood production and ending with the production of final products such as furniture. This model will be described in detail in chapter 3.

The model of the national economy which was worked out by Knop (1983) is a simulation model. This model, in which the national economy is considered as one sector, is used to estimate several variants of economic growth. These variants

- reflect different scenarios of given socio-economic goals and efficiency respectively,
- are consistent with regard to macroeconomic proportions,
- provide the needed input data for the input-output model of the national economy as a whole.

These different variants are evaluated with the help of indicators of efficiency. In the second step this model is linked with the input-output model of the national economy as well as other detailed models (e.g. simulation model to planning R&D). As in this model system the distribution of the disposable primary resources to the different social activities, i.e. to the different productive and non-productive sectors of the economy, is the main concern, the input-output model as well as the model of the forest resources have to be linked with this model system.

3. THE INPUT-OUTPUT MODEL OF THE FOREST SECTOR

3.1. The structure of the input-output model

The input-output model concerns the main lines of the flow of wood within the national reproduction process. The disaggregated model has 69 sectors, the aggregated model has 14 sectors Table 1 .

Each sector is characterized by a set of technological coefficients a_{ij} indicating the amount of commodity i that is required to produce one unit of commodity j.

$$A = \left[a_{ij} \right] = \left[\frac{X_{ij}}{X_j} \right] \qquad i,j = 1,2,\ldots,n$$

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[2] The time horizon of 100 years was chosen because within this space of time the forest will be reproduced completely, provided that the average cycle of cultivation amounted to 100 years. Therefore, the influence of the so-called "intensification measures" on the organic production within the whole production cycle can be simulated.

TABLE 1 Product classification in the input-output model

	I-O-T 69x69	I-O-T 14x14
Raw wood	11	1
Sawn wood	4	1
Chemical pulp	1	1
Mechanical pulp	1	1
Fibreboards	1	1
Particleboards	2	1
Veneer	1	1
Furniture	19	1
Wood-based packages	4	1
Construction	5	2
Papers and board	2	1
Musical instruments play things Sport kits/cultural articles	4	1
Other wood-based final products	14	1

where X_j is the gross product of commodity j and X_{ij} is the required input. Forming the static balance requirement we get

$$x = Ax + y$$

where $x = \left[X_j \right]$ and $y = \left[Y_i \right]$ is the final demand of the forest sector which is defined according to final demands of

a) individual consumer,
b) government,
c) investment,
d) net export demand,
e) demand for intermediate products for such industries which are not included in the product classification of the input-output model.

Below the matrix of intermediate products, a matrix M reflects the input and output of wood residues and waste paper respectively. One row represents the input and output coefficients of wood residues. Each element is denoted by $(m_{rj} - m_{sj})$ where

$m_{rj} = \frac{M_{rj}}{X_j}$ represents the output of wood residues per unit gross product of commodity j and

$m_{sj} = \frac{M_{sj}}{X_j}$ represents the input of wood residues per unit gross product of commodity j.

A positive number implies the (net-) output of wood residues; a negative number implies the (net-) input of wood residues.
In another row, the coefficients of waste paper input

$$m_{tj} = \frac{M_{tj}}{X_j} ,$$

where M_{tj} is the waste paper input in the production of commodity are included.
The matrix M has the following structure:

$$M = \begin{bmatrix} m_{r1} - m_{s1}, \ldots, m_{rn} - m_{sn} \\ m_{t1} \qquad , \ldots, m_{tn} \end{bmatrix}$$

Below the matrix M[3] the matrix B can added which reflects the input of labour in the production of commodity j. Each element of this matrix is denoted by

$$b_{qj} = \frac{B_{qj}}{X_j} \qquad q = 1,2,\dots,z$$

where B_{qj} is the input of labour of a certain qualification group q in the production process j.
In the matrix G the capital intensities can be reflected. Each element of the matrix is characterized by

$$g_{lj} = \frac{G_{lj}}{X_j} \qquad l = 1,2,\dots,k$$

where G_{lj} is the input of capital stock of the kind l in the production process j.
The matrix Q contains the input coefficients of other natural resources e.g. energy and water. Each element is denoted by

$$q_{gj} = \frac{Q_{gj}}{X_j} \qquad g = 1,2,\dots,d$$

where Q_{gj} is the input of the resource g in the production process of the commodity j.
The solution can be computed as:

$$\begin{bmatrix} x \\ m \\ b \\ g \\ q \end{bmatrix} = \begin{bmatrix} & I - A^{-1} \\ M & I - A^{-1} \\ B & I - A^{-1} \\ G & I - A^{-1} \\ Q & I - A^{-1} \end{bmatrix} \cdot y$$

where

$b = \left[B_q\right]_{zx1}$	vector of labour forces,
$B = \left[b_{qj}\right]_{zxn}$	matrix of coefficients of labour input,
$g = \left[G_l\right]_{kx1}$	vector of capital stock,
$G = \left[g_{lj}\right]_{kxn}$	matrix of coefficients of fixed capital input of the kind l in the production process j,
$q = \left[Q_g\right]_{dx1}$	vector of other reguired resources,
$Q = \left[q_{gj}\right]_{dxn}$	matrix of coefficients of the input of the resources g in the production process j,
$m = \begin{bmatrix} M_r - M_s \\ M_t \end{bmatrix}$	vector of the utilization of wood residues and waste paper respectively.

The input-output model of the forest sector is compatible with an input-output model for the national economy as a whole, because all products which are included in the aggregated input-output model of the forest sector

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[3] In the first version of the input-output model the matrices B,G, and Q could not be worked out as a result of insufficient availability of data.

are contained in the input-output model for the national economy in the same aggregation.

Before the use of the input-output model in industrial planning is discussed, some analytical results, which can be obtained on the basis of the input-output analysis, shall be emphasized. Table 2 contains some of the corresponding indicators.

1. Estimation of the degree of the utilization of wood residues. In the matrix M one row represents the input and output of wood residues. The sum of the differences between the inputs and outputs of wood residues

$$\sum_{j=1}^{n} \left(M_{rj} - M_{sj} \right)$$

indicates the degree of a closed cycle of wood utilization. Hence, this is an indicator of the pollution of the environment, on the one hand, and of the utilization of one kind of secondary raw materials for the production sector, on the other.

2. The degree of wood finishing can be given. This is the reciprocal number of the coefficients of the total expenditure of wood. The coefficients indicate the amount of commodity j that is produced per unit of wood used, which can be expressed in physical as well as in value terms. Hence, an indicator of efficiency of wood utilization is given. It must be mentioned that this indicator is useful only when wood is the basic material in production of the commodity j because, otherwise, the increasing substitution of wood by other raw materials pretends to be a higher finishing of wood.

3. The stability analysis of the coefficients of direct expenditure, which was made on the basis of the input-output model for 1980, illustriates - in a certain sense - the bottlenecks of the system. Such a "bottleneck" is for example the input of veneer per unit of furniture production. The results of the stability analysis corroborated the practical experience of decision makers.

4. Estimation of the amount of wood consumption in wood equivalent terms. It means that the net import of intermediate wood products and final wood-based products, which are converted into raw wood with the help of coefficients of direct expenditure, are added to the domestic consumption of raw wood. This indicator is often used for international comparisons, especially the coefficient of wood consumption in wood equivalent terms per unit of the GNP. The wood consumption in wood equivalent terms can be estimated in two manners: on the one hand, without consideration of wood residues, on the other hand, with wood residues. The latter kind ich characterized by several partial counts of wood. The wood consumption in wood equivalent terms without consideration of wood residues can be estimated in the following:

$$\bar{R} + a\,w^{I} - a\,w^{E} = \bar{\bar{R}}.$$

The wood consumption in wood equivalent terms with consideration of wood residues[4] can be calculated as follows:

$$\bar{R} + a\,w^{I} + h\,(I-A)^{-1} w^{I} + h\,x + H^{I} - a\,w^{E} - h\,(I-A)^{-1} w^{E} - H^{E} = \bar{\bar{R}}.$$

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[4] In this model equation the waste paper consumption can be considered if waste paper is converted into raw wood terms.

TABLE 2 The allocation of wood and intermediate products in the GDR in 1980.

Distribution of raw wood Consumption[a] of raw wood = 100%	Distribution of intermediate products = 100%			Consumption of intermediate products			
	Furniture	Wood-based package	Paper and boards	Doors/ windows/ roofings	Construction	Musical instruments etc.[b]	Other final products[c]
31.8% Sawn wood	9.4	18.6		12.7	8.5	3.2	47.6
2.2% Fibreboard	36.3	3.2		36.2		1.8	22.5
10.9% Particleboard	86.6					3.2	10.2
24.1% Chemical pulp			69.6				30.4
4.6% Mechanical pulp			100.0				0
0.8% Veneer[d]	96.1			2.4		1.5	0
25.6% Others							
Wood-consumption in wood equivalent terms %							
- without wood-residues	14.8	7.1	20.0	5.8	3.6	1.6	47.1
- with wood-residues[e]	13.5	5.2	32.0	4.9	2.7	1.3	40.4
Degree of finishing of wood (Mark/Mark)	11.7	2.2	3.6	4.1		21.0	

[a] Consumption = Production + Import - Export.

[b] Play things, sport kits, cultural articles.

[c] Not for playwood.

[d] Inclusive of remedy.

[e] With waste paper.

The designations mean:

$a = \left[a_j\right]_{1xn}$	vector of coefficients of total expenditure of raw wood,
$w^I = \left[W_i^I\right]_{nx1}$	vector of imports,
$w^E = \left[W_i^E\right]_{nx1}$	vector of exports,
$h = \left[h_j\right]_{1xn}$	vector of coefficients of direct expenditure of wood residues to produce one unit of commodity j,
$\bar{R}$	raw wood production,
$\bar{\bar{R}}$	raw wood consumption in wood equivalent terms without wood residues ,
$\bar{\bar{\bar{R}}}$	raw wood consumption in wood equivalent terms with wood residues ,
H^I	import of wood residues,
H^E	export of wood residues,
$x = \left[X_i\right]_{nx1}$	vector of gross product.

3.2. The use of the input-output model of the forest sector in industrial planning

In the central planning, the detailed input-output model of the forest sector with 69 sectors can be used in the short-term planning (i.e. planning horizon of one year) and in the medium-term planning (i.e. planning horizon of five years), whereas the aggregated model can be used in long-range planning. The application of the detailed model in the short-term and medium-term planning is proposed.

