

OPTIMIZATION OF BRANCH PRICE LEVEL RELATIONS
IN PLANNED ECONOMY

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OPTIMIZATION OF BRANCH PRICE LEVEL RELATIONS IN PLANNED ECONOMY

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1. *About reflecting rent of natural resources in prices.*

Several functions are performed by prices in the economy of the USSR. They are used in project-and-plan calculations for evaluation of efficiency of economic measures and for analysis of tendencies of economic development — this function may be called approximate. For the purpose of performing it prices must as well as possible reflect production costs and efficiency of using the products by the consumer. But at the same time it is considered that prices must be a toll of distribution of financial and material resources between the branches of economy and population groups and also a tool of stimulation, i.e., backing up state priorities in relation to growth rates of production of various articles.

Under conditions when prices of the most part of articles are set by the central organs, theoretical discussions that after all determine a conception underlying price formation practice rise in importance.

As it is known, in the USSR prices perform not only measuring and stimulating functions, but also the distributing one. As a result of the price reform carried out at the beginning of the thirties wholesale prices of industrial products were set at their prime costs level with the inclusion of minimal profit necessary for present-day activity of enterprises. The main part of accumulations was received by the state in the form of turnover tax at the expense of the difference between wholesale and retail price levels.

Such a principle of price setting was justified by the necessity of centralization of all the financial resources for redistribution of them to newly created and rapidly developing industries, development of new territories etc.

As the problem of raising efficiency of the social production was becoming first and foremost and as economic science was developing and the methods of national economy planning and control were improving, the measuring function of price was more and more coming to light as a principal one.

As to the functions of price, they are either of immediate consequence of fulfilling its main function (a stimulating function, for example) or can be fulfilled by other economic mechanisms (for example, a redistributing function with more success can be fulfilled by the financial and credit system).

At the same time if for the sake of fulfilling other functions the price stops reflecting correctly the expenditure which is socially necessary, no other system can substitute it in fulfilling this measuring function.

The theory of economy optimisation proves the necessity of taking into account in prices not only current but also capital expenditure and also volumes of utilization of natural resources and distribution of production. When mass price revision of 1967 was carried out, branch profitability rate levels were set with regard to branch fixed and current assets-product ratios. However, the problem of taking into account the rent of natural resources in price still has not been solved.

The urgency of this problem is becoming more acute as the shortage of some natural resources all over the world is making itself more and more felt.

In the USSR this factor becomes apparent not through their absolute scantiness, but in rapid input growth in extractive industries and agriculture owing to worsening of geological extraction conditions, shift of production to remote underdeveloped regions, labour resource shortage for agriculture etc.

Mechanism of taking into account rent of natural resources in prices and in other estimates of goods, and mechanisms of withdrawal of it from production enterprises may be various. Besides a direct financial mechanism of rent withdrawal, two price-lists system may be used: differentiated prices reflecting local production conditions for producers and common (within the same transportation costs) — for consumers. The difference of these

prices for a given producer must correspond to the rent of natural resources that are used by him. Besides, the rent is withdrawn in the form of turnover tax.

In the actual economic control system both these instruments are used in metallurgy, fuel industries, in agriculture. However, even combined use of them usually does not provide the full exposure and taking the rent into account.

It is beyond all question that the most important condition under which prices can, in general, positively influence the economic development, is the strive of economic and planning organizations and working collectives for maximization of national economic effect, i.e., for minimizing input and maximizing results of production.

Most economists recognize now the necessity of reciprocal connection between a plan and a price system.

What does the correspondence of a price to the plan of economic development mean? It means that a price must indicate what extra costs the national economy will incur in order to obtain extra million tons of coal or metal, or what extra resources will be obtained if it succeeds in sparing this million and not making corresponding capital and current input. In other words, a price must reflect incremental costs of production.

Prices set according to such a principle ensure full reflection of natural resources rent. The most precise incremental costs evaluations can be determined from calculations by means of optimisation models, if these models reflect both production and consumption conditions fully enough. It is most important to take incremental costs into account in the branches which utilize natural resources.

In the USSR incremental costs norms (ICN) are regularly calculated and used in project-and-plan calculations in fuel-and-power complex. Calculations are carried out in some other branches which utilize natural resources.

ICN calculations and application in separate branches do not allow to use in a full measure all the possibilities of improving planning methods laid potentially in this instrument, because when doing so, mutual influence of changes in input norms for production in various branches is not taken into account. Today considerable ex-

perience in evaluations of the incremental costs levels in various branches is accumulated, and there is a possibility to start the ICN development and use them for long-term project-and-plan calculations on the scale of the whole national economy.

