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Ascertaining the Influence of Cutting Down Specific Consumption of Materials over Production in National Economic Branches

"Cutting down the material consumption, increasing the rate of physical products in a ton, is the essential problem of the economic efficiency."

Nicolae Ceauşescu

1. The decrease in the level of productive material expenditure against the value of products is a key factor which serves the increase in the degree of turning material resources to good account and, in the last analysis, the growth of national income. The main effort for cutting down material expenditure must be directed towards bringing down specific consumption of materials, raw materials and power. The need for such savings is emphasized by the very fact that material resources are limited.

2. Cutting down specific consumption of materials in a certain branch results in indirect effects on the production level in other branches. It is absolutely necessary to know indirect effects with a view to controlling adequately the volume of branch productions. The input — output tables offer a possibility to ascertain these implications. This possibility arises from the similarity existing between the concepts "specific consumption of materials" and "coefficient of direct expenditure", this latter being specific of the interbranch balance.

In order to describe the method which enables to lay bare the impact that cutting down of specific consumption of materials in a certain branch bears on the production level in other branches, a conventional balance comprising four "pure" branches[1]) has been chosen: three national branches

[1]) A "pure" branch is assumed to be a sum of products, groups of products or related material services.

Table 1

Input—Output Table

— An example of computation —

(millions lei)

	Branch 1: Metal	Branch 2: Tractors	Branch 3: Other industrial products	Branch 4: imported products	Total	Construction fund	Expansion fund	Net export	Total final consumption	National production (employed)
Branch 1: Metal	125	115	130	0	370	25	95	75	195	565
Branch 2: Tractors	190	80	180	0	450	85	95	50	230	680
Branch 3: Other industrial products	65	195	10	0	270	310	0	150	460	730
Branch 4: Imported products	40	60	80	0	180	45	20	–245	–180	0
TOTAL	420	450	400	0	1270	465	210	30	705	1975
Amortization	15	20	40	0	75					
Population's primary incomes	70	90	190	0	350					
State and co-operative sector primary incomes	60	120	100	0	280					
Total added value	145	230	330	0	705					
National production (achieved)	565	680	730	0	1975					

("metal", "tractors" and "other industrial products") and a branch of imported products, employed both in the production process of national branches and in the constituents of final consumption.

This description does not restrain the sphere of applicability of the method because its unaltered reasonings can be generalized and, consequently, the method can be used with a balance of any size; in turn, it facilitates the follow up of the balance and the practical aspects become conspicuous.

3. The production structure of the tractor branch is induced in the balance by the elements entered in the respective column (column number 2) and is rendered obvious by means of the coefficients of direct material expenditure and the primary factors ($a_{ij} = x_{ij}/X_j$):

Table II

Production structure coefficients of the tractor branch

Branch 1: Metal	Coefficients of direct expenditure of materials	0.169117
Branch 2: Tractors		0.117647
Branch 3: Other industrial products		0.286764
Branch 4: Imported products		0.088235
Total consumation with objects of work		0.661763
Amortization	Coefficients of direct onsumption of primary factors	0.029412
Population's primary incomes		0.132353
State and co-operative sector primary incomes		0.176471
Total added value		0.338236
National production		1.000000

The production structure coefficients entered in Table II (coefficients of direct expenditure) have the signification of specific consumption: of materials (for instance, 0.169117 expresses — in lei — the value of the metal used in the production process of the tractor branch in order that this branch shall achieve an 1 leu production, or of primary factors (for instance, 0. 132353 expresses — in lei — the value of wages required in order that the tractor branch shall achieve an 1 leu production.

4. We write:

X_t for the production value of the tractor branch;
p_t for the cost price of one tractor;
Q_t for the amount of tractors turned out (physical production of the tractor branch);
X_m for the production value of the metal branch;
p_m for the cost price of one ton of metal;
Q_m for the amount of tons of metal turned out in this branch (physical production of the metal branch);
$q_{m,t}$ for the quantity of metal required by the tractor branch for the achievement of its production;
$x_{m,t}$ for the value of metal required by the tractor branch for the achievement of its production;
c for the specific consumption of metal per product unit of the tractor branch.