Test calculations which were made in the Cenral Planning Bureau showed that the disaggregated model is a powerful tool to estimate effective proportion between production and final demand[5]. Thereby, on the basis of model runs, made by the Central Planning Bureau, clues to the allocation of production tasks and available resources to production entities (i.e. enterprises) can be obtained. It must be mentioned that due to the aggregations in product classification the direct attaching of production tasks to production entities is often impossible so that complementary methods must be used (Brautzsch 1984). With regard to the use of the input-output model

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[5] It must be considered that the very long production time, i.e. the growth period of trees, determines that the level as well as the structure of raw wood production (e.g. the tree species structure, the structure of wood assortments) are relatively strongly fixed for a long time. One could speak of an inertia in reaction of forest to structural changes in wood demand. With regard to the input-output model of the forest sector and the considered model system, in the short-term and medium-term planning the feedback of raw wood demand, which is estimated on the basis of the input-output model, to the raw wood production in forestry is hardly possible. The advantage of this model system may consist rather in long-term planning because then the reaction of wood demand to wood production and the necessary resource allocation labour, capital, other resources can be simulated.

in the long-range planning I intend to point to some special features of the time behaviour of the technological coefficients. One has to consider that production technologies in the primary wood processing industry[6] are to a large extent based on old and well-known principles. Therefore, the technology is international, and productivity is largely connected with the age and size of the production plant. The normal life-span of machinery is several decades (Andersson et. al. 1984). Hence, from the technological point of view, one can observe the relative stability of technological coefficients in their time behaviour (Figure 1). Besides, the life cycle of primary forest products is long. Product innovations appear on the market very rarely[7]. Innovations have usually only meant improvements in existing products (Andersson et. al. 1984).

Consumption of primary forest products results almost entirely from input needs in the secondary wood-processing industry[8]. In these industries wood competes with other raw materials, and different wood-based materials compete with one another. The alternatives differ in technological as well as in economical items. The latter especially refer to costs of production of materials as well as to cost of using them and the cost of maintenance (Grossmann and Lönnstedt 1983). Besides, competitive substituts will not necessarily be materials. For example, information can be provided on paper as well as on via telematics on a screen. People need the service or the function, not a special kind, how this function is fulfilled. Thus, people need the information, not the paper, and they prefer the most convenient way to fulfill this function (Grossmann and Lönnstedt 1983). The competition of wood products with other raw materials as well as the functional replacement of wood products appear mainly in technological coefficients. In general, on the macroeconomic level a clear trend of these substitution processes can be observed (Figure 1) whereas on the micro-economic level the corresponding technological coefficients have been developed - as detailed analysis showed - abruptly. However, on the macro-economic level the clear trend of the technological coefficients of the primary as well as secondary wood-processing industry can be forecasted on the basis of such time series analysis. As extensive experience showed the appraisal of these coefficients by experts on the basis of time series is the most efficient way.

These features of the time behaviour of the technological coefficients seem to facilitate the application of the input-output model in the long-range planning. But on the other hand, the long-range estimation of the demand of wood-based final products is very difficult. In the GDR these investigations are still at the initial stage. Here is much room for future investigations.

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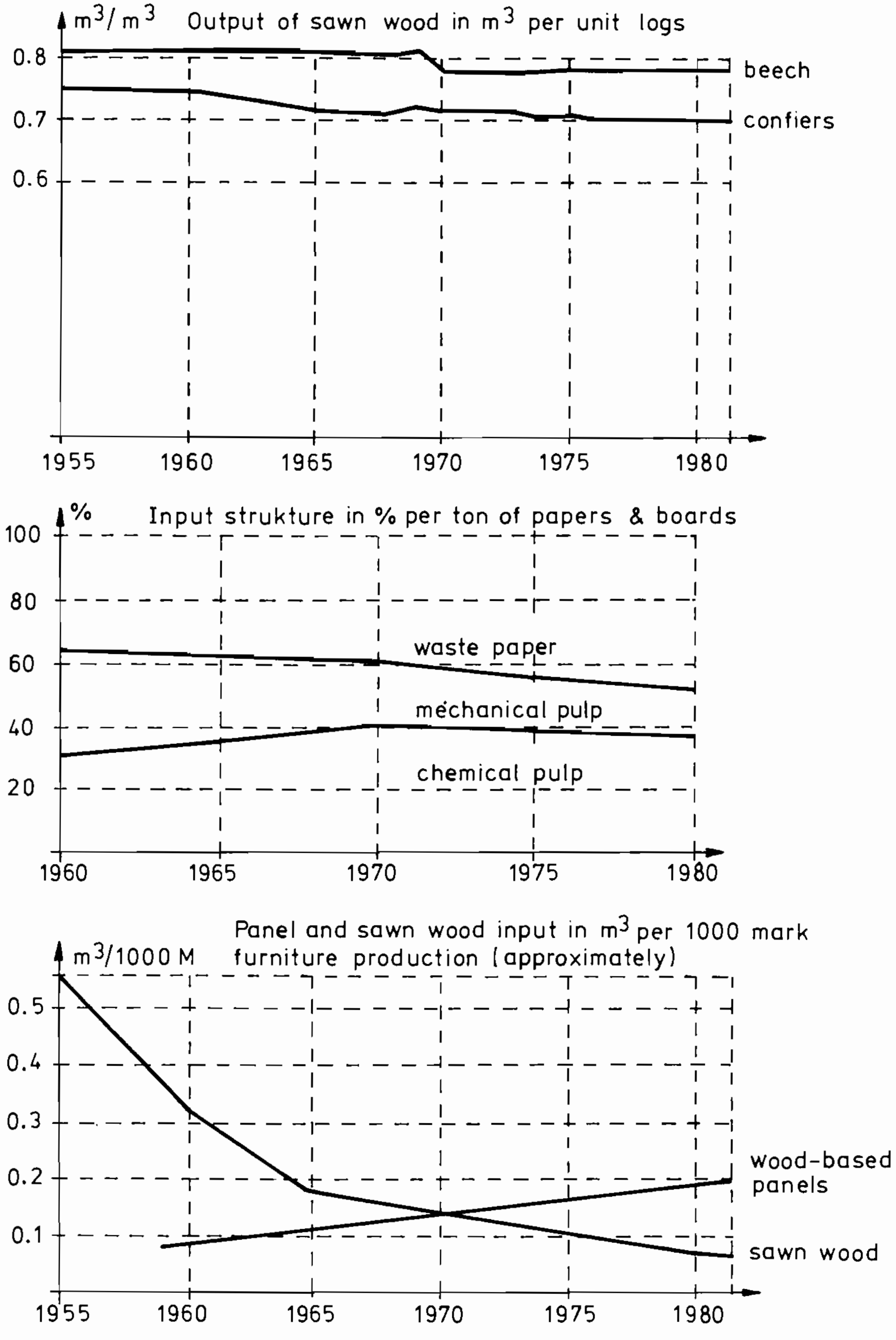
[6] The primary wood processing industry comprises the manufacturing of sawnwood products (such as sawn wood and railroad sleepers), peeled and slized wood products (such as veneer plywood), reconstituted wood products (such as fibreboard and particleboard), and chemical processing products (such as chemical pulp).

[7] Such innovations within the forest sector were the mechanical pulp process, the sulphite and the sulphate process, the plywood, fibreboard and particleboard process.

[8] The secondary wood processing industry covers the transformation of wood-based intermediate products (sawnwood, panels, pulp, etc.) into final products (furniture, paper, etc.).



Sources: Arnold et.al. 1981, Leykauf 1965, Statistical Yearbook.

FIGURE 1 Development of selected technological coefficients.

4. OUTLOOK

In this paper the input-output model of the forest sector of the GDR and its use in industrial planning are described. The first attempt is made to link the input-output model with the forecast model of forest resources and the model of the national economy.

Although these three models are existing separatly and the connecting links between these models are theoretically clarified, the verification of the interactions is still at its initial stage. Among other things this is due to the fact that needed data are not sufficiently available. Apart from difficults in linking these models, the estimation of the long-term development of final demand for wood products has to be improved.

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INPUT-OUTPUT MODEL FOR ANALYZING NATIONAL ECONOMICS OF VARYING ENERGY INTENSITIES

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1. INTRODUCTION

One country in which the external trade plays an important role has a relatively great freedom of movement in the field of the development of branches. The necessary resources can be produced - within certain limits - by import and the import can be balanced by the export of various branches. Naturally, the various sectoral structures of the import and of the export have different impact on the economy. The impacts are very differentiated depending also on the energy intensity of the production structure and on the proportion of the products with high energy intensity in the external trade.

In this paper, I demonstrate the impacts of development of branches with different energy intensity on the requirements of resources. The moderately different development of branches has even significantly different consequences which points out the appropriate direction of the development of branches and of the transformation of the economic structure.

2. FORMATION OF THE VARIANTS OF EXTENSIVE DEVELOPMENT

The variants express increase of the production level in the several developed (i.e. not excluded of the development) branches and their surplus requirements of different resources which are necessary for the increase of an internal final consumption (including the investment) of a given level and structure. Accordingly, the products of those branches which are excluded in the given variant should be imported and balanced by the export of the other branches.

For the investigation I used the input-output table of the Hungarian Central Statistical Office from 1981. I aggregated the branches of this very detailed table to 38 branches. The aggregation extended mainly over the branches with a low energy intensity.

The first variant excluded from the development the raw material producing branches (i.e. metallurgy, building materials industry with a high energy intensity, and heavy chemistry). They represent about 9% of the gross output of the whole economy.

On the other hand, the second variant excludes the chemical industry (i.e. plastic processing, pharmaceutical industry, cosmetical and household chemical industry). In 1981, they gave 13% of the gross national output.

There is the third or basic variant which represents a non-selective development excluding none of the branches from the development.

In the calculations with the input-output model, I employed the following main assumptions or treatments:

- the external terms of trade correspond to the internal price ratios (i.e. the Hungarian price system corresponds to the "world market" prices),
- in order to determine the export-import products' internal prices and the real input requirements of the export in every branch, I added the balance of the subventions and deductions to the value of the export (and import) calculated by the exchange rates (this treatment naturally modifies the value of the gross output too),
- I aggregated the two - dollar and rubel - directions of the external trade into one assuming their constant proportion or that they can substitute each other (it was necessary also because I had the import deductions only aggregated),
- the surplus requirement of crude oil and natural gas should be imported (this sector is also excluded from the development),
- the import is non-competitive i.e. the import coefficients are constant,
- the inner square doesn't include the capital consumption, the external trade and labour. It makes, for example, easier the investigations of the impacts of different terms of trade.