Experimental calculations of ICN on the basis of input-output balance in which the incremental costs obtained from branch projections were put instead of average costs columns for branches utilizing natural resources (fuel and power, timber industry, agriculture) were carried out in the Central Economic-Mathematical Institute of the USSR Academy of Sciences.

These branches are represented in this model in a more detailed way than the manufacturing ones. Mining industry is separated from ferrous metal industry, and timber cutting, coal industry, gas industry, oil-extracting industry, oil-processing industry are represented separately. Agriculture is divided into plant growing and livestock raising. Besides, coal and gas industry and electric power are divided into two regions: European and Asian part of the country. As a result of it, the model represents 27 linear equations.

This article contains methodology and analysis of these calculations for the conditions of 1972 and 1982.

2. *Price dynamics influences their level relations.*

The other cause bringing to understated price level on fuel and stuff and manufacturing branches is a considerable difference in price dynamics of these two branch groups. The thing is that centralized control over the average price level movement has different rigidity, different efficiency for various production types and production groups. It is most efficient for monoproduction or for branches producing mass homogenous production (e.g., electric power and the other industries of the fuel-and-power complex). Price levels of such kinds of products are changing strictly in accordance with centralized decisions. On the contrary, the possibility of centralized price level control is restricted in branches producing a large number of articles with a high degree of production renewal.

Price movement owing to this factor is not reflected fully in published price indices on product groups, because in annual index

calculation changes of prices are taken into account only for those articles produced this year which were produced last year too. New products are considered to be products having a price which did not change during a year.

There is, however, a number of methods of indirect estimating price indices movement for homogenous kinds of large product groups which are based on the dynamics of production costs for article-representatives, or on interconnections of technical and economic indicators characterising in equal measure all industrially developed countries⁽¹⁾. Each of these methods has some faults, however, they give a possibility to assess approximately those price movement rates which do not correspond to changes of consumption properties of products.

The difference in price dynamics on production of different branches of the national economy and industry is indirectly confirmed in dynamics of costs and profit per unit of output during periods between successive price revisions.

The levels of profitability in prices of the two groups of branches indicated above are equalized in mass price revisions. But such revisions are carried out seldom (15 years have passed between two succeeding revisions in 1967 and in 1982).

3. *Some questions of incremental costs determination.*

The traditional incremental costs determination is linked with description of differential ground rent origin. Price is set according to the cost of the worst of the lots cultivated during this period (marginal lot), and lots with lower cost levels obtain some rent which is not equal to zero (see Fig. 1). According to it, the term « marginal costs » is often used, instead of the term « incremental costs ». For increasing production bulk X it is to be passed to higher per unit costs⁽²⁾.

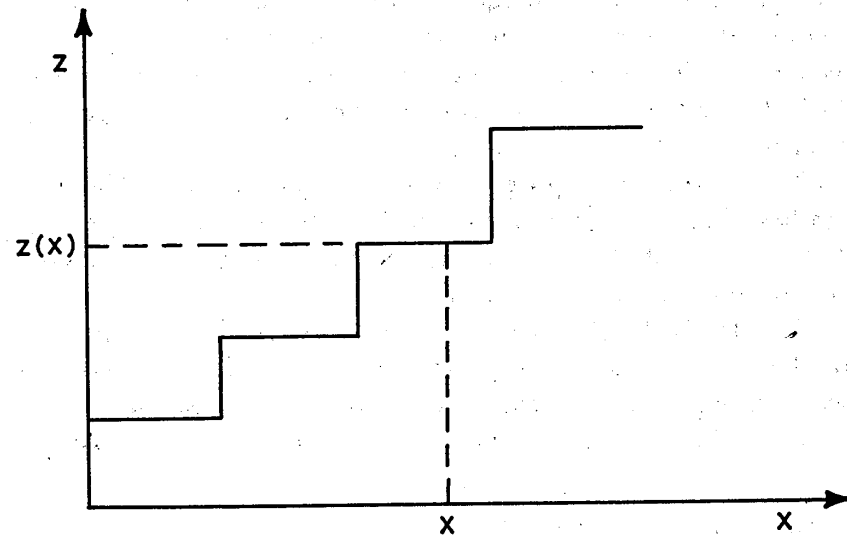
More adequate description of dependence of per unit costs on production bulk growth consists in the possibility for each lot i to

(1) See *Izvestija AN SSSR, serija ekonomicheskaja*, 1981, No. 6, pp. 62-73.

(2) Not only current, but also capital costs should be taken into account, so it is to be said about discounted costs.

incremental output to some extent $x_i \leq X_i$ owing to shifting to more intensive ways of production, and per unit discounted costs rise with the increase of output: $\hat{\zeta}_i = \hat{\zeta}_i(x_i)$. Then the incremental costs level $\hat{\zeta}(x)$ will be attained at the same time on several or even on all the lots and the rent can also appear on each of the lots owing to the difference between marginal and average costs.