There will follow the subsequent defining relationships:

$$Q_t = \frac{X_t}{p_t}; \qquad Q_m = \frac{X_m}{p_m} \tag{1}$$

$$q_{m,t} = \frac{x_{mt}}{p_m}; \tag{2}$$

$$c = \frac{q_{mt}}{Q_t} = \frac{\frac{x_{mt}}{p_m}}{\frac{X_t}{p_t}} = \frac{x_{mt}}{X_t} \cdot \frac{p_t}{p_m} = a_{mt} \cdot \frac{p_t}{p_m} \tag{3}$$

Assuming in the given example:

$$p_t = 68000 \text{ lei per tractor}$$

$$p_m = 2300 \text{ lei/ton of metal}$$

and taking into account that out of the balance are extracted:

$$x_{mt} = 115 \text{ million lei}$$

$$X_t = 680 \text{ million lei}$$

$$X_m = 565 \text{ million lei,}$$

there will follow according to formulas (1), (2) and (3):

$$Q_t = \frac{680 \text{ million lei}}{68000 \text{ lei/tractor}} = 10000 \text{ tractors}$$

$$Q_m = \frac{565 \text{ million lei}}{2300 \text{ lei per ton of metal}} = 245652 \text{ tons of metal}$$

$$q_{m.t} = \frac{115 \text{ million lei}}{2300 \text{ lei per ton of metal}} = 50000 \text{ tons of metal}$$

$$c = \frac{50000 \text{ tons of metal}}{10000 \text{ tractors}} = 5 \text{ tons of metal per tractor.}$$

5. For further computation the following two possible hypotheses will be assumed:

a) a cut down of specific consumption of metal from c to c^* is possible in the tractor branch;

b) the metal branch continues to supply the same quantity of metal $(q)_{mt}$ required by the tractor branch.

The immediate consequence of these hypotheses is, of course, a possibility of increasing production in the tractor branch (amount and value). If we assume $c^* = 4.9$ tons of metal per tractor, the cut down of specific consumption of metal in the tractor branch will be:

$$(1 - c^*/c) \cdot 100 = (1 - 4.9/5) \cdot 100 = 2\% \tag{4}$$

The coefficient of cutting down this specific consumption will be:

$$k = c^*/c = 4.9/5 = 0.98 \tag{5}$$

The physical (quantitative) production of the tractor branch achievable under the new conditions will be:

$Q_t^* = q_{mt}/c^* = 50000$ tons of metal/4.9 tons of metal per tractor = $= 10204$ tractors.

Particularly important in the subsequent computation is the coefficient of the possible increase in the production of the tractor branch by means of a cut down of specific metal consumption in this branch: Q_t^*/Q_t.

Taking into account relationship (5), the value of this coefficient is:

$$Q_t^*/Q_t = (q_{mt}/c^*)/(q_{mt}/c) = c/c^* = 1/k = 1/0.98 = 1.0204 \tag{6}$$

6. The production increase in the tractor branch brings about indirect effects in all the economic branches. Whereas for the achievement of an increased production (10204 tractors instead of 10000) the quantity of metal required by the tractor branch remains unaltered, the achievement of the new, increased, production involves, however, inputs of products from other branches—for which specific consumption has not been altered—in an increased quantity.

Indeed, whereas for a physical production of 10000 tractors the respective branch required an input of 195 million lei from the "other industrial products" branch (rubber, paint, leather, etc.), that is to say 195 million lei/10000 tractors = 19000 lei/tractor at present [1]), for a production of 10204 physical units the tractor branch shall require a larger input: 19500 lei/tractor × 20204 tractors = 198978000 lei.