3. COMPARISON OF THE VARIANTS

In the comparison, I considered the accumulated depreciation (amortization), wage, import, capital (net value of fixed assets) and manpower requirements of the internal final consumption. The internal final consumption includes the consumption of the population and the investment (the change in the stock is uncertain, accidental and insignificant). My calculations are based on the level and structure of the year 1981. Having determined the import content I calculated the necessary export and its accumulated requirements. I added these requirements to the requirements of the internal final consumption because they are necessary for it.

Next, I calculated and compared the energy intensity of the variants. For this I used the net energy cost indices:the net energy cost sums, the value (price) of the used up basic energy carriers, and the value of the energy import. These indices show the economic relations of the energy requirements and allow to avoid the double counting and several fictitious conversions.

4. MAIN RESULTS OF THE MODEL CALCULATIONS

The calculated resource requirements of the different variants can be seen in the following table (the detailed results are presented at the end of this paper):

TABLE 1 The requirements of the variants (billions of Ft).

	1	2	3
Variant	non-energy -intensive	energy -intensive	basic
Depreciation	96.4	106.2	101.3
Wage	368.4	365.3	356.6
Net value of fixed assets	2 089	2 226	2 105
Manpower (thousand person)	6 228	6 111	6 006
Net energy cost	108.4	154.1	142.9

One can see that in the variant of high energy intensity there are 10.2% more depreciation, 6.6% more capital and 42.2% more energy requirements, than in the variant of low energy intensity. On the other hand, it needs 1.9% less persons but only 0.8% less wage. The different percentage changes in the manpower and wage derive from the high wages in the raw material production and mining (in these branches the working conditions are much worse too).

In order to summarize the different capital and labour requirements I used the differences in the depreciations and wages. Though the energy intensive variant needs Ft 3.1 billion less wage it induces Ft 9.8 billion more depreciation. Thus, the variant of low energy intensity is better than the high energy intensive one by Ft 6.7 billion. Naturally, it would be better if we could calculate using the real cost of the replacement of the consumed capital and the total cost of labor (i.e. there are also governmetal expenditures connected with the labor force). But this kind of adjustment wouldn't presumably change the result significantly.

The Ft 6.7 billion difference can be interpreted that the variant with a high energy intensity requires a surplus cost about 1% of the GDP as compared with the requirement of the variant with a low energy intensity. Otherwise, it means that the net income of the economy is by 2% lower in the variant with a high energy intensity. In comparison with the basic variant the energy intensive variant is worse in every respect.

Comparing the variant with a low energy intensity with the basic variant we can find that the latter is better by Ft 6.9 billion. But this doesn't mean that the best development policy is the non-selective one. Namely, it only shows that the selectivity is not radical. In order to demonstrate this I modified the variant with a low energy intensity excluding from the export all branches but the machine industry and the non-energy intensive chemical industry. It means a more radical selectivity in the development but even this is not extreme because in the internal production I didn't exclude the other branches from the development. Thus, we have the 4th variant which combines the exclusion of the raw material production with a stronger development of the engineering industry and non-energy intensive chemical industry (first of all, in the export). Consequently, the requirements of the 1st and 4th variants are differing only in their requirements of the export. While the 1st variant needs Ft 539 billion export to balance the total import requirements (including that of the export) the 4th variant needs more, that is Ft 585 billion. This can be explained by a bigger import-content of the export of the 4th variant. But thanks to the better other coefficients of the selective export of the 4th variant the necessary depreciation, wage, fixed assets and manpower is smaller by Ft 6.3, 16.1, 182 billion and 182 000 persons, respectively. Thus, the total requirements of the 4th variant are: Ft 90.1 billion depreciation, Ft 352.3 billion wage, Ft 1 907 billion fixed assets and 6 million 11 thousand persons. Consequently, the 4th variant needs significantly fewer resources than the basic one except for the manpower. The manpower requirement is practically equal in the two variants. Calculating the balance of the depreciation and wage we can find that the selective and non-energy intensive development i.e. the 4th is better than the non-selective one by Ft 15.5 billion that is by 2% of the GDP or 4% of the net income of the economy.

5. SOME CONSIDERATIONS ABOUT THE RESULTS

If I could have calculated using the real terms of trade (i.e. with the world-market prices) presumably the results of the variant with a high energy intensity would have been even worse. It is because the applied (Hungarian) internal prices of raw materials are significantly higher than the world market prices while it can't be said (to such a degree) of the other branches.

The manpower requirement is the only factor that supports the development of the raw materials production. But knowing the existence of large, excessive, unnecessary personnel in the Hungarian manufacturing industry and in other branches we can see that the minimally bigger manpower requirement should not be a real obstacle to the development of the manufacturing industry. The problem can be solved by a better regulation.

A greater energy requirement involves three other statements too:

- if from the point of view of the energy import the terms of trade are worse than in the model - and that is probable - the position of the raw material production is even worse than it seems from the calculations;
- if the prices of the energy import rise or the quantity of the import energy is limited, the energy-intensive development will break down;
- the raw materials producers (especially the chemical industry)get the energy-carriers (e.g. natural-gas) at much lower producer prices than the average consumer and this leads to distortions in the accumulated requirements in the model showing a better image of the raw materials production.

TABLE 2 The accumulated requirements of the variants (billions of Ft).

Variant	1				2				3			
	Con.	Inv.	Exp.	Total	Con.	Inv.	Exp.	Total	Con.	Inv.	Exp.	Total
Import (including the final import)	208.7	105.2	225.5	539.4	214.6	121.7	242.0	578.3	190.7	93.7	179.5	463.9
Net energy costs (in the production)	51.9	12.4	44.1	108.4	58.7	15.0	80.4	154.1	62.7	19.8	60.4	142.9
Depreciation	45.7	10.8	39.9	96.4	46.5	9.8	49.9	106.2	49.3	13.1	38.9	101.3
Wage	176.0	50.9	141.5	368.4	172.4	43.6	149.3	365.3	181.5	54.7	120.4	356.6
Manpower (thousand persons)	2 970	801	2 457	6 228	2 902	670	2 539	6 111	3 061	866	2 079	6 006
Fixed assets (net)	1 169	188	732	2 089	1 171	167	888	2 226	1 215	221	669	2 105
Level of activity	556.8	206.2	539.4		556.8	206.2	578.2		556.8	206.2	463.9	

Con. = consumption,
Inv. = investments,
Exp. = exports.

IMPACT OF CONSTRAINTS IN ENERGY IMPORTS AND ENERGY PRODUCTION OF FINAL DOMESTIC DEMAND

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1. INTRODUCTION

Several events of the past ten years have clearly demonstrated how important the problem of energy dependency has become. In the case of Switzerland, this problem is crucial since all types of primary energy except one, the hydroelectric power, are imported. This means that restrictions on imports of secondary energy products cannot be compensated, except in the case of electricity, by domestic production of secondary energy products if restrictions on imports of primary energy products are imposed at the same time.

These constraints in energy imports and production can be tackled by two strategies: reduction of direct consumption of energy by the final consumers, essentially households, and/or reduction of intermediate consumption by the producing branches. The latter situation implies, if no mofification occurs in the energy intensity in the production processes, modification of the production structure and consequently modification of final demand also for non-energetic products.

In this paper, we are concerned with the measurement of the impact of energy constraints on the final domestic demand by means of an input-output formalisation which allows to take into consideration all the interactions in the economic system.

2. WHICH INPUT-OUTPUT MODEL?

2.1. The Problem of Conversion of One Form of Energy into Another Form of Energy

In the case of energy utilisation, it is important to separate the amount of energy which is used in conversion processes from that which is used either as intermediate input by the producing branches or by final demand components (Households, Exports, Changes in stocks). This distinction is important because the quantity of energy used in transformation to obtain a given amount of another type of energy usable by producing branches or final demand, can only be modified by reducing the conversion, transportation and distribution losses or by changing the combination of energy inputs used in energy conversion. No attention was given to this problem in the classical input-output model in monetary units. In the same way, the input-output model which mixes data in physical units for energy input and production and data in monetary units for the other input and productions[1] did not emphasize the case of energy input used in conversion processes. It is the paper by Lager[2] which finally proposed a satisfactory treatment of these questions by building an input-output model in physical units which concerns only the conversion processes of energy. This model can then be linked with the classical input-output model in monetary units.

2.2. A Short Presentation of the Model Proposed by Lager

The input-output system of energy conversion proposed by Lager is

$$q = A^E q + (s - Wm) \tag{1}$$

with the following definitions of the different vectors and matrices:

- q - domestic production of energy products, in physical units,
- s - total resources of energy to be used in the producing branches or to satisfy the final demand, in physical units,
- m - imports of energy products, in physical units,
- W - is a matrix of efficiency coefficients, which is defined as $(I - L)$, where L is a diagonal matrix of loss coefficients, the losses taken into consideration at this stage being the distribution and transportation losses,
- A^E is a matrix of input coefficients of the different forms of energy per unit of energy produced.

The elements of the A^E matrix depend on[3]

- the input coefficients of the different forms of energy in the conversion processes,
- the market-shares of the different conversion processes in the production of energy,
- the loss coefficients relating to the conversion losses as well as to the distribution and transportation losses.

Since, in our current problem, we need to distinguish the uses of domestically produced energy from those of imported energy, we separate the input coefficients in the A^E matrix into input coefficients of domestically produced energy and coefficients of imported energy. We also separate, in the s vector, the energy which is domestically produced from that which is imported. This leads to the following systems:

$$q = A^{Ed} q + s^d \tag{2}$$

$$W^m m = A^{Em} q + s^m \tag{3}$$

where the indices d and m concern respectively the domestic production and the imports. Under the hypothesis $W^m = W$ we have (1) = (2) + (3).

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[1] See: Beutel, and Murdter (1981); Beutel, and Stahmer (1982).

[2] See: Lager (1982).

[3] For a complete formalisation of this model, see Lager (1982).