FIGURA 1.



If $\hat{\zeta}$ and $\bar{\zeta}$ are incremental and average discounted costs then the share of rent in ICN is

$$r = \frac{\hat{\zeta} - \bar{\zeta}}{\hat{\zeta}} \quad (1)$$

It may also be expressed by the ratio $z = \frac{\hat{\zeta}}{\bar{\zeta}}$

$$r = 1 + \frac{1}{z} \quad (1a)$$

Thus, the rent arises if there is a difference of production costs owing to the difference in natural conditions. Production conditions

can be considerably different even on adjacent lots or in mines of the same coal basin and give rise to costs differentiation which may be called inner-regional. Besides, incremental costs levels calculated for each region or basin may also differ from each other ⁽³⁾. Such an interregional costs differentiation gives rise to some rent only in case of transportable production. Costs difference for non-transportable goods production gives rise to necessity of prices or ICN levels differentiation between regions, but it does not give rise to any rent. Here incremental costs coincide with the average ones. For example, the need in fresh dairy products can be met only by local cattle breeding farms. Therefore, cattle breeding is developed even in those regions where costs are several times the average for the country. A different situation can be seen in plant growing. Its products are, as a rule, easily transported. At the same time, the dispersion of per unit costs owing to difference in natural conditions is considerably higher in plant growing in comparison with cattle breeding ($z = 1.8$ and 1.2 , accordingly) and the most important factor of rising its efficiency is concentration and specialization of production. Regional planning allocation of production is here in need of the use of ICN being set at the production costs level of the marginal region. At the same time, purchase prices, as a rule, reflect average costs.

In natural resources-using branches incremental costs level is determined, as a rule, by deposits or lands with the worst production conditions. It is, however, not a general rule.

If, in particular, incremental costs concept is applied to manufacturing industry whose costs level is determined not by natural resources constraint (as these have different degree of accessibility), but by progressiveness of technology and technique quality, incremental costs, as a rule, should be determined by the best and not by the worst conditions of production.

A complicated question which arises in connection with incremental costs determination is their stability degree with respect to oscillations of necessary volume of production. Obviously, incremental costs level cannot be determined by the costs of production

⁽³⁾ The share of rent in ICN level for a branch of the national economy or industry is calculated by the formula (1), where incremental costs value average for all the branch production.

for a too little share of the whole output, because this level may be too high owing to chance causes and, at the same time, it may change sharply with changes of output. As one of the aims of ICN calculation is just correction of output and clearing up on which of the worst lots or deposits development of production for planning period is expedient, ICN must remain stable under feasible oscillations of such a kind. Therefore, incremental costs magnitude average for the interval of feasible changes of production volume should be taken as a norm. In other words, the averaging interval corresponds to those worst lots or deposits for which the expediency of use in planning period may be in question.

In conformity with agriculture similar considerations were formulated in Pashaver (1972, 88-90) in the form of more concrete proposal of taking the averaging interval according to production volume as equal to the insurance fund.

In other branches it is more difficult to shape concretely the general consideration given above for determination of the averaging interval. However, under the conditions of five-year and long-term plans elaboration, dynamics of costs norms within a five-year period usually cannot be reflected owing to considerable uncertainty in many parameters. Therefore, prices and ICN levels seem to be considered as stable for each five-year period. In accordance with it, incremental costs may be determined as costs on those lands and deposits where the main increase of production for a given five-year period is realised.

These costs are, as a rule, higher than the branch's average, because if they prove to be lower than the average ones, it will mean that the use of the most part of lands and deposits is not profitable for the national economy, and the production in them must be curtailed.

4. *Dynamic rent.*

Lately, in connection with the use of dynamic optimisation models for incremental costs calculations, significance of one more factor has been recognized. It is not reflected in the traditional static scheme given above, but influence decisively ICN levels

(Leipounsky, 1971; Eshinetal, 1982). This factor operates in all extractive industries where production is connected with irretrievable extraction of limited reserves (they are limited for a given deposit or region) of some resource and production conditions are worsening (and costs rise) as long as the extracted volume is rising. In agriculture under correct management there is no direct dependence of production conditions on production output.

