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Options in Solving Methodological Problems of the Interbranch Balance

Although the first interbranch balance was published 33 years ago, no pattern model of such a balance has been drawn up so far. In this article, the authors state their point of view with respect to the way of solving certain methodological problems.

The constant development of Romanian economy results in a specialization of production and co-operation among various enterprises, in a intensification of the contacts among various manufacturing units and in an expansion of the relations with foreign countries. Under such circumstances, the traditional analysis and planning methods turn out to be insufficient and new, up-to-date forms are required to contribute to an increase efficiency in using the material means and investments in the productive process.

The interbranch balance can be represented, in its most general form, in the illustrative scheme on page 66.

The interbranch quadrants are organically related to one anothor and they reflect in a correlated way the process of expanded reproduction on a national scale and by separate branches. These quadrants lay bare the interbranch production—consumption relationships and enable a correlation of the coefficients expressing quantitatively the dependency of certain branches, on the one hand, and the intermediate productive consumption, on the other hand, both on a national scale and by branches.

By totalling the lines we obtain the relationships concerning the material structure of production, that is the products distribution (destination) for each branch, These relationships, termed *balance equations of output distribution*, are expressed under the following form:

$$X_i = \sum_{j=1}^{n} x_{ij} + Y_i \qquad (i = 1, 2, ..., n) \tag{1}$$

Illustrative scheme of the interbranch balance

Consuming branches / Productive branches		Intermediate productive consumption					Final consumption				Social product
		Branches of material production				Total	Total	Out of which:			
		Industry	Construction	Agriculture	Other branches			Consumption	Accumulation	Export	
		1	2	j	n	a	b	c	d	e	$f = a + b$
		Quadrant I					Quadrant II				
Industry	1	x_{11}	x_{12}	x_{1j}	x_{1n}	$\sum x_{1j}$	Y_1	C_1	A_1	E_1	X_1
Construction	2	x_{21}	x_{22}	x_{2j}	x_{2n}	$\sum x_{2j}$	Y_2	C_2	A_2	E_2	X_2
Agriculture	i	x_{i1}	x_{i2}	x_{ij}	x_{in}	$\sum x_{ij}$	Y_i	C_i	A_i	E_i	X_i
Other branches	n	x_{n1}	x_{n2}	x_{nj}	x_{nn}	$\sum x_{nj}$	Y_n	C_n	A_n	E_n	X_n
Total	a	$\sum x_{i1}$	$\sum x_{i2}$	$\sum x_{ij}$	$\sum x_{in}$	$\sum\sum x_{ij}$	$\sum Y_i$	$\sum C_i$	$\sum A_i$	$\sum E_i$	$\sum X_i$
State, co-operative organizations and population's primary incomes	b	Quadrant III					Quadrant IV				
		x_{01}	x_{02}	x_{0j}	x_{0n}	$\sum x_{0j}$					
Social product	f	X_1	X_2	X_j	X_n	$\sum X_j$					

where

n = number of branches reflected in the balance;
X_i = gross production of branch i;
x_{ij} = quantity of products (raw materials, fuel, etc.) produced by branch i and transferred for intermediate productive consumption to branch j;
Y_i = final product of branch i, that is, the share of production X which is not used for intermediate productive consumption in other branches, but is meant for accumulation (investments, increase of stocks and reserves), for consumation (individual and social), and for export.

By totalling the columns we obtain the composition relationships according to the production value. These relationships, termed balance equations of production costs are expressed under the form:

$$X_j = \sum_{i=1}^{n} x_{ij} + x_{0j} \qquad (j = 1, 2, ..., n) \tag{2}$$

where x_{0j} = State, co-operative organizations and population's primary incomes, as well as amortization.