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[1]) Specific consumption of products from the "other industrial products" branch in the tractor branch has been assumed unaltered.

The computation of the new inputs required is carried out with the aid of formula:

$$x^*_{ap,t} = x_{ap,t} \cdot Q^*_t/Q_t = x_{ap,t} \cdot 1/k \qquad (7)$$

where:

$x_{ap.t}$; $x^*_{ap,t}$ = the old and, respectively, the new (value) input proceeding from the "other industrial products" branch towards the tractor branch.

The same reasoning requires a re-computation of primary inputs in the tractor branch (amortization, wages, profits, taxes, that is to say elements of the added value), which are to be increased in the column of the tractor branch in order to enable it to achieve the assumed increased production.

We can see that the new values of the production structure elements of the tractor branch (column number 2 in the balance) are found out by multiplying the older values by factor $1/k$ save for value x_{mt} which, according to the assumed hypothesis, remains unaltered.

The column number 2 in the balance, made up following the described computation, has the appearance:

Table III

	Branch 2: Tractors
Branch 1: Metal	115 × 1 = 115000
Branch 2: Tractors	80 × 1.0204 = 81633
Branch 3: Other industrial products	195 × 1.0204 = 198980
Branch 4: Imported products	60 × 1.0204 = 61224
Total	456837
Amortization	20 × 1.0204 = 20408
Population's primary incomes	90 × 1.0204 = 91837
State and co-operative sector primary incomes	120 × 1.0204 = 122449
Added value	234694
National production	691531

and the new structure coefficients of production in this branch, resulting from the cutting down of its specific metal consumption, will be:

Table IV

Branch 1: Metal	Coefficients of direct expenditure of materials	0.166298
Branch 2: Tractors		0.118047
Branch 3: Other industrial products		0.287738
Branch 4: Imported products		0.088534
Total consumption with objects of work		0.660617
Amortization	Coefficients of direct consumption of primary factors	0.029511
Population's primary incomes		0.132802
State and co-operative sector primary incomes		0.177069
Total added value		0.339382
National production (achieved)		1.000000

An analysis of the given figures leads immediately to the natural conclusion related to the cut down of the metal specific consumption in the tractor branch that the cost-price of the products turned out in this branch falls down. The new cost-price p_t^* is achieved by dividing the new value production achievable in this branch by its increased physical (quantitative) production $p_t^* = 691531000$ lei/10204 tractors $= 67770$ lei per tractor [1]).

7. The indirect effects which the alteration of production structure in the tractor branch brings on the other branches are accounted for by the

[1]) The direct computation formulas are as follows:
— Achievable physical production: $Q_t^* = X_t(1/k \cdot p_t)$
— Achievable value production; $X_t^* = X_t[1 - (1 - k) \cdot a_{mt}/k]$.
— Cost price brought down by the cut down of specific consumption:
$p_t^* = [1 - (1 - k)\, a_{mt}] \cdot p_t$.

chain relationships that the increased demand for materials and raw materials of the tractor branch entails over production of the other branches.

The ascertainment of these indirect effects, extremely difficult through classical methods, is substantially simplified by the matrix computation proper of the mathematical model of the interbranch balance. At the same time, the results thus obtained are strictly exact, since the balance model takes into account all the production relationships among the branches of national economy.

The elements required for this computation are: the matrix of direct (respectively total) expenditure coefficients as obtained under the new conditions induced by specific metal consumption in the tractor branch, together with the column vector of production achieved in branches assigned for final consumption.