Worsening of extraction conditions as long as extracted volume is rising becomes apparent usually both during exploitation of a single deposit (necessity of extra costs in connection with sinking of intrastatum pressure, deepening of mine etc.), and for a given region or the country being regarded on the whole owing to necessity of passage to new deposits which are, as a rule, more difficult of access and have worse production conditions. Under these conditions, production of extra quantity of resources at the present time with unchanged plan of extraction for the next year requires not only direct discounted costs for deposit development and extraction of this quantity, but also increase of discounted costs in the future which is connected with earlier passage to worse production conditions. This change of future costs owing to extraction variation at present, must be reflected in resource evaluation this year, or else it will be impossible to link a local decision made on the basis of such evaluations with the necessity of maximisation of long-term global plan efficiency. As it will be shown further, under the conditions of such industries as oil-and-gas industry which are characterised by high growth rate of per unit costs on extracting resource, these extra costs may be 30-60 per cent of direct discounted costs on prospecting and extraction. This additional component of incremental costs has been named dynamic rent.

Let us denote $v(t)$ summary volume of resource extracted by a time moment t and assume that direct discounted costs (c) on prospecting and extraction of extra resource unit any moment t depends only on the magnitude of $v(t)$:

$$c = c(v).$$

Then the total discounted incremental costs (ζ) connected with extraction of extra resource unit (with regard for the dynamic factor indicated above) in the year t is equal to

$$\zeta(t) = c[v(t)] + \int_0^{\infty} c_v v(\tau) [v_\tau(\tau)] e^{-E(\tau-t)} d\tau$$

where E — discount rate of costs made at different time moments, c_v and v_τ — the derivatives of the functions c and v . Integrating by parts, we obtain

$$\zeta(t) = E \int_0^{\infty} c[v(\tau)] e^{-E(\tau-t)} d\tau \quad (2)$$

If it is assumed that the costs $c^t = c v(t)$ rise over time at a constant rate q , i.e., $c^t = c^0 e^{qt}$, then

$$\zeta(t_0) = \frac{E}{E - q} c^0 \quad (3) \quad (4)$$

The formula (2), naturally, is suitable only under the condition $q < E$. If costs growth rates q are too high, the assumption of retaining such rates for indefinitely long time in the future becomes inadequate. In particular, exceptional growth of discounted costs in oil-extraction is observed during the last 16 years. According to forecasts it may be expected that the same rates will be retained till 1990 when extraction increase passes to deposits of the Caspian Sea country, northern districts of the Tjumen region and East Siberia. Then the rates of further costs increase must slow down.

For the sake of exposition simplicity we shall further agree to call direct costs in a marginal deposit without taking into account the dynamic rent (c), marginal costs and the term « incremental costs » will mean magnitude including dynamic rent (ζ).

(4) The formula (3) was first deduced by J.V. Sheveljov. See journal « Ekonomika i matematicheskie metody », tom XX, no. 6, pp. 1103-1112.

It is necessary to bear in mind that the formula (2) is true only in case if the single cause of costs c change in time is exhaustion of deposits being worked and the necessity to pass to smaller and remote deposits, mines deepening etc. connected with it.

Data about marginal discounted costs for oil, gas and coal for different five-year periods allows to evaluate dynamics of them and using the formulae (2) and (3), to obtain the ratio values $D = \frac{\zeta(t_0)}{c^0}$.

It is obvious that high values of the coefficients D (1.27-1.3 for gas and 1.73-2.0 for oil) not only will change numerical ICN values in comparison with marginal costs, but also marginal power-bearers for ICN system and for marginal costs system may prove to be different. Thus, in 1972 marginal costs on oil in the European part of the USSR were lower than costs on power coal. Apparently, this circumstance have played a definite part in rapid expansion of mazut use in the capacity of boiler-and-stive fuel. At the same time, being calculated with regard to dynamic rent, ICN, already in 1972, show much higher costs level for oil and mazut in comparison with coal. Similar ICN and marginal costs relations for coal and mazut existed in 1982. If marginal-average costs ratio is denoted by m , then $z = mD$.

Estimates of this value are shown in Table 1.

5. Reflection of resources interchangeability in prices and ICN.

When setting up prices and ICN, reflection of products (resources) interchangeability in consumption is of great importance.

Prices of interchangeable kinds of production are determined not by costs on each of them taken separately, but by that of them which must be used for covering change of summary need in the total volume of all the groups of interchangeable production kinds (marginal resource). If there are not any constraints on expansion and curtailment of some products in a group, then prices and ICN must be determined by costs for the product which is the cheapest for the national economy. On the contrary, if production of cheaper goods is limited, then the prices and ICN are determined by costs for the most expensive product (expansion of production of which is not limited).

Similarly, the choice of marginal resource is influenced by possibilities of consumer passage from one resource to another, i.e., by interchangeability limitations, if they exist. Consequently, the question of choice of marginal resource which determines price or ICN level for the whole group of interchangeable ones depends on « boundary conditions » of the problem determining means for expansion of production and consumption of each of group resources with invariable efficiency.