2.3. Introduction of Constraints and Study of Their Impact using the Input-Output System of Energy Conversion

By introducing a distinction between primary (p) and secondary (s) energy and by putting the zero blocks in the A^E matrices[4], we can rewrite the former systems of equations as:

$$\begin{bmatrix} q_p \\ q_s \end{bmatrix} = \begin{bmatrix} A^{Ed}_{pp} & A^{Ed}_{ps} \\ 0 & A^{Ed}_{ss} \end{bmatrix} \begin{bmatrix} q_p \\ q_s \end{bmatrix} + \begin{bmatrix} s^d_p \\ s^d_s \end{bmatrix} \tag{4}$$

$$\begin{bmatrix} W^m_p & 0 \\ 0 & W^m_s \end{bmatrix} \begin{bmatrix} m_p \\ m_s \end{bmatrix} = \begin{bmatrix} 0 & A^{Em}_{ps} \\ 0 & A^{Em}_{ss} \end{bmatrix} \begin{bmatrix} q_p \\ q_s \end{bmatrix} + \begin{bmatrix} s^m_p \\ s^m_s \end{bmatrix} \tag{5}$$

The impact of constraints in m and q_p on the remaining set of variables, except s^d_s, should result from the solution of the following system of equations

$$s^d_p = \left(I - A^{Ed}_{pp}\right) q_p - A^{Ed}_{ps}\, q_s \tag{6}$$

$$s^m_p = W^m_p\, m_p - A^{Em}_{ps}\, q_s \tag{7}$$

$$s^m_s = W^m_s\, m_s - A^{Em}_{ss}\, q_s \tag{8}$$

This system of (2p + s) equations contains (2p + 2s) unknown variables $(s^d_p, s^m_p, s^m_s, q_s)$; hence, we will have to introduce other constraints on some variables, depending on the structure of the A matrices, in order to get a solution. As to the impact on s^d_s, it can be evaluated through:

$$s^d_s = \left(I - A^{Ed}_{ss}\right) q_s \tag{9}$$

An example will be given with reference to Switzerland.

In order to study the impact of these constraints on direct consumption of domestically produced energy by final consumer and on final demand of domestically produced non energetic products, we have to focus, at this stage, on the impact on s^d: resources of domestic energy products not used in the conversion processes. The impact on s^m, nevertheless, is also interesting if we want to study the possibility of substitutions between domestically produced and imported energy.

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[4] The dot replaces the indices d and m or p and s depending on the context.

2.4. The Link with the Classical Input-Output Model

The classical input-output model is given by:

$$x = A^d x + f^d \tag{10}$$

$$\bar{m} = A^m x + f^m \tag{11}$$

where

x - is the vector of domestic production of the producing branches, in monetary units;

$\bar{m}$ - is the vector of imports, in monetary units;

f^d and f^m - are the vectors of final demand respectively for domestic production and for imports, in monetary units;

A^d and A^m - are the matrices of input coefficients concerning respectively domestically produced input and imported input.

In order to link the above model with the earlier one, we have to distinguish, in the s^d and s^m vectors, the part which is used by the producing branches from that which is directly consumed by the final demand. As to the amount used by producing branches, we distribute it in the different branches. We then have:

$$s^d = S_x^d i + y^d \tag{12}$$

$$s^m = S_x^m i + y^m \tag{13}$$

where the $S_x^{\bullet}$ matrices denote the utilisation of energy by the producing branches and $y^{\bullet}$ the direct final demand of energy by the consumers. We can also write:

$$s^d = E_x^d x + y^d \tag{14}$$

$$s^m = E_x^m x + y^m \tag{15}$$

with $E_x^{\bullet} = S_x^{\bullet} \hat{x}^{-1}$, and finally

$$s^d = E_x^d (I - A^d)^{-1} f^d + y^d \tag{16}$$

$$s^m = E_x^m (I - A^d)^{-1} f^d + y^m \tag{17}$$

Let us, furthermore, define:

$$y^d = E_y^d f^d$$

with $E_y^d = S_y^d \hat{f}^{d-1}$, S_y^d being a matrix of utilisation of domestically produced energy by final demand which is distributed by producing branches. The S_y^d matrix has then non zero cells only in the branches corresponding to the energy products.

The equations (16) then become:

$$s^d = \left(E_x^d (I - A^d)^{-1} + E_y^d \right) f^d \tag{18}$$

The impact of the considered constraints on s^d is, by these equations, transferred on f^d.

An the dimension of f^d is generally greater than that of s^d, we will again have to fix some of the f^d in order to get a solution for the remaining ones. By defining:

$$M = E_x^d (I - A^d)^{-1} + E_y^d \tag{19}$$

we can write equation (18) as:

$$s^d = \begin{bmatrix} M_1 & M_2 \end{bmatrix} \begin{bmatrix} f_1^d \\ f_2^d \end{bmatrix} \tag{20}$$

where

f_1^d - are the final demands whose values are fixed,

f_2^d - are the other final demands, the dimension of f_2^d being the same as that of s^d.

We finally obtain:[5]

$$f_2^d = M_2^{-1} \left(s^d - M_1 f_1^d \right) \tag{21}$$

By changing the final demands which are fixed, we can measure different kinds of impact on f^d, of the considered constraints in m and q_p. If. in addition, these constraints influence s^m, it is possible through equation (17) to evaluate the consequences, on y^m, of impact on f^d.

3. COMPILATION AND RESULTS OF LAGER'S MODEL APPLIED TO SWITZERLAND

Lager's model uses data contained in the energy balances. Such balances have been published in Switzerland, by the "Office federal de l'energie" since 1974[6]. Nevertheless, we decided not to evaluate the Input-Output model of energy conversion for all the past years, as other necessary information is available only for certain periods[7]. This information especially concerns the disaggregation of petroleum products into Fuel, Motor-fuel and Others[8]

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[5] This is possible only if we can evaluate the inverse of M_2; unfortunately, this is not always the case as we will see with reference to Switzerland in which the cells of M_2 are extremely small in value.

[6] See Office federal de l'energie.

[7] A compilation for all the periods would be interesting for studying the evolution of the A^{Ed} and A^{Em} matrices over time as was done for Austria; see: Lager, Musil, and Skolka (1983).

[8] This disaggregation can be found in the publications of "Union petroliere". See: Union petroliere.

and the distribution of intermediate uses of energy in the different branches. Lager's model was therefore computed for Switzerland for the years 1981-1984. Concerning the distinction between domestically produced and imported energy we had to introduce imports coefficients for all forms of energy. The division of the input coefficients of energy in the conversion processes into input of domestically produced and input of imported energy was then made proportionally to the imports coefficients. We also used these coefficients of proportionality to distinguish the amount related to domestically produced from that of imported energy, in the losses and in the total resources of energy not used in conversion. Using the methodology presented in Lager's paper, we evaluated the A^{Ed} and A^{Em} matrices. Table 1 gives these results for 1984. We took into consideration 11 forms of energy: 1. Coal; 2. Crude Oil; 3. Hydroelectric and Nuclear Power; 4. Wood; 5. Waste Products; 6. Gas; 7. Fuel; 8. Motor-fuel; 9. Other Petroleum Products; 10. Electricity; 11. District Heat. The first five forms of energy concern primary energy, whereas the latter five are secondary energy. The sixth one, i.e. Gas, is composed of natural gas (99.16%) and manufactured gas (0.84%) as no disaggregation is available between these two forms of gas if we look at the uses of this type of energy. We chose to put Gas in the group of secondary energy products in all the matrices and vectors when they are partitioned.

From Table 1, one can see that only two forms of secondary energy require more than one form of primary energy to be produced: they are Electricity and District Heat. As it was already mentioned in the introduction, the main types of primary energy are imported in Switzerland. This country is, therefore, highly dependent on foreign countries for the production of secondary energy. Only Electricity and District Heat can be obtained from domestic primary energy; even here restrictions could appear as Hydroelectric power is probably not far from its maximum possibilities. Concerning the uses of secondary energy in the production of secondary energy, we can notice that the production of Electricity and District Heat, as well as the production of Manufactured gas need secondary energy which is imported or produced with imported primary energy. This situation emphasizes the energy dependency of Switzerland.

4. THE CLASSICAL INPUT-OUTPUT MODEL FOR SWITZERLAND

Switzerland is one of the few countries where no input-output table is published officially. A research on this subject was recently undertaken by a team in the Department of Econometrics of the Geneva University, in collaboration with the Federal Statistical Office, in view of elaborating an input-output matrix when primary statistical data are scarce[9]. This work resulted in the estimation of such a table for 1975[10]. In one of our previous works using Swiss data, we could isolate, in the imports, the amount directly used by final demand[11]. The separation of the X matrix $X = Ax$, of intermediate consumption into X^d and X^m was obtained by assuming that imports of good i used as intermediate imports were distributed along

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[9] This work was made possible by a grant of the Swiss National Fund of Research.

[10] See: Antille (1983).

[11] See: Antille, and Gilli (1985).

TABLE 1 Matrix A^{Ed} and A^{Em} for Switzerland, 1984.

		Gas	Fuel	Motor Fuel	Other Petroleum Products	Elec- tricity	District Heat
Coal	d	0	0	0	0	0	0
	m	0	0	0	0	0.0017	0.0892
Crude Oil	d	0	0	0	0	0	0
	m	0	1.0081	1.0081	1.0081	0	0
Hydroelectric and nuclear power	d	0	0	0	0	0.7827	0.0406
	m	0	0	0	0	1.0692	0.0555
Wood	d	0	0	0	0	0	0
	m	0	0	0	0	0	0
Waste products	d	0	0	0	0	0.0163	0.8584
	m	0	0	0	0	0	0
Gas	d	0	0	0	0	0.0001	0.0027
	m	0	0	0	0	0.0060	0.3152
Fuel	d	0.4158	0	0	0	0.0019	0.1002
	m	0.7883	0	0	0	0.0036	0.1900
Motor fuel	d	0	0	0	0	0	0.0020
	m	0	0	0	0	0.0001	0.0042
Other petroleum products	d	0	0	0	0	0	0
	m	0	0	0	0	0	0
Electricity	d	0	0	0	0	0.0512	0
	m	0	0	0	0	0	0
District Heat	d	0	0	0	0	0	0.0979
	m	0	0	0	0	0	0
	d	0.4158	0	0	0	0.8522	0.1018
	m	0.7883	1.0081	1.0081	1.0081	1.0806	0.6541

$$A_{84}^{Ed} = \begin{bmatrix} 0 & A_{ps}^{Ed} \\ 0 & A_{ss}^{Ed} \end{bmatrix} \qquad A_{84}^{Em} = \begin{bmatrix} 0 & A_{ps}^{Em} \\ 0 & A_{ss}^{Em} \end{bmatrix}$$

the corresponding row of intermediate uses proportionally to these intermediate uses. The coefficients of proportionality are:

$$k_i = \frac{u_i^m}{u_i},$$

where

u_i^m is the intermediate use of imported good i,

u_i is the intermediate use of both domestically produced and imported good i.