The altered matrix of direct expenditure coefficients is achieved through direct computation [1]):

$$A^* = \begin{Vmatrix} 125/565 & 115/691.531 & 130/730 & 0 \\ 190/565 & 81.633/691.531 & 180/730 & 0 \\ 65/565 & 198.980/691.531 & 10/730 & 0 \\ 40/565 & 61.224/691.531 & 80/730 & 0 \end{Vmatrix} = \begin{Vmatrix} 0.221238 & 0.166298 & 0.178082 & 0 \\ 0.336283 & 0.118047 & 0.246575 & 0 \\ 0.115044 & 0.287738 & 0.013698 & 0 \\ 0.070796 & 0.088534 & 0.109589 & 0 \end{Vmatrix}$$

and the matrix [2]) of total expenditure coefficients is achieved through a mathematical reversing operation of matrix $(E - A^*)$:

$$(E - A^*)^{-1} = \begin{Vmatrix} 1.515994 & 0.408468 & 0.375333 & 0 \\ 0.683201 & 1.418622 & 0.478010 & 0 \\ 0.376141 & 0.461505 & 1.197179 & 0 \\ 0.209034 & 0.205090 & 0.200126 & 1 \end{Vmatrix}$$

The column vector of final consumption is found out subject to the conditions under which the production increase in the other branches is limited only to meeting the new production demand induced by the new production structure of the tractor branch. In other words, the other branches will continue to deliver the same quantity of products for final consumption, whereas the excess production of these other branches will go only to intermediate consumption. With respect to the tractor branch, this is able to achieve an additional physical production of 204 tractors (that is, in terms of value,

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[1]) Matrix A^* and matrix A — original — differ only in the coefficients of column number 2 (of the tractor branch). The coefficients of column number 2 of matrix A^* can be obtained through the coefficients of column number 2 of matrix A through direct computation:

$$\overset{*}{a}_{m,t} = a_{mt} \cdot k/[1 + a_{mt}(k - 1)]$$

$$\overset{*}{a}_{m,t} = a_{i,t}/[1 + a_{m,t}(k - 1)]$$

where i is any branch except the metal branch.

[2]) The coefficient of total expenditure A_{ij} expresses the total necessary products and productive material services which must be achieved in branch i and which must be provided by this branch to the whole economy in order that branch j may deliver one leu with final consumption. For instance, the "other industrial products" branch must achieve and supply to national economy a production of 0.461505 lei in order that the tractor branch may supply a production of one leu with final consumption.

691531000—680000000 = 11531000 million lei) that may be allotted for export, However, we must export that part of this additional production shall be required for intermediate, indirect consumption of the other branches in view of an adequate increase in their production, so that it will be possible to export only part of the additional production.

The computation of the production that the tractor branch can provide directly to final consumption, under the new circumstances, is as follows:

$$Y_t^* = 230 + (1/1.418622)\,[(691.531 - (0.408468 \times 195 + 1.418622 \times 230 + + 0.461505 \times 460 - 0.205090 \times 180)] = 238557000 \text{ lei.}$$

The column vector of final consumption shall be:

$$Y^* = \begin{Vmatrix} 195 \\ 238.557 \\ 460 \\ -180 \end{Vmatrix}$$

8. The production of the branches necessary for a balance in national economy under the conditions of the given problem is found out with the aid of the balance equation:

$$X^* = (E - A^*)^{-1} \cdot Y^* \tag{8}$$

The computation for the given example leads to the following necessary production per branches:

$$X^* = \begin{Vmatrix} 565.947 \\ 691.531 \\ 734.145 \\ 1.745 \end{Vmatrix}$$

We can remark that, beside the natural, predetermined production increase in the tractor branch, the other branches must be able to increase their own production:

the metal branch by 947000 lei;

the "other industrial products" branches by 4145000 lei;

the "imported products" branch by 1745000 lei.

These production increases achieved through the cutting down of specific metal consumption in the tractor branch are a synthesis of indirect effects that this economic phenomenon involves on the scale of national economy. Of course, we shall bear in mind that all the computation has been carried into effect in the hypothesis that the metal branch continues to supply to the tractor branch the same quantity of metal which it delivered under conditions that the referred to specific consumption was $c = 5$ tons of metal per tractor. It is understood that this hypothesis imposes the condition that the tractor branch shall have a processing capacity for this whole quantity of metal also under the new technology in which c becomes $c^* = 4.9$ tons of metal per tractor.