When we deal with a long-term forecast, the means of production and consumption expansion coincide with the real means of development of the national economy. In retrospective calculations, if actually created production capacities of producers and consumers of each of the resources are taken into account, then it turns out that there are no means for variations and hence, there is no possibility of taking into account interchangeability conditions in ICN or prices determination. Strictly speaking, under such conditions, the same concepts « ICN » and « optimal price » become senseless.

In other words, in retrospective calculations the concept « ICN » becomes relative and depends on « boundary conditions » assumed, i.e., assumptions of variation possibilities.

So that the norms calculated for the past and present periods were comparable with ICN set for the future period, those deviations from the actual trajectory of economic development which seem to be feasible in case of corresponding changes in the plan decisions made for the last 10-15 years till the moment under review must be regarded as permissible ones. Obviously, when using such calculations it should be remembered of the « boundary conditions » assumed.

A classical example of interchangeability is the group of various power-bearers and also electric power produced by hydro and atomic-electric power stations (HEPS and AEPS).

In calculations with the interbranch model the following suppositions were accepted. For 1972 coal is regarded as the marginal fuel both in Europe, and in Asia. It should be noted that incremental costs on gas are lower than those on coal. But gas output was then only 19.5 per cent (Narodnoe..., 1973, 258) from the total power-bearers output in the country, and capacity expansion for gas

output during the ninth five-year plan period was, without it, executed at maximally feasible rate [8 per cent a year, Narodnoe, 1973, 258)], hence, feasible power need changes could not be met at the expense of gas output changes.

In 1982 coal becomes the cheapest fuel in the Asian part of the USSR owing to rapid increase of expenses on gas and cutting costs for coal in the Asian part owing to the development of open coal pits in Ekibastooz, Kansko-achinsky and Kooznetzky basins. But gas still remains the cheapest power-bearer in the European part. For all that, in the eleventh five-year plan period output means of gas and means of its transportation to the European part may already not be considered as the main constraint for expansion of its consumption. Preparedness of branch-consumers themselves to the transition from mazut of coal to gas use is no less serious constraint. Gas export potentialities are not boundless either.

ICN of power-bearers determination by extraction and transportation costs must, in particular, drive us to the conclusion that curtailment of qualitative power coals output and transportation of them to the European part and substitution of them by gas in the fuel-and-power balance are efficient. Must such a conclusion be considered as obligatory one and such a policy be held in plan calculations? Apparently, no.

Such a conclusion is obligatory only under those conditions when there are no factors dictating expansion or at least conservation at the attained level of coal output. But rapid rise of costs on oil and gas extraction and transportation may in the near future lead to such a situation when coal is cheaper than gas in Europe and its output expansion is required again. But as some difficulties, first of all, the social ones connected with curtailment and subsequent expansion of output make one prefer the variant of development (probably, less economic) meaning conservation of attained coal output level.

ICN setting per one conventional fuel ton (cft) of coal according to its interchangeability with gas leads to situations when in a number of coal deposits they would not cover discounted extraction and transportation costs though on the average some rent level is provided by this industry.

In perspective AEPS must be a marginal power source in Europe. But in 1982 the share of these station in the total power balance was too small and some difficulties linked with putting AEPS capacities into operation shows that extra needs in power cannot yet be met at the expense of this source. HEPS are very cheap power source, but their share in the total power balance is not large and its increase is limited by natural conditions.

Oil and products of its processing take a special place among fuel-and-power resources owing to possibility of using them in the capacity of motor fuel or raw materials in chemical or oil-chemical industries, their relatively light transportability and high export value.

Usually both in ICN calculations and in actual price formation evaluations of mazut and other dark oil-products are obtained on the basis of their interchangeability with other power-bearers. ICN of mazut so obtained may further be used for ICN calculation of motor fuels and crude oil according to the following approximate relations between costs values (Makarov, 1979; Rookovodjashic..., 1974):

$$\zeta_0 + c_1 = \alpha_e \zeta_e + \alpha_m \zeta_m \quad (4)$$

$$\zeta_m + c_2 = \beta_e \zeta_e + \beta_m \zeta_m \quad (5)$$

where ζ_0 , ζ_m and ζ_e — ICN per one ton of crude oil, mazut and light oil-products, c_1 and c_2 ⁽⁵⁾ — per unit costs in primary oil-refining of 1 ton crude oil and in secondary refining (cracking) of mazut, α_e , α_m , β_e , β_m — the shares of light and dark oil-products output from one ton of initial stuff correspondingly under primary and secondary refinement.

The relations (4) and (5) determine functional connection between ICN of mazut and crude oil (ζ_m and ζ_0), so setting one of these norms uniquely determines the value of the other.