In order to use these results in our calculations, we had to aggregate the initial (34 x 34) X^d and X^m matrices in 14 producing branches[12]. The vector x of domestic production was also aggregated in the same way.

Unfortunately, we had to introduce the 1975 A^d matrix in our calculations as the most recent census of enterprises available is for 1975. A new census is now under way which will allow us to elaborate an input-output table for 1985.

We also had difficulties with the data concerning the x and f^d vectors over time as these vectors are not given in the Swiss national accounts. The x vector for industrial branches results from an extrapolation of the 1975 data by means of Indices of industrial production at constant prices; as for the production of services we used data established by the "St. Galler Zentrum für Zukunftsforschung"[13]. The vector of final demand for domestically produced goods and services is obtained by

$$f^d = (I - A^d)\ x .$$

An S matrix of utilisation of energy by producing branches as well as a y vector of final demand of energy could be built on the basis of information of the "Office federal de l'energie"[14]. This information concerns the 14 producing branches already mentioned, the consumption by households, the exports and the changes in stocks. Concerning the Motor fuel, we attributed it almost completely to the final demand, as in its utilisation for transportation no distinction is made between households, transport services and other producing branches. The partition of S into S^d and S^m and that of y into y^d and y^m are based on the same hypothesis as the one introduced for the compilation of the different matrices in Lager's model.

Using all the above information, we established the following equalities for Switzerland in 1984:

$$s^d = \left(E_x^d\ (I - A^d)^{-1} + E_y^d \right) f^d ,$$

$$s^m = E_x^m\ (I - A^d)^{-1} f^d + y^m .$$

These equalities, together with Lager's model for 1984, form the starting point for the example of simulation we performed for Switzerland.

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[12] The list of these branches is given in the Appendix.

[13] See: Meier et al. and Non published Data.

[14] See: Office federal de l'energie.

5. STUDY OF IMPACT USING THE INPUT-OUTPUT SYSTEM OF ENERGY CONVERSION IN THE CASE OF SWITZERLAND

To study the impact of constraints in m and q_p on the remaining variables, we have to use the equation systems (6) to (9). The fact that some variables are zero, namely[15] q_1, q_2, m_5, m_9, m_{11}, as well as their corresponding s: s_1^d, s_2^d, s_5^m, s_9^m, s_{11}^m, reduces, in the case of Switzerland, the system of equations (6) to (8) to a system with 11 (2 p + s - 5) equations and 17 (2 p + 2 s - 5) variables. We, therefore, have to fix 6 of them in order to get a solution. s_3^d and s_3^m are fixed to be zero, their corresponding values in the data; for the remaining four, we had to choose three among q_7, q_8, q_9 and s_2^m and one among q_6 and s_7^m, this is imposed by the structure of the A_{ps}^{Ed} and A_{ps}^{Em} matrices. We decided to fix the values of q_6, q_9 and s_2^m, as well as that of q_8, while the value of this latter variable will, nevertheless, be modified in our simulations.

The causal links between the exogenous variables (m, q_p and the six variables whose values are fixed) and the endogenous one can be seen in the diagram (Figure 1). It also contains the links between q_s and s_s^d which are included in the system (9).

From this diagram, we see that it is the constraints put on m_3 (imports of nuclear power) or q_3 (domestic hydroelectric power) which affect most of the s variables. The constraints put on m_2 (imports of Crude Oil) or on m_7 (imports of Fuel) and m_8 (imports of Motor Fuel) affect only q_7 and q_8 and then s_7^d and s_8^d or s_7^m and s_8^m.

6. SIMULATION OF CONSTRAINTS AND MEASURE OF IMPACT IN THE CASE OF SWITZERLAND

For the numerical application to Switzerland, we decided to modify the imports of Crude Oil, either by reducing them or by increasing them. These modifications are linked with two situations regarding the imports of Fuel or Motor-fuel: in the first situation, these imports remain unchanged whereas in the second situation, they are also reduced.

Each of these alternatives leads to different values of (s_7^d, s_8^d) and of (s_7^m, s_8^m), the resources, respectively, of domestically produced and imported Fuel and Motor-fuel not used in the conversion processes. The results

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[15] For the correspondence between index numbers and forms of energy, see Appendix.

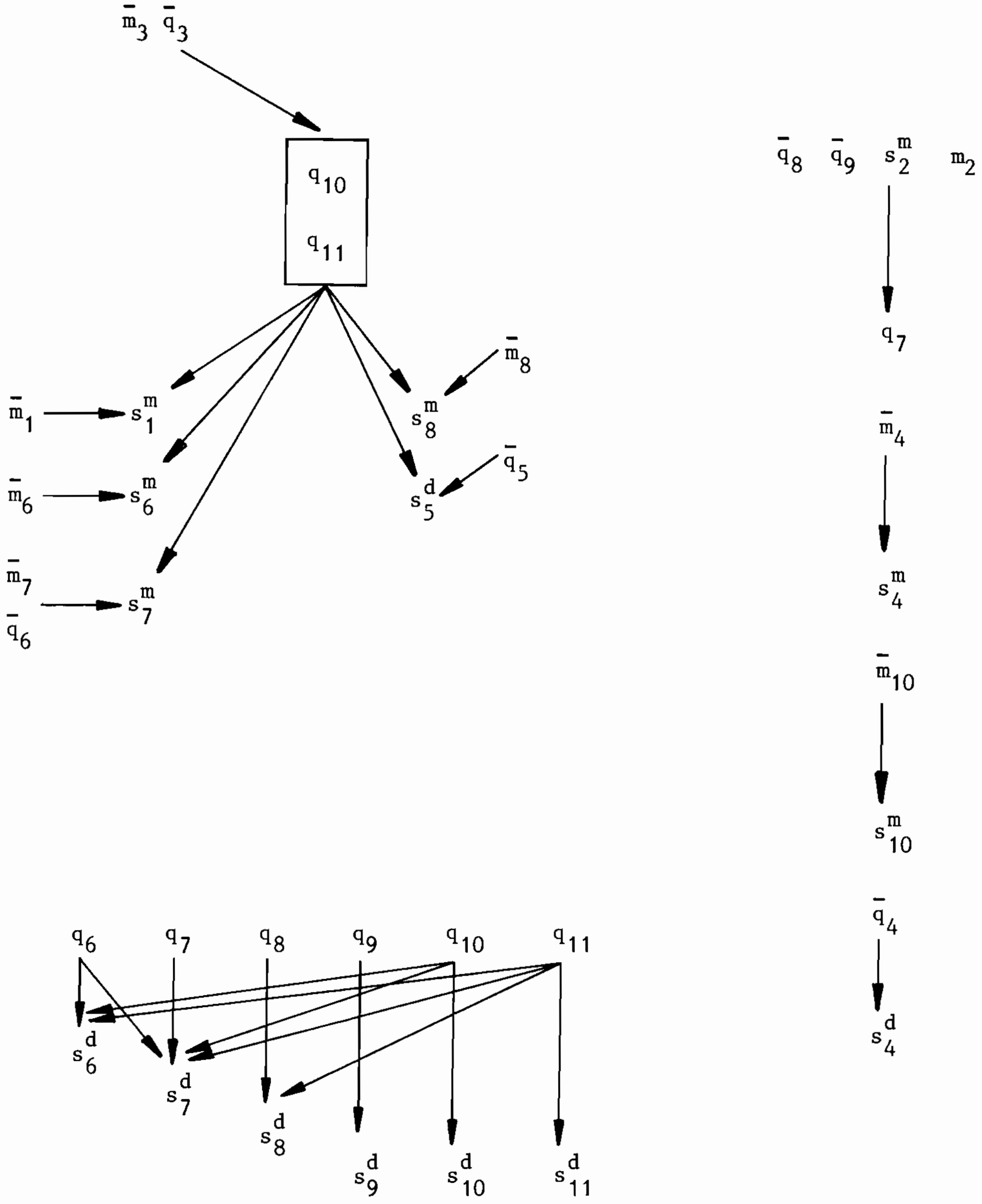

FIGURE 1 Links between model variables (a line on a variable name denotes an exogenous variable).

for s_7^d and s_8^d, of course, depend on the value given to q_7, the production of Fuel.

Concerning the transfer of the impact on s_7^d and s_8^d onto the final demand f^d, initially we wanted to use the system (21), changing the final demands contained in f_1^d and f_2^d.

But at this stage of our work, we were faced with the following problems:

a. As, in the vector s^d, three cells are zero in value, we had to reduce the number of equations in the system (21) and fix 6 among 14 of the final demands, instead of 3 as initially planned.

b. The matrix M_2, of order 8 x 8, resulting from the system (20) had so small a determinant in value (10^{-40}) that it was impossible to invert it. Hence, we decided to use to system (16) which isolates the final demand for energy products in physical units. The new definition for the M matrix in this system is:

$$M = E_x^d (I - A^d)^{-1}$$

The partition of this M matrix also leads to an M_s matrix which could not be inverted.

c. After several attempts, we finally found a partition of the new M matrix into a five by five M_2 matrix which could be inverted but the inverse matrix was unfortunately ill- conditioned so that we were not in a position to evaluate, simultaneously, the effects of our constraints on the five remaining final demands. Even when the problem was reduced to two equations, no simultaneous solution could be found. Therefore, in order to get a solution, we had to follow the steps described below.

The imposition of a constraint on y_7^d (final demand of domestically produced Fuel) together with fixed fonal demands in monetary units except for two, allows to evaluate the values of the free final demands consistent with the restriction on s_7^d. Naturally, for the free final demands we obtain one of them as a function of the other one.

The utilisation of the new vector f^d and of the constraints in s_8^d leads to the determination of y_8^d (the final demand for domestically produced Motor-fuel).

Finally, the utilisation of the new vector f^d and of the constraints in s_7^d and s_8^d allows to evaluate, using the system (17), the impact on y_7^m and y_8^m, the final demand for imported Fuel and Motor-fuel.

Table 2 gives the result for a few trials in which the free final demands in monetary units are those for Chemical products and for Machinery.