The mathematical model of the interbranch balance is meant to express the interbranch dependencies within national economy through the so-called production functions, showing the way the production level is affected by its factors. The correlated expression of the production functions is one of the basic problems of planning. Mathematically speaking, the interbranch dependencies are expressed by the consumption coefficients, which reflect the quantity of products supplied by various branches in order to ensure the production of the branch analyzed. These coefficients, usually denoted by a_{ij}, express a ratio between the amount of total costs in branch i for manufacturing products required by branch j, and the amount of total production of branch j:

$$a_{ij} = \frac{x_{ij}}{X_j} \tag{3}$$

which gives

$$x_{ij} = a_{ij} \times X_j \tag{4}$$

We should note that these costs coefficients reflect direct relationships between branches, being denominated for this reason direct consumption coefficients. They point out how the production increase of a certain branch bears an influence on the production achieved by other branches. For instance, an increase of the trucks made by the corresponding industry will require an additional consumption of steel, pig iron, electric power, etc., which means direct consumption. It is obvious that this increase of raw materials consumption will require, in turn, a production increase by the branches supplying raw materials, that is, new consumptions of steel, power, etc. These total consumptions, sensibly differing from the direct ones, are ascertained with the aid of integral consumption coefficients.

The concrete data expressing the interdependencies of the branches of national economy at a given moment, as well as the coefficients of direct

consumption and of integral consumption for each branch proceeding from other branches or from own production, are of particular importance for the analysis and planning, in view of finding out technical and economic relationships by applying up-to-date mathematical methods of investigation.

In order to find out integral consumption coefficients, we should start from the way of expressing the amount of total production of a branch through the system of equations shown before (1), by substituting x by the equality shown (4):

$$X_i = \sum_{j=1}^{n} a_{ij} X_j + Y_i \tag{5}$$

With the direct consumption coefficients of this system of equations the matrix

$$A = (a_{ij}) \tag{6}$$

is formed, and the system of equations expressed above in a matrix form becomes

$$X = AX + Y \tag{7}$$

or, in a modified form,

$$(E - A)\, X = Y \tag{8}$$

The solution to the matrix equation being given by the equality

$$X = (E - A)^{-1}\, Y \tag{9}$$

where:

$(E - A)$ = the difference between the unit matrix and the technical coefficients matrix of direct consumption;
X = the line vector with components $X_1, X_2, \ldots, X_n$
Y = the column vector of final consumption with components $Y_1, Y_2, \ldots, Y_n$.

Such systems of equations are practically solved by means of the reverse matrix, which enables obtaining immediately the quantities $X_1, X_2, \ldots, X_n$ by multiplying each line of the matrix by the column vector of free terms. By reversing the matrix, the integral consumption coefficients can be calculated, that is, the sum total of direct and indirect consumption of the products of a branch meant to enable the production of another branch. Since the computation to be carried on is extremely laborious, this problem can be approached only by making use of electronic computers.

As soon as we get the reverse matrix (through the complete elimination method or through other methods) and the free terms column (given or chosen), we can find out any element belonging to the column of unknowns.

That means that as soon as we have a possibility of assigning diverse values to the free terms column, respectively values corresponding to a set of products used for non-productive consumption and accumulation, we can find out the desired number of plan variants for developing national economy.

Having at our disposal data concerning the final production structure of a branch as well as the table of integral consumption coefficients, we can ascertain the production of each branch by multiplying each line vector of the matrix by the column vector of final production.

On the basis of the data obtained from the interbranch statistical balance, the following can be, then, found out:

— the mutual dependencies between the branches reflected in the balance, in the sense that a change in the production level or structure of a branch involves a series of changes in the production level and structure of the branches with which that branch has input-output economic relationships;

— the dependency between the production level, on the one hand, and the final consumtion amount (accumulation, non-productive consumption, export), on the other hand;

— the required production level for obtaining a certain amount of final consumption for a given structure and the changes required by the production level and structure, by branches, in the eventuality of a change in final consumption structure;

— the influence exerted by a possible change in prices or in wages on money accumulations.

* * *

In the specialty literature and in the papers written so far there is a different approach to the solving of certain basic methodological problems related to the drawing up of the interbranch balance. It is only natural that the classification of the branches, the balance size and the way of including the import in the balance should differ from one country to another and that the balance should be adapted to the specific features of each economy in agreement with its structure and diversification degree. However, there are also problems related to principles, whose way of solving has direct implications for the expressing capacity of the balance and for its possibilities of use.