It should be noted that under the conditions, when oil output is enough for satisfaction of national economy requirement in motor

⁽⁵⁾ The value of c_2 must include also costs on improving mazut obtained as a product of secondary refinement.

fuel at the expense of only primary refinement and practically without use of secondary processes, and not the whole crude oil output, but only its part is refined, crude oil, as well as mazut is valued only as boiler-and-stove fuel. In this case the relations (5) must be replaced by equation

$$\zeta_0 = \zeta_m \quad (5a)$$

The relations (4)-(5) were used in calculations for 1982, the relations (4)-(5a) — for 1972.

ICN calculations carried out on the basis of assumptions indicated above with the use of the relation expressing interchangeability of mazut with other power-bearers result in ICN values of oil which are lower than those obtained by calculations on the basis of oil extraction and transportation costs. For the year 1982 this difference is very considerable: about 1.5 times. the use of ICN values calculated on the basis of interchangeability would mean efficiency of strategy of rapid curtailment of oil output. At the same time its extremely high export value shows that interchangeability principle from the point of view of power equivalent for such a resource as oil is not suitable. Therefore, our position is that ICN of oil and oil-products should be set at a higher level: on the basis of the costs on extraction, transportation and refinement of oil (without regard for interchangeability with the other power-bearers). It would promote exclusion of oil and mazut from boiler-and-stove fuel balance and substitution gas and coal for them. When doing so, ICN of mazut and motor fuel (ζ_m and ζ_e) are calculated by means of the relations (4)-(5) or (4)-(5a) proceeding from a given ζ_0 .

As it is seen from the previous exposition incremental costs evaluation for fuel industries is characterised by a number of peculiarities. Not only the difference between marginal and average costs, but also dynamic rent and power-bearers interchangeability should be taken into account.

Foreign trade may be considered as the most important sphere of interchangeability. If one rouble expenditure on production of export resource allows to import articles saving more than one rouble of national economy costs, the expansion of exporting and importing

these articles is efficient until some new constraints arise impeding further export expansion with the same costs or further import expansion with the same efficiency of using import articles.

In this sense the reflection of interchangeability in ICN is equivalent to determination of their relations for exported and imported kinds of production by world market prices.

As for the national economy of the USSR, in the most part of branches export and import make a small share of the total production volume and means of export and import expansion and world market price level are hardly forecast, therefore, when calculating ICN, world market prices, as a rule, are not reflected or they are reflected while developing not main, but auxiliary variants.

ICN calculated proceeding from home production and consumption conditions allow to assess national economic efficiency of various orientations of export and import structure.

For this purpose currency coefficients are used. They express national economic costs at actual home prices which are necessary for obtaining one currency rouble (when exporting) and national economic effect which would be obtained per one currency rouble (when importing). In ICN terms currency coefficient for a group of articles is equal to $c_c = \frac{\xi}{p_w}$, where ξ — average ICN of this group

TABLE 1. — Evaluations of incremental extraction and transportation costs to the corresponding average costs ratios for fuel-and-power production.

Power-bearer's name	Year	$z = mD$
1. Coal (in the European part)		1.6
2. Coal (in the Asian part)		1
3. Gas (in the European part)	1972	2.1
4. Gas (in the Asian part)		2.1
5. Oil		5.1
1. Coal (in the European part)		1.5
2. Coal (in the Asian part)		1.36
3. Gas (in the European part)	1982	2.1
4. Gas (in the Asian part)		2.1
5. Oil		5.36

of articles in actual prices and p_w — world market prices in currency roubles. A number of kinds of imported products which are stable in the sense of efficiency of their home use and making a considerable part of the total import may be chosen and those directions of export expansion or import curtailment may be considered to be effective which would obtain more effect than the costs provided that extra currency obtained by means of it would be used for purchase of these « basis » kinds of import.

In other words, export expansion or import curtailment are efficient if $c_c < \bar{c}_c$, where \bar{c}_c — currency coefficient of « basis » kinds of production.

6. Model for reflection of branch interactions in ICN.

For a long time models based on interbranch balances have been used for calculations of branch price levels (see Belkin, 1973, 1983). They represent a system of equations of the following type

$$p_j = \sum_i p_i a_{ij} + w_j + \pi_j, \quad j = 1, \dots, n \quad (6)$$

Here lower indices i and j denote a branch number, n — the quantity of branches, p_j — calculated unknown price indices relative to actual prices (more exact, to those prices at which the interbranch balance was drawn up), a_{ij} — input-output coefficients (they also included thorough capital repairs and rehabilitation costs), w_j — labour input per output unit which is measured by per unit wages (in agriculture it includes also payments from collective farms and income of private husbandries) with addition of state social insurance deductions.