The computed values for the new production required enable the drawing up of an adequate balance comprising all the influences that the cutting

Table V

	Branch 1: Metal	Branch 2: Tractors	Branch 3: Other industrial products	Branch 4: Imported products	Total	Consumption fund	Expansion fund	Net export	Total final consumption	National production (achieved)
Branch 1: Metal	125.210	115.000	130.737	0	370.947	25	95	75	195	565.947
Branch 2: Tractors	190.318	81.633	181.023	0	452.974	85	95	58.557	238.557	691.531
Branch 3: Other industrial products	65.109	198.980	10.056	0	274.145	310	0	150	460	734.145
Branch 4: Imported products	40.067	61.224	80.454	0	181.745	45	20	—246.745	—181.745	0
Total	420.047	456.837	402.270	0	1279.811	465	210	36.812	711.812	1991.623
Amortization	15.025	20.408	40.228	0	75.661					
Population's primary incomes	70.117	91.837	191.079	0	353.033					
State and co-operative sector primary incomes	60.101	122.449	100.568	0	283.118					
Total added value	145.243	234.694	331.875	0	711.812					
National production (achieved)	565.947	691.531	734.145	0	1991.623					

down of specific metal consumption in the tractor branch affects national economy.

This balance shall adopt for the tractor branch the new production structure found out in section 6, maintaining for the other branches the production structures existing in the original balance.

9. The evaluation of the savings achievable on the scale of national economy as a result of cut down specific metal consumation in the tractor branch is possible through a comparison between the branches production required for the achievement of final consumption Y* in the two situations: original, computed through $c = 5$ tons of metal per tractor, and subsequent, computed through $c^* = 4.9$ tons of metal per tractor.

The computation formula is:

$$E = e \cdot [(E - A)^{-1} \cdot Y^* - (E - A^*)^{-1} Y^*] \tag{9}$$

where:

A is the original matrix of direct expenditure coefficients;
e is a unit line vector (summation vector).

Subsequent productions

$$X^* = (E - A^*)^{-1} \cdot Y^*$$

are the ones computed in section 8, and their sum is:

$$\sum X_i^* = 1993368000 \text{ lei.}$$

For computing productions

$$X = (E - A)^{-1} \cdot Y^* \tag{10}$$

the original matrix A, of direct expenditure coefficients is ascertained:

$$A = \begin{Vmatrix} 125/565 & 115/680 & 1307/30 & 0 \\ 190/565 & 80/680 & 180/730 & 0 \\ 65/565 & 195/680 & 10/730 & 0 \\ 40/565 & 60/680 & 80/730 & 0 \end{Vmatrix} = \begin{Vmatrix} 0.221238 & 0.169117 & 0.178082 & 0 \\ 0.336983 & 0.117647 & 0.246575 & 0 \\ 0.115044 & 0.286764 & 0.013698 & 0 \\ 0.070796 & 0.088235 & 0.109589 & 0 \end{Vmatrix}$$

as well as the matrix of the relevant total expenditure coefficients:

$$(E - A)^{-1} = \begin{Vmatrix} 1.518550 & 0.413781 & 0.377627 & 0 \\ 0.683805 & 1.419883 & 0.478433 & 0 \\ 0.375938 & 0.461087 & 1.197034 & 0 \\ 0.209040 & 0.205107 & 0.200129 & 1 \end{Vmatrix}$$

Productions computed through relationship (10) will be:

$$X = \begin{Vmatrix} 568.536 \\ 692.144 \\ 733.939 \\ 1.752 \end{Vmatrix}$$

and their sum will be:

$$\sum X_i = 1996371000 \text{ lei.}$$

In order to achieve *the same final consumption* are, consequently, required branch productions amounting to a total value of 1996371000 lei — for uncut down specific consumption — and to 1993368000 lei if specific consumption under examination is brought down by 2 per cent. The difference 1996371000 — 1993368000 = 3003000 lei stands for the savings achievable through cut down requirements of branch productions which meet the same final purpose: the same value of final consumption.