Such a problem refers to the way of including the amortization and investments in the balance. The solutions envisaged differ in accordance with the way in which the essence and the part of the interbranch balance are interpreted as a model of national economy.

There is, on the one hand, the tendency of considering the interbranch balance as development of the social product and of working it out according to its basic principles, and, on the other hand, there is the conception considering the interbranch balance as a completely new tool whose functions consist in ascertaining the quantitative aspects of the interdependencies of the branches of national economy from a specific standpoint.

The supporters of the former view insist in the necessity of observing, when drawing up the interbranch balance, one of the principles governing the balance of the social product as regards the division of production into material cost, living labour and surplus product. The latter two constituent parts belong to quadrant III, whereas the material expenses belong to quadrant I; hence, the requirement that this latter quadrant should include the cost related to the amortization of fixed capital assets as well. "The first quadrant of the balance reflects not only the consumption of objects of la-

bour but also of means of labour, under the form of their amortization, which corresponds to the share of machine building industry production meant for the simple reproduction of fixed capital assets" [1].

The absence of an interbranch balance in which the amortization should be found in quadrant I is explained by the supporters of the aforesaid theory for practical reasons — having in view the great difficulties related to the separation of investments required by simple reproduction, which is carried out at the expense of amortization — although they insist in the necessity of finding a modality of accomplishing such a separation in the future.

In contrast with this standpoint is the view according to which the system of dependencies underlying the interbranch balance should have an input-output character with the capacity of reflecting the effective transfer of goods and services from a branch to another, from the producer to the consumer, in the sense that each input of a branch should be concomitantly an output of another branch. For this reason, the drawing up of the chessboard of the interbranch balance requires a considerable amount of work for investigating each place from the standpoint of the nature of mutual dependencies and for checking the correlations from the viewpoint of the technological process [2].

Consequently, the solution according to which the inner side (quadrant I) of the interbranch balance should include all materiall costs, no matter whether these were related to objects of labour or to means of labour, would infringe a basic requirement of the balance, since it would artificially include in its mathematical model some elements which do not represent an input-output process and do not meet the essential and indispensable condition of existence of a linear dependency, in the sense that:

— The production transfers from a branch to another in the input-output balance model refer exclusively to objects of labour, as their separations from the means of labour is one of the primary prerequisites of the mathematical model which should express linear-type dependencies within a given time period. However, it is known that the amortization level depends on certain set quotas, which are not included among the input-output dependencies reflected in the balance. Besides, by including the objects of labour together with the means of labour, the material production costs are mixed with part of the investments, whereas by separating them the possibility of representing the dependencies related to the objects of labour in quadrant I is secured, and the investments appear as a whole (rough investments) in quadrant II.

— The amortization, as a monetary flow, does not coincide with the material flow, as the amortization computing is not accompanied by an affective consumption of materials. However, only the products that are manufactured and consumed during the time interval considered stand in quadrant I, whereas the amortization — representing the gradual consumption of fixed means which are yielding their value to the product — is a partial consumption of goods produced before the time interval considered. For this reason, the amortization cannot be included in quadrant I, but as a line vector in quadrant III.

Apart from all this, one should realize that an inclusion of the amortization in quadrant I would mean to make evident in the columns of this qua-

drant part of the production of means of production representing investments for simple reproduction. The filling up of this column would require a separation of the means of production intended for simple reproduction from the ones intended for expanded reproduction, under conditions that such a separation is unusual and practically impossible. Irrespective of the financing source (amortization or accumulation) and of the type of reproduction (simple or expanded), investments make up a whole and should be dealt with as such in quadrant II of the balance.

In this respect, we think that there is no essential contradiction between the principle of the social product balance, on the one hand, and the meeting of the requirements of the interbranch balance mentioned before, on the other hand, which entails a rearrangement of the constituent elements of material expenses. This means that the structure of the elements belonging to the interbranch balance may differ from the corresponding indicators belonging to other balances of national economy, and these differences must be known in order to correlate them with the data of the other balances.

The interbranch balance is a new instrument, with specific functions, whose essence consists in providing the quantitative expression of the production technological dependecies but not in synthesizing or replacing other balances of national economy. This basic requirement must govern the solving of certain problems of comparability and contents with the aid of other balances, and not the other way.