TABLE 2 Results of simulations of constraints

		1984	1	2	6	9	12
$\overline{m}_2$	TJ	170530	167119	idem 1	idem 1	162000	173940
$\overline{q}_7$	TJ	99018	97038	"	98028	94067	101000
q_8	TJ	64519	63116	"	62126	61012	65922
s_7^d	TJ	97455	95475	"	96465	92504	99435
s_8^d	TJ	64492	63089	"	62099	60985	65894
$\overline{y}_7^d$	TJ	53474	53404	"	52939	50800	54544
y_8^d	TJ	63082	61688	"	60695	59593	64481
f_5^d	10^6 fr	12616	8002	"	10308	3350	17231
$\overline{f}_8^d$	10^6 fr	10002	10002	"	10002	8001	10002
$\overline{m}_7$	TJ	187736	187736	183981	idem 2	idem 1	idem 2
$\overline{m}_8$	TJ	136280	136280	133555	"	"	"
s_7^m	TJ	184775	184775	181020	"	"	"
s_8^m	TJ	136225	136225	133500	"	"	"
y_7^m	TJ	101387	103113	99360	98500	105704	95900
y_8^m	TJ	133253	133264	130540	130530	133283	130510
y_7^{d+m}	TJ	154861	155517	151764	151439	156504	150444
y_8^{d+m}	TJ	196335	194952	192228	191225	192876	194991

The exogenous variables are overlined.

The numbers refer to the previous diagram.

Other simulations were also performed as it can be seen from the scheme in Figure 2, but their results do not diverge very much from those in Table 2. In this table, one sees, for example, that a reduction of 2% of crude oil imports (m_2), which is absorbed by decreases in the final demand for domestically produced Fuel and Motor-fuel and by an important reduction in the final demand for Chemical Products, has different impacts on the total final demand for Fuel and Motor-fuel. In the case of Fuel, the reduction of y_7^d is compensated by an increase in y_7^m whereas this does not appear for the Motor-fuel. There is no compensation when the imports of Fuel and Motor-fuel

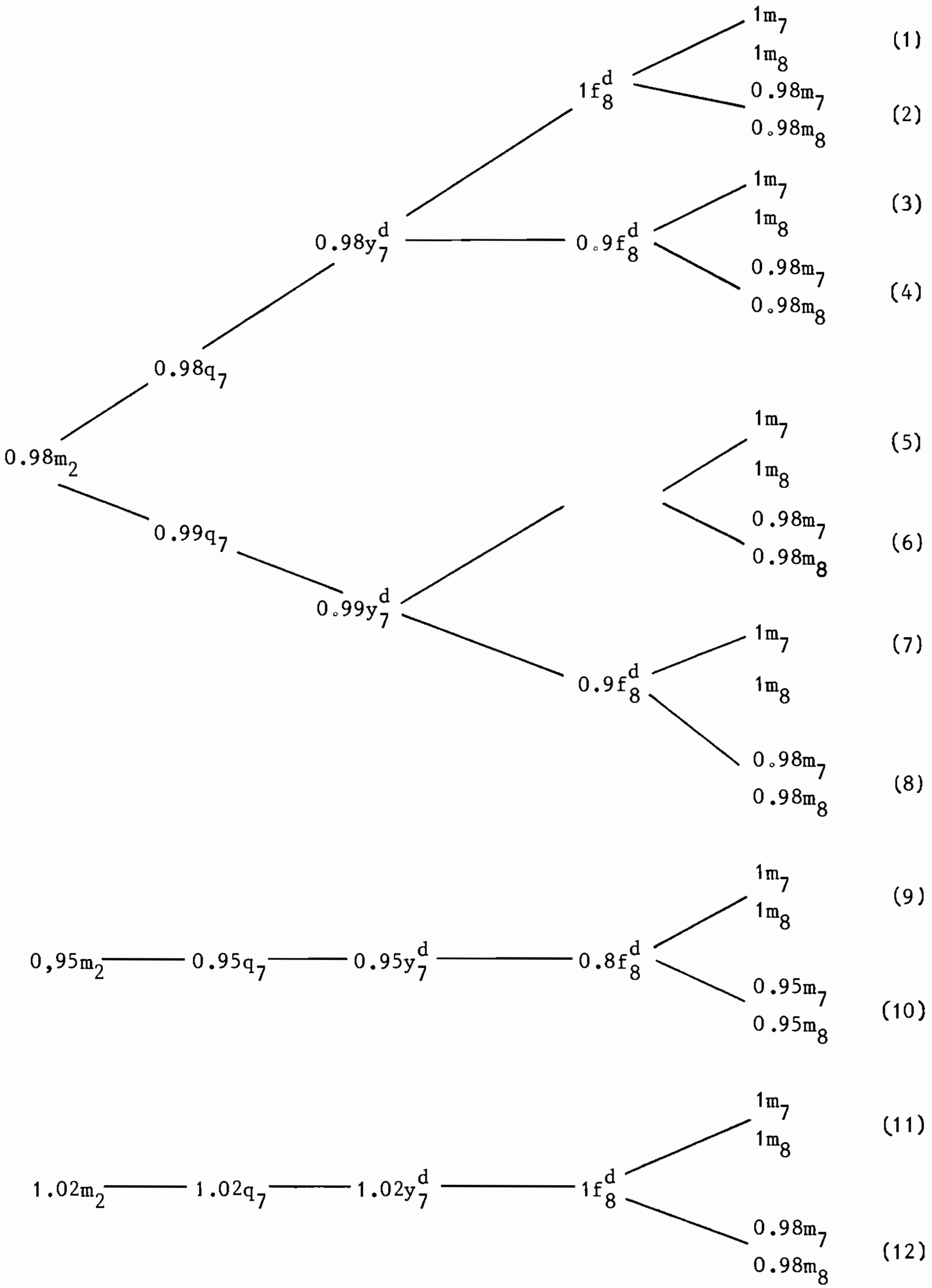

FIGURE 2 Values of the constraints imposed in the simulations.

are reduced simultaneously. It can be also seen that the same reduction on m_2 leads to different pairs of the final demand in monetary units for Chemical Products (f_7^d) and for Machinery (f_8^d) depending on the modification we impose on the production of Fuel (q_7).

The simulation (9) is presented to stress the fact that an important reduction of imports of crude oil (5%) cannot be faced by modifying only the two final demands under consideration. The reduction has to be spread over all the final demands. As regards the simulation (12), we notice that an increase in the imports of crude oil (2%) linked with a decrease of the same percentage in the imports of Fuel and Motor-fuel does not allow to maintain the total final demand for Fuel and Motor-fuel at its previous level, this of course under the hypothesis made for q_7 and f_8^d.

Let us notice that the results of these simulations have to be considered under the two following reservations: the data concerning the input coefficients in the A^d matrix refer to 1975; the solutions do not satisfy the simultaneous system (20), which means that only the equations related to s_7^d and s_8^d are in equilibrium. The evaluation of a vector s^d consistent with the new vector f^d leads to differences of about 1% to 3%, these differences are transfered on q, using the equations (2):

$$q = (I - A^{Ed})^{-1} s^d.$$

The equations (3):

$$W^m m = A^{Em} q + s^m$$

give the new values of m as a function of the new values of q and s^m. This latter vector is recalculated through the system (17) inserting new values in f^d and y^m.

In the vectors q and m, we are especially interested in the values of the cells which were fixed i.e. q_7, q_9, m_2, m_7 and m_8. Among these values three are modified:

m_7 through the modification in q_6

q_9 through the modifications in f^d

m_2 through the modification in q_9,

these modifications being in the range of 0.1% to 0.2%.

7. CONCLUSION

This paper presents a framework for measuring the impact of constraints in imported or domestically produced energy on final demand. Unfortunately the theoretical framework could not be directly used and we were obliged to determine partial solutions only. Nevertheless, the methodology used to evaluate these solutions can be seen as a tool of the economic policy regarding the energy dependency of a country.

This tool obviously suffers from the troubles inherent in the input-output analysis, that is, the impossibility of considering substitutions between energy products used in production. It should therefore be linked with the analysis and forecasts of energy efficiency in the production processes in order to include technical modifications in the measure of the impact.

As far as the numerical results are concerned, we repeat that they are only an example of what could be done. The A^d matrix has to be updated; the constraints as well as the final demand to be fixed should result from the economic analysis.

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APPENDIX

Forms of Energy

1. Coal
2. Crude Oil
3. Hydroelectric and Nuclear Power
4. Wood
5. Waste Products
6. Gas
7. Fuel
8. Motor-fuel
9. Other Petroleum Products
10. Electricity
11. District Heat

Producing Branches

1. Food, beverages, tobacco
2. Textiles, clothing
3. Paper products
4. Rubber and plastic products
5. Chemical products
6. Quarrying, non-metallic mineral products
7. Metallurgy
8. Machinery
9. Building and construction
10. Electricity, gas and water
11. Crude oil, natural gas and petroleum products
12. Other industries
13. Transportation services
14. Agriculture and other services

SPECIAL INPUT-OUTPUT MODEL FOR ANALYZING THE EFFECTIVENESS OF THE ENERGY SUPPLY SYSTEMS

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1. INTRODUCTION

In the Institute of Industrial Economics (Hungary) a special model has been developed in the recent years for analyzing the energy supply systems of different structures, by transforming the whole energy flow diagram into input-output tables. The study here tried to give a short summarizing overview about the manners and results of the model investigations carried out in the recent years. Methodically, the model was elaborated on the base of 14 x 14 input-output matrices representing 1975 national energy balance data and those of the energy demand projection for a 15 years' development. The quantified results originate mainly from the computation of 22 x 22 and 26 x 26 matrices based on 1983 balance data[1]. The two investigations differ not only in their sizes but in their content, and methodically as well. The latter is suitable for analyzing the effects of structure changes in the steam and electricity generation (coal, -oil-, natural gas).

2. MODEL CONCEPTIONS

The input-output model illustrated schematicly on Figure 1, includes the spheres of the energy supply system (fields of model) as follows:
- the productions (and imports) of the primary energy carriers (PEP),
- the main types of energy conversions (EC),
- transport of energy carriers and losses before the phase of final energy use (during storage, transport and distribution by grids and pipelines LS and ETD) and

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[1] In the model of 22 x 22 the sequence of the branches is: (see Figure 1)
- PEP 1 Lignite; 2 Brown coal; 3 Coal; 4-5 Crude oil (5 import); 6-7 Natural gas (7 import);
- EC 8 Briquette; 9 Dehydrated lignite; 10-11 Coking (10 Coke, 11 Oven gas); 12-14 Refining (12 White products; 13 Black products; 14 Material types); 15 Town gas; 16 Steam (for use); 17 Steam (for electricity); 18-19 Electricity generation (18 Condensational, 19 Reactive); 20 Warm water;
- LS 21 Losses in storing;
- ETD 22 Energy transport and distribution.

