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Karasz, P.

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P. Karasz

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A-2361 Laxenburg, Austria

FOREWORD

Many of today's most significant socioeconomic problems, such as slower economic growth, the decline of some established industries, and shifts in patterns of foreign trade, are inter- or transnational in nature, so that intercountry comparative analyses of recent historical developments are necessary. The understanding of these processes and future prospects provides the focus for IIASA's project on Comparative Analysis of Economic Structure and Growth.

Our research concentrates primarily on the empirical analysis of interregional and intertemporal economic structural change, on the sources of and constraints on economic growth, on problems of adaptation to sudden changes, and especially on problems arising from changing patterns of international trade, resource availablity, and technology. Input-output techiques are mature techniques, but still important means of an analysis of structural changes. In this paper P. Karasz gives a short overview of the Czechoslovakian I/O model built in general in such a way that it may be used for analytical purposes as well as for being linked to a set of INFORUM-type models.

Anatoli Smyshlyaev
Project Leader
Comparative Analysis of
Economic Structure and Growth

INFORUM-TYPE MODEL FOR CZECHOSLOVAKIA

Pavol Karasz

*Research Institute for Regional Economic Planning,
Cintorinska 5, 816 44 Bratislava, Czechoslovakia*

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 modeling 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 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 use 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 structure of the economy, as other 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 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 (at the aggregated or disaggregated level) over the time horizon of a forecast.

Predicted 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).

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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 non-productive services in the 28 industries shown in Appendix 1 on the supply side.

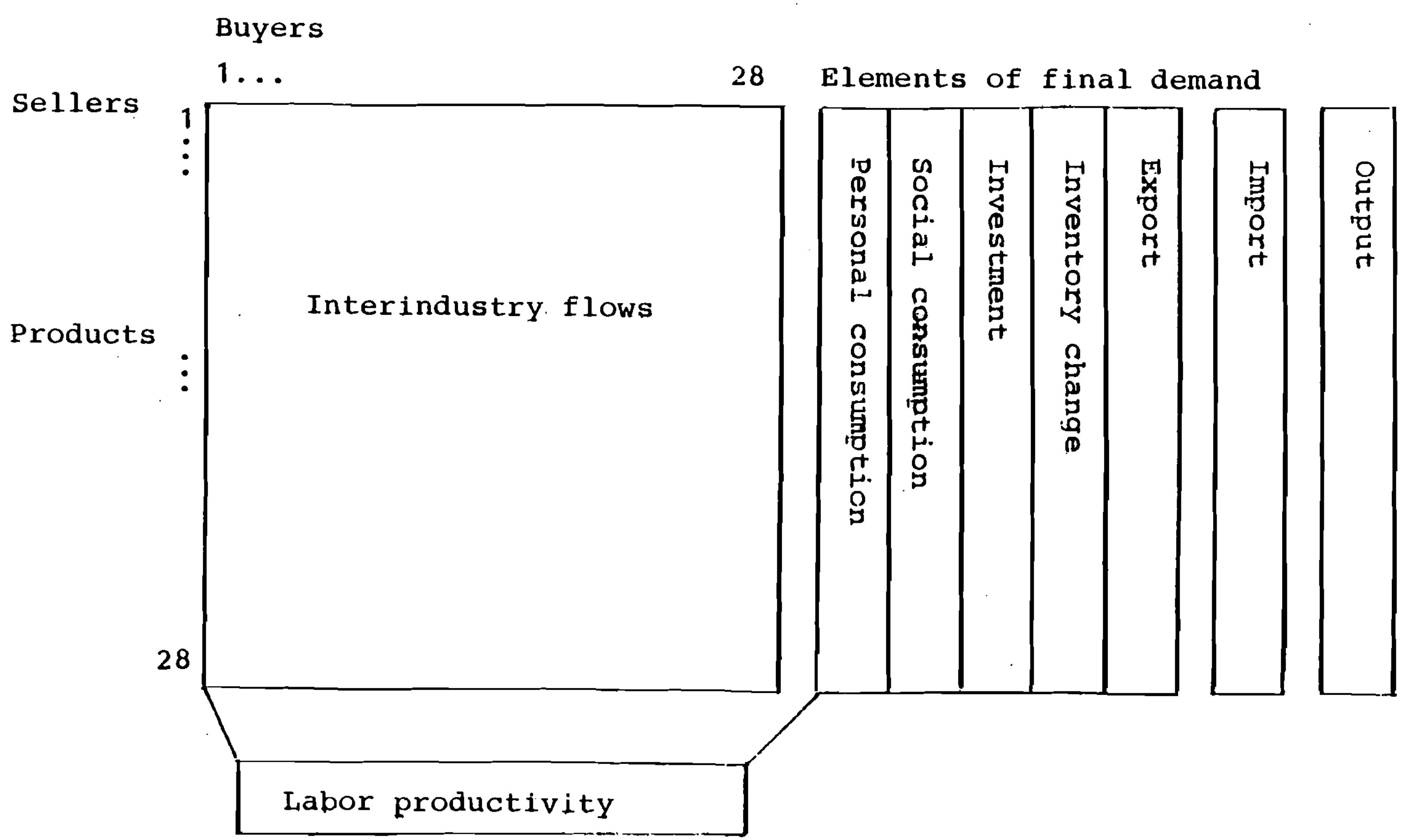

Figure 1. What the Czechoslovak model shows for each year.