Only by observing this rule will the interbranch balance be able to reflect the correlations which cannot be reflected in the other balances of national economy. The relationship between the input-output type balance and other balances of national economy should be approached not from the standpoint of the identity of certain common aspects, but from the one of their complementarity.

Viewed as such, the relationship between the input-output type balance and the other balances—among which we should cite the material balances, the balance of production, consumption and accumulation of the social product, as well as the balance of production, distribution, redistribution, and final use of national income — is obvious.

The problem of the way of reflecting the activity of certain branches, — for instance, the goods turnover — is in close connection with the principle of consequently reflecting the input-output relationships in quadrant I of the interbranch balance.

It is considered that on choosing the branches in the interbranch balance, the intersection of the lines and columns in quadrant I should result in production technological relationships, and not in turnover relationships, for it is only in this way that the quantitative dependencies necessary for the analysis and planning of the production technological relationships can be found out. In agreement with this principle, the goods turnover should apper in the interbranch balance as a distinct branch that renders certain services to other branches (quadrant I) and ensures a certain amount of goods for final consumption (quadrant II). The function of trade as a redistributor of materials among the branches should not be reflected in quadrant I of the interbranch balance. For instance, if woven materials proceeding from the branch of tex-

tile industry reach the branch of confections through the instrumentality of the turnover branch, this intermediate stage must not be reflected because in the input-output mathematical model we have to do with an input from the textile branch to the confections, but not with an input from the textile branch to the turnover branch and next from this one to the confection branch. The service rendered by the turnover branch should apper on a separate line in quadrant I, and the material flows of the other branches should be expressed in this quadrant as if they occurred directly between the producer and the consumer, without the instrumentality of turnover.

The value of the services rendered by trade is represented in quadrant I under the form of material turnover costs, and in quadrant III under the form of wages paid to the workers in this branch, and of profits. In this way, the branch of goods turnover is represented in quadrant I only by the turnover costs, while the goods sold for consumption or investment are represented only in quadrant II, for unproductive consumption or for accumulation [3]. We think that this solution is the only possible one from the standpoint of representing the production technical dependencies. The solution aimed at reflecting the relationships producer-trade and trade-consumer in the balance would be an interesting scheme from the standpoint of the link analysis, but it would be unserviceable for reflecting input-output relationships from the standpoint of production technological dependencies.

The third problem derived from the requirement of representing the production technical dependencies is related to the classification of branches of national economy. A branch classification in which the unit surveyed is the enterprise, included in a branch or another, depending on the value preponderance of its products, is used in current statistics and planning. Since the enterprises have not, as a rule, a homogeneous production, the branches include different products in present classification. With a view to make evident the technical production dependencies in the interbranch balance, the branches should be as pure as possible. To this end a new branch classification becomes necessary, in which the unit surveyed is not the enterprise but the product, as the branch is ascertained through a product or a group of homogeneous products. In such a case, the heterogeneous production of an enterprise should be included in as many branches as different products are manufactured.

The specialty literature emphasizes the particular importance of the way in which products and activities are grouped in the interbranch balance in order to make evident, as much as possible, the degree of social division of labour in the corresponding stage and the production tenchnical dependencies among the branches of national economy. The experience has proved that the more homogeneous the branches considered, the more effectively can the interbranch balance be used as a mathematical model [3].

One of the most difficult problems related to the pure branch classification of national economy for balance purposes concerns the ensuring of a comparability between the new and the traditional classification. As the plan is incumbent on the enterprises and these ones report its fulfilment, the use of cost coefficients in the balance for substantiating the plan assumes the drawing up of a passing key from the traditional to the pure branches classification.

Such a recomputing entails a number of difficulties which somehow hamper the use of this tool in drawing up and substantiating the plan. It is possible that a balance drawn up with considerable effort may not be used at the due level on account of the great discrepancies existing between the current classification in statistics and planning, on the one hand, and the classification used in drawing up the interbranch balance, on the other hand. Besides, a codified list of products is required, in order to secure their unitary classification by the enterprises in the branches which are the object of the balance, as well as the adaptation of the accounts so that each product may be classified both from the standpoint of the manufacturing branch and of the consuming one. This preparatory work should be carried out with particular care. In this respect, a good knowledge of the structure and degree of diversification of economy is necessary, because the datailing and grouping of the products are decisive for the balance size. A balance comprising an exaggerated number of branches is liable to great difficulties in data collection and mathematical processing of the model, while the results facilitated by a balance comprising few branches are not quite noteworthy.