Per unit profit π_j in price is usually connected with capital expenditure on production and set proportional to either assets-output ratio φ_j

$$\pi_j = \mu \varphi_j \quad (7)$$

(the model of « production prices »), or net capital investments per unit of output average for a given branch

$$\pi_j = \nu k_j \quad (8)$$

(« self-financing » price proposed by N.J. Petrakov /11/. It corresponds to heightened profitability of production assets in rapidly developing branches). Assets-output and capital-output ratios are reflected in structure of assets-forming branches of interbranch balance (in our calculations — engineering industry and construction) and revaluated at unknown prices p_j :

$$\varphi_j = \sum_i p_i \varphi_{ij}, \quad k_j = \sum_i p_i k_{ij}$$

In order to obtain branch ICN levels the some model (6) may be used with replacement of coefficients a_{ij} , w_j , φ_j , χ_j expressing average costs by analogous ones showing incremental costs. As the purpose of calculating ICN is, in particular, in comparing discounted costs on production of different products and in improving distribution of capital investments to expansion of production, the right-hand side of (6) should be replaced by the sum of per unit discounted costs on a marginal deposit or in a marginal district of production and transportation costs multiplied by coefficient D reflecting dynamic rent. If only aggregate level of marginal discounted costs per one rouble of branch output (calculated at actual prices) and their structure is near to average costs structure reflected in interbranch balance, then the following equation instead of (6) should be written for determination of ICN

$$p_j = z_j (\sum_i p_i a_{ij} + w_j + \nu \sum_i p_i k_{ij}), \quad j = 1, \dots, n \quad (6a)$$

where $z_j = D_j m_j$, $m_j = \frac{\zeta_{mj}}{\zeta_{aj}}$ and ζ_{aj} and ζ_{mj} — average and marginal discounted costs levels per one rouble of j -th branch output. The coefficient z_j is linked with the share of rent in increase costs by the relation (1a). This relation remains invariant in the simplest model (6a).

Calculations for fuel industries show that the values of the ratios prove to be highly stable. It permits to suggest a hypothesis that the parameter z_j (or r_j) should, as a rule, change little when passing from actual prices to ICN, i.e., that the share of rent may be quite safely evaluated according to statistical data at actual prices.

According to 5. products' interchangeability was reflected in the model only with respect to gas and coal. It was assumed that the relations of actual prices on the average approximately correctly reflect calorific capacity relations and other consumption properties of these resources. In this case branch ICN level ratios should be equal to branch levels ratios of actual prices and hence, the equation must be fulfilled

$$p_c = p_g \quad (9)$$

(p_c and p_g — indices of transition from actual prices to ICN for coal and gas). As it was noted in 5., coal was taken in the capacity of marginal fuel in 1972 both in Europe, and in Asia. It was also taken in this capacity in 1982 in Asia. Therefore, the corresponding equations (6a) for gas are not used and are replaced by (9) in the model. Marginal power-bearer for Europe in 1982 was gas, so the equation (6a) for coal is replaced by the equation (9). It should be noted that subsidiary variant of calculation where coal is assumed to be marginal power-bearer both in Asia, and in Europe gives ICN values which are near for all the branches. For oil-extraction ICN were calculated on the basis of branch costs without reflection of interchangeability both in 1972 and 1982. The values of coefficient z for fuel are given in Table 1.

It should be noted that ICN for mazut evaluated per conventional fuel unit calculated with regards to branch interactions was in 1972 higher than ICN for coal and gas by 20 per cent and 1982 — already by 46 per cent owing to more rapid rise of oil extraction costs.

Evaluation of the parameter z for ferrous metal industry was based on the following assumptions: 1) the whole of rent of natural conditions is concentrated in iron-ore industry; 2) since the production of different iron-ore enterprises differs considerably in composition and quality and prices on it do not always reflect relations of its efficiency from the point of view of further processing it, the share of rent in iron-ore industry was evaluated according to the difference between average and marginal costs of pig-iron production (with regard to share of costs for iron-ore in the total output of pig-iron);

3) dynamic rent was not taken into account ($D = 0$) because of comparatively slow stock increase. As a result, the values of z being near to 1.3 were obtained for 1972 and 1982.

Determination of magnitude and structure of marginal costs for manufacturing industries, infrastructure and distribution sphere is difficult even theoretically because of a large number of kinds of their production, rapid renewall of assortment etc. When calculating branch price and ICN levels for these branches, only average costs represented in interbranch balances and average assets-product ratios may be used. The main purpose of this work is to determine influencing ICN system by natural resource rent. Therefore, more detailed reflection of conditions in other branches remains beyond the model.

Since instead of capital investments, assets value was used and their technical level, average age etc. differs from one branch to another, then the use of the principle of « production price » with common rate of profitability per assets unit may not be regarded as obligatory.