- ultimately, the final use of the "outer" consumers (FU), excluding that of the power-generation branches, (which is charged to the matrix coefficients respectively), and the total energy resources (TER).

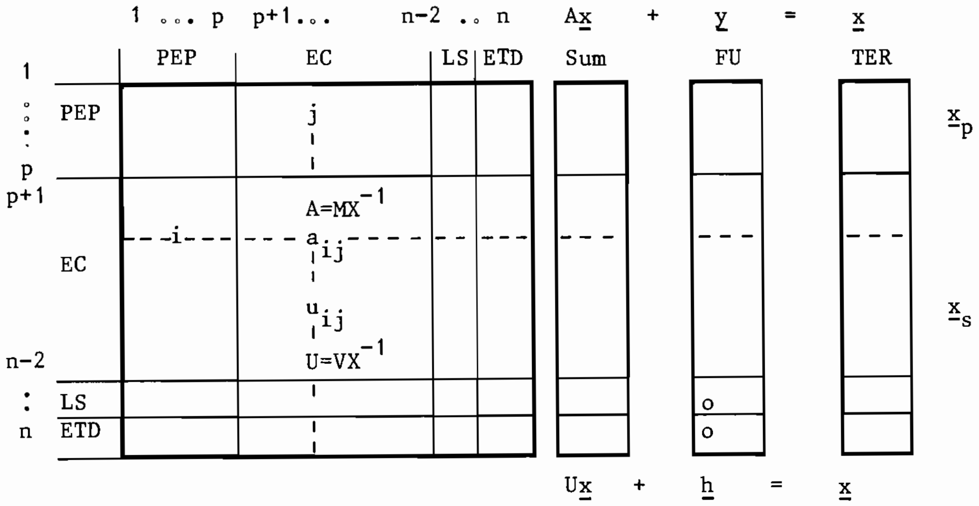

FIGURE 1 The scheme of the model.

PEP - Primary Energy Productions; EC - Energy Conversions; LS - Losses in storing; ETD - Energy Transport and Distribution; x_p - Primary Energy Resources; x_s - Secondary Energy Resources; h - Auxiliary vector ($y+x_s$) or ($\underline{x}-\underline{v}$).

The investigations carried out on the basis of the input-output models aim generally at evaluation of the effectiveness of the energy supply systems at the present time as well as for the future, detailed as follows:

1. Computation of energy resources values (x) for the future, in the function of energy structure variants (with various A coefficient matrices), while the "outer final use" (y) will be approximately constant.
2. Outlining the requirements of the national resources (e.g. investments, manpower) needed for the development of power-engineering changing in the function of various supply systems.
3. Analyzing the losses (v) and the efficiency (η) for the whole energy system and for single processes. It is carried out in two aspects: in power-generation sector and on the national economy level. The main task of these types of analyses is to reveal the striking loss-inducing phases of the processes of interest aiming at improving the effectiveness of the energy supply.
4. The evaluation of the energy savings of different structures at the level of the whole power-generation system.
5. Comparing the power-generation and economic effects by changing energy carriers between each other e.g. by substituting imported for domestic ones.

3. MAIN METHODICAL PROBLEMS

The special input-output model has to be suitable for analyzing the energy supply system (energy producing, conversion and distributing processes) in power-engineering sense as usual in the practice. That causes the necessity of ensuring consistency of the energy flow and the input-output tables. It mainly means that we have to eliminate the double (plural) countings from the accumulated results computed by matrix algebraic connections, or we have to interpret them from the power-engineering viewpoint. Inside the energy supply system, there are, namely, connections of many directions between all processes (outputs from some, as inputs for others), which result in double countings. The problem and its solution (in principle) can be well seen on the Figure 2.

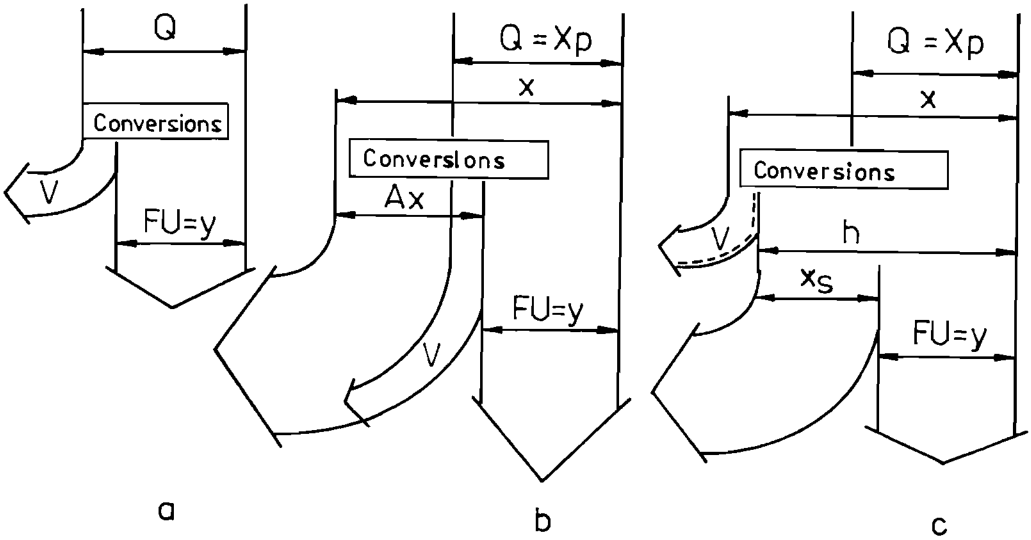

FIGURE 2 The same energy flow in different senses.

The variant (a) shows the original (simplified) energy flow, aggregated for the whole system. From the real resources (Q), after their partial conversions, there is available a final use (Fu = y) for the national economy.

The variants (b) and (c) illustrate the situation according to the input-output matrices of both types (Figure 1 A or U), when $x>Q$ is the accumulated (double counted) energy resource received by computations and the real resource Q from the accumulated x value in the vector of the primary energy carriers x_p only. The accumulation of the resource x appears in the accumulated losses Ax in the case (b), and mainly in the fictitious final use $h = y+x_s$ in the case (c), respectively.

It has to be emphasized that in all the three cases the direct losses of the energy supply system (v) include - unlike in the classical methods - not only the conversion losses but the final use of all the power-engineering branches and the LS and ETD components (the latter twice in the case (c)).

4. MAIN CONNECTIONS FOR COMPUTATIONS

On the basis of input-output models, (similarly, but more detailed than those) outlined in Figure 1 and of the energy flow diagrams in Figure 2, connections of different kinds can be set up to link both sides of the energy flow, the final use (y) and the resources (x) and to analyze the situation of the losses and efficiencies. To formulate the connections, we used:

- two types of matrices of direct specific coefficients i.e. A and U, the first one concerning the energy allocations and the second the energy losses[2];
- and the inverse matrices derived from the former.

The columns and rows of the matrices express, using the same terms, both the power-engineering processes (energy production and conversion), and their primary (x_p) or secondary (x_s) energy carriers.

The basic formulae for computing the main characteristics of the energy supply systems on the basis of energy flow are:

$$A\cdot x + y = x \quad \longrightarrow \quad x = (E-A)^{-1}\circ y = R\circ y$$

$$U\cdot x + h = x \quad \longrightarrow \quad x = (E-U)^{-1}\cdot h = S\cdot h$$

In the basic formulae the coefficients are as formerly mentioned. A complete overview of the main connections and the coefficients can be seen in the Table 1. Further connections for analyzing the energy supply at the national level shall be detailed in the later adaptability examples.

TABLE 1 The main connections and coefficients.

		On the basis of matrices				Dimensions
		of allocation		of losses		
Basic formulae		$\underline{x} = A\underline{x}+\underline{y}$		$\underline{x} = \underline{h}+U\underline{x}$		J/Year
		$\underline{y} = (E-A)\circ\underline{x}$		$\underline{h} = (E-U)\circ\underline{x}$		J/Year
		$\underline{x} = (E-A)^{-1}\cdot\underline{y} = R\cdot\underline{y}$		$\underline{x} = (E-U)^{-1}\cdot\underline{x} = S\circ\underline{x}$		J/Year
Matrices and their coefficients	D	M	$[m_{ij}]$	V	$[v_{ij}]$	J/Year
	D	$A = M\circ X^{-1}$	$[a_{ij}]$	$U = V\cdot X^{-1}$	$[u_{ij}]$	J/J
	T	$R = (E-A)^{-1}$	$[r_{ij}]$	$S = (E-U)^{-1}$	$[s_{ij}]$	J/J
	T			$U\cdot R$	$[u_{ij}\cdot r_{ij}]$	J/J
Vectors of losses and their coefficients	column D	$A\circ x$	$[m_{ij}]$	$\underline{v} = U\cdot\underline{x}$		J/Year
	row D	-		$\underline{v} = \left[\sum_i u_{ij}\cdot x_j\right]$	$j=1\ldots n$	J/Year
	column T	$A\cdot x = (R-E)\circ y$	$[\varrho_{ij}]$	$\underline{v} = (S-E)\circ h$	$[\sigma_{ij}]$	J/Year
	row T	-		$\underline{v}^{T} = \left[\sum_i \sigma_{ij}\circ h_j\right]$	$j=1\ldots n-2$	J/Year
	column T	$\underline{v} = U\cdot R\cdot\underline{y}$			$[v^T_{ij}]$	J/Year
	row T	$\underline{v}^{To} \equiv \left[\sum_i u_{ij}\circ r_{ij}\cdot y_j\right]$			$j=1\ldots n-2$	J/Year

D - direct; T - total (with former phases).

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[2] The A and U specific matrices can be defined for analyzing the past and the present from the matrix of energy allocation M and of energy losses V res-

5. SOME RESULTS OF INVESTIGATIONS

Within the framework of this study it is possible to get an insight only few main results in some research fields, such as efficiency and losses of energy supply, computation of demand for energy resources and national resources, and finally, the effect of energy conservation and substitutions.

5.1. Efficiency of the Energy Supply

The efficiency of the processes can be expressed at the power-engineering and at the national level by means of the A or R matrix coefficients respectively.

Power efficiency for production: $\eta_e = 1/(1+a_j)$
for conversion: $\eta_e = 1/a_j$
"National level" efficiency for both: $\eta_n = 1/r_{jp}$

where

$$a_j = \sum_{i=1}^{n-2} a_{ij} \qquad (j = 1 \ldots n-2)$$

$$r_{jp} = \sum_{i=1}^{p} r_{ij} \qquad (j = 1 \ldots n-1)$$

In the Table 2, there are final quantitative η results of the computation, proving the main effects of the interrelationships of the processes in the energy-supply system. It is an important feature that there are gaps (rather different) between η_{en} and η_n values.