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

3. THE TYPES OF BEHAVIORAL FUNCTIONS USED

a. Personal Consumption

In the sphere of modeling of personal consumption we have started 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) $C_i^t = \alpha_i + \beta_i Y^t$, or

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

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 (taxes, etc.).

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.

Income elasticities for goods produced by essential branches from the point of view of personal consumption are described below[2]:

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

b. Social Consumption

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

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

[2] They are short-run elasticities and their sum is not equal to one, because the lagged dependent variable is important for many commodities, i.e. model (ii) has been used.

where

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

c. 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:

$$\Delta I_i^t = a_i(\alpha + \beta X^t) \quad (1)$$

where

ΔI_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 invetory change we obtain the function:

$$\Delta I^t = 10844.31 + \underset{(0.0079)}{0.028}\, X^t \quad .$$

d. 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 construction volume 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:

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

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 striking 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 treat the given function as a reflection of 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 function for total investment is estimated as:

$$V^t = 72326.76 + \underset{(0.08)}{1.0075}\, V^{t-1} + \underset{(0.0006)}{0.0282}\, X^{t-1} - \underset{(0.024)}{0.0662}\, X^t \; .$$

The total investment is split into the relevant branches (equipment and construction) by shares derived from the base year.

e. 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;

D_i^t - value of world imports of the i-th commodity in current prices (in million franco crowns).

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 exporter's position (more production - more exports) and a positive value of c_i corresponds to demand orientation of the producer's position (more world trade - more exports). On the other hand, a negative value of b_i corresponds to non-supply conditions from the exporter'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 some branches are given below:

Branches	a_i	b_i	c_i
Fuel industry	3229.6	-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)
Machine building	-27137.4	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	-1719.6	0.19 (0.00)	-0.02 (0.00)
Wood industry	4350.6	-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 (0.02)	-0.01 (0.00)
Textile industry	-296.1	0.11 (0.02)	0.03 (0.00)
Clothing industry	160.9	0.11 (0.07)	0.03 (0.00)
Leather industry	-1117	0.34 (0.05)	0.006 (0.000)
Food industry	8173.1	-0.06 (0.00)	0.04 (0.00)
Transportation	-8111.1	0.28 (0.01)	0.03 (0.00)
Trade	-4772.9	0.4 (0.04)	0.13 (0.03)

From the above coefficients follows that only in the fuel industry, the wood industry, and the food industry there are non-supply conditions from the exporter's position. This fact is given first of all by the character of goods determined by the above branches, and also by the role of these goods within the Czechoslovak economy. The non-demand conditions from the producer's position in ferrous metallurgy, machine building, production of building components, and glass, ceramics, and procelain mainly follow from the level of competent goods with respect to the situation of foreign markets.

f. Imports

In the sphere of import modeling the pure supply approach was preferred. This fact was supported first of all by the character of the Czechoslovak foreign trade. More than 70% of the Czechoslovak imports are from socialist countries, and in this area the dominating aspects are, in general, the needs of the buyer country, i.e. imports are considered as complementary ones. 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 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 determination 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, $a_i \geq 0$. 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 estimated coefficients of the import functions are given below:

Branches	a_i	b_i
Fuel industry	-65650.5	1.66 (0.08)
Ferrous metallurgy	1482.8	0.05 (0.00)
Nonferrous metallurgy	-4219.4	0.56 (0.02)
Chemical and rubber industry	408.2	0.24 (0.00)
Machine building	-4044.6	0.33 (0.01)
Production of electrical machinery and appliances	-1390.2	0.15 (0.00)
Textile industry	-2401.9	0.18 (0.00)
Transportation	-5939.3	0.30 (0.00)

g. Labor Productivity

The starting point for an 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). 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.

Assuming that changes in labor productivity are determined by the character of the economic system's development, labor productivity is defined as a function of time:

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

where

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

At the national level rates of growth of labor productivity are about 3.5%:

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

4. CHANGES IN COEFFICIENTS

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

A logistic curve is defined by the differential equation

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

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

The solution of this differential equation is

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

where A is a constant of integration.

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

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

or

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

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

The above equations have been applied only for the most important coefficients (see Appendix 3). For the rest of the coefficients the structure derived from the base year was 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 considering a share of intermediate inputs in total output. Changes in these shares are given below for a selected group of branches.

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
Machine building	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 recent stage 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 INFROUM-type models linked in the sphere of foreign trade.

The basic contribution of the real side of the model by 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 mechnisms. It seems to be reasonable to start with the linkage of the Czechoslovak model to the models of 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 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 highly developed centrally planned economies and post-industrial types of market economies can be an interesting subject for research.

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.

Branches	Pers. cons.	Soc. cons.	Invest.	Inv. 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						

x - essential branches

APPENDIX 3.

Branches

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								

x - important coefficients