One of the problems dwelt on in specialty literature refers to the prices used in estimating production in the interbranch balance. Here, we have to do with two aspects: the option between the consumer's and the manufacturer's price, and the consequences resulting from the mathematical processing of the balance, due to the price differences.

Some specialists hold the view that it is advisable to draw up the balance in agreement with consumer's prices —including transport and turnover costs — since the data are easier to collect from the enterprises accounts and the prices reflect the effective value amount of supplies. Some others state that, on the contrary, it is preferable to represent the balance in agreement with manufacturer's prices, for enabling a purer expression (without carriage and turnover costs) of the production technological dependencies and of the contribution made by the transport and turnover branches, by representing in the balance the services rendered by these to the other branches.

This problem stays open because theoretical reasons in favour of both variants can be brought forward and, from the practical standpoint each of them offers certain advantages. It is typical that most balances in the socialist countries have been drawn up in both variants.

As regards the second aspect of the price problem, it is generally considered that the indicators should be represented in the balance under the form of unitary prices, because this is one of the essential conditions of further mathematical processing of the interbranch balance and the deviation of prices from their value prevents an effective ascertainment of the part the various branches play in creating the national income and distort any efficiency computation [6], [7]. Consequently, a number of authors think that the prices must reflect actual relationships as regards production social costs and that the prices must be unitary for the same product [5].

The coefficients of direct costs established on the basis of non-unitary prices result in distortions when reversing the computation matrix for the

coefficients of total costs. Starting from this, the problem of carrying out computation in view of ascertaining pure prices and representing the interbranch balance in conventional prices has been set forth [3]. However, such attempts have not given serviceable results because:

— any model drawn up in pure conventional prices would deviate from the reality and would not correspond to the actual proportions in economy;

— any bearing to actual sizes of production, national income and social product would disappear;

— computation in view of ascertaining pure prices requires an enormous amount of work and, in the specialist's opinion, is applicable to homogeneous products alone;

— all results obtained from a mathematical model and represented in pure conventional prices cannot be used for real analysis and planning work, for any reasoning would require an intricate computation for transposing pure prices into effective ones.

For the reasons expounded, all the statistical balances have been drawn up in effective prices faithfully reflecting the actual ratios between the prices. There is a general opinion that the problem of prices homogenity can be solved only in the long run, at the same time with a general improvement of this price system.

A methodological problem of capital importance, whose solving differs from a country to another, concerns the way of including imports in the interbranch balance. It is obvious that the differences may be conditioned by the importance that is granted to this branch and by its weight within production costs or within final consumption.

In the interbranch balance imports may be meant for intermediate productive consumption (raw materials, fuel, etc., and in this case they represent "inputs" for the productive consumption of various branches) or for final consumption, either for accumulation (equipment, machinery, etc.) or for population's consumption (woven materials, cosmetics, colonial produces, etc.).

We think that for the Romanian economy, that has complex economic relations with foreign countries, the import operations should be reflected in a series of variants, in order to make the corresponding analysis in the due time. It is important to compute the coefficients on the assumption of including imports into the production of similar branches, but also to separately compute the coefficients only for the products existing in the inner market. By confronting the two computations, certain conclusions can be reached with a view to better turn to account the national resources.

The specialty literature marks a distinction between the *competitive imports* — concerning imported goods that are also manufactured in the respective country, but in insufficient quantities — and the *non-competitive imports*, comprising goods that are not manufactured in the respective country at all.

In the practice of drawing up the interbranch balance in the socialist countries, no such delimitation is made, from this point of view, as to the imported goods, but it is considered, however, that this aspect must be stu-

died in view of a possible separation in the future, including only competitive imports together with national production in the matrix of intermediate consumption.