10. These savings resulting from the difference of total productions required for the achievement of the same final consumption shall be supplemented by the savings obtainable through a deduction in the price of tractors. Indeed, it has been pointed out that the immediate effect of cutting down specific metal consumption in the productive process of the tractor branch is the fall of cost price for each tractor from 68000 to 67770 lei per tractor. This means that the production of the tractor branch, amounting to 691,531 million lei expresses the production of "cheap" tractors; if the 10204 tractors (physical production corresponding to production value amounting to 691,531 million lei) were sold at the older cost price of 68000 per tractor, a higher production value would result:

$$10204 \times 68000 = 693872000 \text{ lei}$$

The difference 693872000—691531000 = 2341000 lei stands for additional savings obtainable through cutting down the cost of physical unit product in the tractor branch.

Total savings are yielded by summing up the two contributions; they are 3003000 + 2341000 = 5334000 lei.

11. CONCLUSIONS

a) The balance of national economy under the new conditions datailedly expressed in the input-output Table V requires a serious examination, both with regard to the possibility of implementing the computed branch productions — through a new technology in tractor making — as well as to the primary factors increased by the same reason.

b) In order to apply the described analysis method to an actual situation, in other words to an interbranch balance drawn up following an economic census, special investigations shall be carried out with regard to the specific consumption that can really be cut down and to the value of reduction coefficient.

c) The effects of cutting down specific material consumption in certain branches have a complex implication on national economy. The interbranch balance comprises all the aspects of the problem and is the most adequate means to be used for such computation.

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DETERMINATION DE L'INFLUENCE QU'EXERCE LA REDUCTION DES CONSOMMATIONS SPECIFIQUES DE MATERIEL SUR LA PRODUCTION DES DIFFERENTES BRANCHES DE L'ECONOMIE NATIONALE

La réduction des consommations spécifiques du matériel dans une certaine branche de l'économie nationale a des implications directes — dans la production de la branche en question — ainsi que des implications indirectes, dans les productions de toutes les autres branches avec lesquelles la branche analysée entre toujours, directement ou indirectement, en contact. Les implications directes peuvent être facilement calculées en utilisant des méthodes bien connues et assez simples; au contraire, pour déterminer les influences indirectes il est nécessaire d'avoir un modèle complet, à même de rendre compte, en même temps, de la totalité des rapports existants dans l'économie: c'est le modèle entrée-sortie de l'économie nationale.

Cet article offre une approche du problème dans l'optique de certaines hypothèses, initialement exposées, mais qui ne sont pas les seules possibles: de cette façon, il constitue un modèle de la manière dont ce problème doit être abordé et résolu.

ОПРЕДЕЛЕНИЕ ВЛИЯНИЯ СНИЖЕНИЯ УДЕЛЬНЫХ РАСХОДОВ МАТЕРИАЛОВ НА ПРОИЗВОДСТВО ОТРАСЛЕЙ НАРОДНОГО ХОЗЯЙСТВА

Снижение удельных расходов материалов в какой-либо отрасли народного хозяйства оказывает как непосредственное влияние на производство данной отрасли, так и косвенное влияние на производство всех отраслей, с которыми рассматриваемая отрасль соприкасается — также непосредственно или косвенно — в процессе производства. Прямые последствия можно легко рассчитать путем применения известных и сравнительно простых методов; взамен для определения косвенного влияния необходимо прибегать к комплектной модели, имеющей возможность одновременно учитывать совокупность существующих в народном хозяйстве связей: это — модель баланса межотраслевых связей.

В настоящей статье вопрос рассматривается свозь призму изложенных вначале предположений, не являющихся единственно возможными; поэтому указанная модель представляет собой лишь модель способа рассмотрения и решения этого вопроса.