TABLE 2 Efficiency values.

	1	2	3	4	5	6	7	8	9	10–11	12–14	15	16	17–19	20	$\sum$
η_{en}	97.7	97.9	98.6	98.1	100.0	98.0	100.0	96.5	93.4	87.0	93.1	94.2	78.8	35.3	88.5	74.5
η_n	93.9	92.4	94.6	94.6	99.9	93.7	93.7	85.6	83.5	76.1	88.5	83.0	67.8	26.9	66.9	71.2

They are very striking, when a process uses relatively much electricity and/or steam as auxiliary (+transport and losses) for processing, the efficiencies of which are much the worst. Such processes deteriorate very strongly the efficiency of the supply system.

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pectively, available from power-engineering statistics and computed by $A = M \cdot X^{-1}$ and $U \cdot X^{-1}$, where X is a diagonal matrix of the resource vector x. The E is the unit matrix. For computing future demands, the coefficients a_{ij} and u_{ij} are known, or can be prognosticated on the base of supposed power-engineering development.

It is very interesting to analyze the conditions in the case of power generation, being composed of processes one after another (fuel-steam and steam-electricity), on the one hand, and parallelly in the second phase (condensational and reactive power generation), on the other hand. The results can be seen in the Table 3.

TABLE 3 Efficiencies of the Electricity Generation.

Coefficient	A	B		C		D
	Fuel Steam	Steam-Electricity		Fuel-Electricity		$\sum$ Electricity
		cond.	reaction	cond.	reaction	
η_{en}	83.1	37.3	86.1	31.1	67.9	35.3
η_n	73.6	24.2	46.8	24.2	46.8	26.9

The values in section C have been computed as $\eta_A \times \eta_B$ and in the section D as weighted averages of the condensational and reactive power generation, on the basis of C values.

Similarly, Refining (12-14) and Coking (10-11) have been characterized by weighted averages in the table.

In the model 26 x 26, the results of steam and power generation are detailed by energy structure (coal, oil, natural gas). The Table 4 shows the figures of the steam generation.

TABLE 4 Efficiencies of the Steam Generation.

Coefficient	Based on			$\sum$
	coal	oil	n. gas	
η_{en}	67.9	79.9	85.4	79.6
η_n	58.8	66.5	74.5	68.4

Similarly, the coefficients of the power generation, presented in the Table 2 could be detailed according to the energy structure (the computation contains them in such detail).

The difference between η_{en} and η_n of the whole system (74.5 and 71.2%) is motivated by the LS and ETD items of the model (21st and 22nd rows and columns).

5.2. Losses of Processes

For analyzing the losses, the following questions can be put:
- how big losses originate directly in the processes?
- how do the process-losses pass from one to another within the supply system? and
- which total (accumulated) losses charge the energy outputs (y) ?

All these analyses can be carried out in relation to energy units (specific values) or to the whole energy quantities.

The quantified direct loss situation can be outlined on the basis of

U and V matrices consisting of u_{ij} direct coefficients respectively. The summings $\sum_i u_{ij}$ give direct losses in producing the product j (j=1...n-2); u_j are specific and v_j absolute values (J/J and J/Year).

The specific and absolute losses in producing the product j, but containing also the losses coming from the former processes, can be determined on the basis of (S-E) and (S-E)∘< h>relationships.

Finally, the losses relating to the y output can be quantified by using the relationships U∘R and (U·R).<y>. The components of these total loss row vectors are presented as specific ones $u^T_j = \sum_i u_{ij} \cdot r_{ij}$ and the absolute values $v^{To}_j = \sum_i v^T_{ij}$ or $= u^T_j \circ y_j$ (j=1...n-2).

In the Table 5, there are compiled all the three types of absolute losses from which very interesting conclusions can be drawn, analogously to the efficiency relations. Both important questions can surely be answered, i.e. in which processes and in the interest of which of them do the main items of losses of the system rise?

TABLE 5 The losses of processes in PJ.

	1	2	3	4	5	6	7	8	9	10-11	12-14	15	16	17-19	20	21	22	$\sum$
v_j	1.3	5.9	1.9	3.6	0.1	9.1	4.6	1.5	0.3	5.4	28.5	0.6	50.4	180.4	6.4	14.1	19.7	333.6[a]
v^T_j	2.7	13.3	4.7	7.0	0.3	16.6	12.1	2.7	0.4	7.9	37.6	0.8	55.4	162.8	9.1	-	-	333.6[a]
v^{To}_j	0.1	4.9	1.3	-	-	8.2	6.1	6.1	0.1	9.4	35.8	1.6	59.9	174.8	25.5	-	-	333.6[a]

[a] Without double counting of the items 21 and 22 the sum in 299.8 PJ.

Otherwise, on the basis of different loss matrices (V, (S-E)<h> and (U·R)·<y>) different tables of percentages have been set up for the distribution of the losses to select the main loss inducing process phases of the system (to reach the most effective improving by reducing them). It is very remarkable that almost a half of the losses comes from the power generation, and the same amount from the losses in electricity distribution.

5.3. Computation of Energy and National Resources

The energy allocations can be taken into account directly and as accumulated ones, both in specific and in absolute values. The specific allocations can be analyzed on the basis of the A (direct) and R (inverse) matrices. The $a_j = \sum_i a_{ij}$ components give the energy quantity needed for producing one unit of the j energy carrier and the $r_j = \sum_{i=1}^{p} r_{ij}$ that needed for the output unit of j. The latter sum contains only the primary energy (i=1...p), but j=1...n-2. When computing the national resources, we still have to take into account $r_j^T = \sum_{i=1}^{n} r_{ij}$ compiled in the table 6. (See the striking electricity data)!

To compute absolute allocation values, e.g. future energy demands, we use the basic formula $\underline{x} = R \cdot \underline{y}$. In such cases, the final use ($\underline{y}$) and the specific allocations ($\bar{A}$) are generally known, then the R and the x and $Q = x_p$ resources as well as the $M = A\langle x\rangle$ can be determined.

TABLE 6 The direct and accumulated allocation coefficients.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
a_j	.023	.022	.015	.02	.00	.02	.00	1.04	1.07	1.15	1.15	1.07	1.07	1.07
$r_{j \cdot p}$	1.06	1.08	1.06	1.06	1.00	1.07	1.07	1.17	1.20	1.34	1.25	1.13	1.13	1.13
r_j	1.15	1.19	1.13	1.13	1.00	1.14	1.17	2.60	2.42	2.69	2.45	2.28	2.26	2.27

	15	16	17	18	19	20	21	22
a_j	1.06	1.27	1.20	2.68	1.23	1.13	1.0	1.0
$r_{j \cdot p}$	1.20	1.47	1.36	4.13	2.14	1.50	1.43	2.81
r_j	2.69	3.17	2.76	9.65	5.60	3.73	3.50	7.30

In the Table 7, there are presented the main results of the investigation concerning the resource increments of the variants in different structure suppositions for a 15-year development.

TABLE 7 Main characteristics of the variants.

Results		y [PJ]	$Q = x_p$ [PJ]	η %	$Q/y = 1/\eta$
Starting		843.1	1 095.7	77.0	1.30
Variants	1	1 311.1	2 032.5	64.5	1.55
	2	1 330.7	2 095.2	63.5	1.57
	3	1 301.0	2 114.4	61.5	1.63
	4	1 301.0	1 890.3	68.8	1.45
	5	1 301.0	1 890.3	68.8	1.45

The different energy bases of the supply for the variants were lignite, coal, natural gas, atomic energy combinations, respectively. They all differed from the statistical structure of the past, and exceptionally the variant 1.

The striking result is that in spite of nearly the same final use (y) the resource values ($Q = x_p$) vary quite significantly (over 10%). Accordingly the national resources of producing them can differ even to a higher degree. The efficiency decreases in the future because of the higher rate of electricity generation.

The national resources (e.g. manpower, wages, investments) required for the energy supply can be also defined by using the R matrix (the r_j^T coefficients). The results of an example for the labor demand are shown in the Table 8, where the sings are: L = labour in the branches, L/X = 1 their specific values in capita /J, DL the accumulated ones and LL labor related to output (to the final use y).

TABLE 8 Direct and accumulated labour

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$L[10^3$ cap.$]$	9.2	55.0	13.3	48.0	0.8	14.7	3.7	1.1	0.1	3.0	0.9	3.8	1.7	0.7	0.2	13.1	14.7	6.0	0.5	1.0
										3.9		6.2					21.2			
L/X	.17	.31	.16	.05	.00	.07	.03	.03	.03	.13	.13	.02	.02	.02	.03	.08	.07	.08	.05	.02
DL	.18	.32	.17	.06	.00	.08	.04	.27	.24	.35	.33	.05	.05	.05	.15	.26	.28	.94	.50	.22
$LL[10^3$ cap.$]$	0.2	16.1	3.3	-	-	7.0	2.3	8.3	0.1	7.8	0.9	10.2	0.5	1.7	1.0	29.2	-	46.5	3.1	10.1
										8.7		12.4					49.6			

The DL and LL data were computed by the formula: $1 \cdot R \cdot \langle y \rangle$.

5.4. Energy Conservation and Substitutions (and Others)

Analogously to the former observations, the effects of both conservations and substitutions can and have to be taken into account on the basis of the r_j and r_j^T coefficients, by the formulae:

$$\Delta x = R \cdot \Delta y \qquad (\Delta x_p \text{ with the } r_{j(p)} \text{ only})$$

and

$$\Delta L = 1 \cdot R \cdot \Delta y \qquad (\text{for the labor}).$$

Within the analyses of the substitution possibilities, the import-domestic relations are of a great importance. (E.g. instead of one unit output from a certain imported energy carrier charged only with transport one has to produce a domestic primary energy resource of r_{ip} and to handle the total energy quantity and national resources, proportionally with r_j).

Among the further adaptability of the model investigations, the analysis of the energy price system (as task for the future) is worthy of mention.

6. CONCLUSIONS

The study presented only the main results of an experimental work to be continued and enlarged in the future. The results obtained till now prove however the capability of these investigations by the special input-output model to reveal the manifold effects of the energy supply on the economy and to point at the same time the general way of reducing their disadvantages.

The aspects and construction of the prepared model afford a possibility to analyze the situation not only for single country.

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