There is a close dependency between the aggregation degree of the interbranch balance and the distinction marked as to the competitive and non-competitive imports. If, for instance, the production of rolled metal stands as a distinct branch in the balance, any import of this product should be considered as competitive and included as such in the respective branch. However, if rolled metal is included in the balance as three distinct branches — depending on the peculiarites of the technological process or destination —, then the import of rolled metal which is not included in the three types should be considered as a non-competitive import.

* * *

The use of the interbranch balance in planning is an important stage in developing planning methods for national economy, enabling a better ascertainement of the socialist society's demands on the basis of a more objective estimation of the resources and production availabilitis, as well as a decrease of the subjective factors influence in drawing up the national economic plan.

At the same time, the interbranch balance smoothes the path for an intensive use of up-to-date mathematical methods and of electronic computations technique in planning national economy. The drawing up of the interbranch balance and the information obtained on this basis make up a prerequisite for developing optimal planning methods.

The study of the interbranch balance makes possible to lay the foundations for drawing up a few variants of the social production structure, which is one of the prerequisites for a serious economic substantion of the plan.

The experience has proved that the most efficacious use of the interbranch balance is achieved in the research carried out before drawing up the plan for computing the rate, proportion and structure variants by branches of social production, as well as in the subsequent stages of drawing up the plan, in view of a thorough correlation of plan indicators and an analysis of the interbranch relationships. The analysis and planning of the interbranch relationships and proportions on the basis of the balance enables a study of the national economy structure, of the interaction mechanism of the various constituent elements.

Taking as a starting point the conclusions of a number of interbranch balances for several consecutive years, dynamic models for national economy growth in view of making evident the equipoise conditions for a given rate of development can be built up.

The persistence so far of certain methodological, informational and technical difficulties related to the drawing up of the mathematical model of the interbranch balance only emphasizes the complexity of this task alongside the necessity of a further thorough study of the principles governing the mathematical processing.

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OPTIONS DANS LA RESOLUTION DES PROBLEMES METHODOLOGIQUES DU MODELE ENTREE-SORTIE

Ayant comme point de départ le contenu économique du modèle mathématique entrée-sortie et les nécessités de son utilisation dans la planification, les auteurs font l'analyse du sens et des implications des résolutions possibles de certains problèmes fondamentaux de la méthodologie de l'élaboration du modèle.

En ce qui concerne le problème, si controversé, de la manière de concevoir l'amortissement et les investissements, on fait l'analyse du point de vue du but de l'élaboration du modèle entrée-sortie, des diverses opinions qui existent sur le but d'obtenir certains coefficients de la dépendance technologique de production, les plus fidèles aux processus économiques réels. Les auteurs s'occupent aussi de la modalité d'intégrer l'importation au modèle, ainsi que les implications qui s'ensuivent pour celui-ci, implications provoquées par la façon d'exprimer les indicateurs du modèle par des prix différents.

La façon d'aborder les problèmes est celle des mentions sur les ouvrages de spécialité appartenant à ce domaine d'activité, et sur l'expérience acquise par certains pays socialistes en ce qui concerne l'élaboration et l'utilisation du modèle entrée-sortie.

ОПЦИОН ПРИ РАЗРЕШЕНИИ МЕТОДОЛОГИЧЕСКИХ ВОПРОСОВ БАЛАНСА МЕЖОТРАСЛЕВЫХ СВЯЗЕЙ

Исходя из экономического содержания математической модели баланса межотраслевых связей и из требований к его использованию в планировании, авторы рассматривают смысл и последствия возможных решений отдельных методологических вопросов составления баланса.

В спорном вопросе способа охвата амортизации и капитальных вложений рассматриваются существующие различные мнения о цели составления баланса межотраслевых связей: получение коэффициентов производственных технологических зависимостей, наиболее точно соответствующих реальным экономическим процессам. Рассматривается также способ включения импорта в баланс, а также последствия, вытекающие для баланса из выражения его показателей в различных ценах.

При рассмотрении вопросов делаются ссылки на специальные труды в этой области и на опыт, накопленный в отдельных социалистических странах в отношении составления и использования баланса межотраслевых связей.