For those branches where average costs were not replaced by incremental ones (i.e., rent does not arise) in calculations for the year 1982 profitability of production assets was determined according to either principle of « production price » (7) or principle of « self-financing » (8) (for the year 1972 only « self-financing » principle was used), and the values of rates μ and ν were chosen so that the average rate of profitability for the national economy calculated in ICN would coincide with the actual rate for a corresponding year.

Average costs level for nature resource-using branches which is necessary for rent calculation was determined according to a principle (« self-financing » or « production price ») accepted for other branches. After that, the share of rent was determined by the formula (1). Thus, an accepted principle of price formation was kept for all branches including natural resource-using branches too.

The results of calculation by means of the model show that that transition from one principle of reflecting profitability of production assets to the other does not bring considerable changes in values of ICN coefficients (d_j). Therefore, the results given in Table 2 are calculated only for the variant with « self-financing principle which is considered basic.

Table 2 - ICN values relative to the actual national price including turnover tax: and the share of rent in ICN in % (2).

Name of branch	ICN 1972 $E = 0.12$ $\nu = 1.21$		ICN 1982 $E = 0.1$ $\nu = 1.25$		ICN 1982 $E = 0.8$ $\nu = 1$	
	(1)	(2)	(1)	(2)	(1)	(2)
Iron-ore industry	1.22	12.4	1.34	22.2	1.17	22.9
The rest of ferrous metal industry	1.37	0	1.39	0	1.18	0
Coal industry (Europe)	2.63	36.6	2.3	22.4	1.85	17.1
Coal industry (Asia)	1.95	24.8	2.43	24.7	1.92	19.0
Oil-extraction	6.04	78.3	6.03	77.4	5.01	77.7
Oil-processing	2.42	0	3.27	0	2.72	0
Gas-extraction (Europe)	2.76	50.4	2.43	38.4	1.95	35.6
Gas-extraction (Asia)	2.05	33.6	2.23	33.5	1.76	29.4
Other kinds of fuel	1.39	0	1.58	0	1.4	0
Electric power (Europe)	1.69	0	1.87	0	1.55	0
Electric power (Asia)	1.51	0	1.86	0	1.54	0
Engineering and metalworking industry	1.14	0	1.19	0	1.07	0
Chemical industry	1.23	0	1.41	0	1.23	0
Timber industry	1.66	37.9	2.59	41.1	2.31	41.8
Woodworking and pulp-and-paper industry	1.36	0	1.5	0	1.34	0
Building materials	1.33	0	1.4	0	1.23	0
Light industry	0.9	0	1.04	0	0.92	0
Food industry	1.7	0	1.78	0	1.62	0
Other industries	1.48	0	1.85	0	1.64	0
Plant-growing	1.94	36.9	2.23	36.5	2.07	37.4
Livestock-raising	2.36	13.1	1.95	13.7	1.8	15.7
Forestry	1.38	0	1.43	0	1.31	0
Construction	1.29	0	1.34	0	1.2	0
Transportation and communications	1.4	0	1.55	0	1.33	0
Trade, material and technical supplies and state purchases	1.18	0	1.53	0	1.32	0
Other branches of material production	1.19	0	1.17	0	1.05	0
The whole of the national economy	1.6	27.2	1.74	33.3	1.54	32.9

(*) To retail prices.

(**) To purchase prices of 1983.

(***) The share of rent in the national income.

Considerably stronger influence is exerted by accepted values of efficiency parameters E and v . Since in actual prices and in accepted methods of evaluating economic efficiency of capital investments natural resources rent is not taken into account, it is naturally to assume that recommended rates of capital investments efficiency and rate of profitability in prices which should correspond to efficiency of production assets in comparison with labour efficiency prove to be overstated at the expense of including in them a part of rent component. Therefore, for the year 1982 a variant was also calculated in which there were lower values of efficiency rate in incremental costs calculation ($E = 0.088$) and profit-capital investments ratio ($v = 1$). The obtained ICN values were characterised by lower general level: 1.5 times actual price level. The share of rent in the national income changed slightly.

7. *The results of the calculations by means of the model and their analysis.*

ICN indices relative to the actual wholesale prices are given in Table 2.

As it is seen from Table 2, common ICN level in 1982 proved to be 1.74 times as much as wholesale price level (including turnover tax) at the expense of the inclusion of rent in them (in 1972 - 1.6 times). Rent makes up 33.3 per cent (in 1972 - 27.2 per cent of the national income calculated at ICN).

ICN distinctly exceed the actual price level for those branches where rent is stipulated by the model and in food industry (owing to high ICN level for production of agriculture) and partly for the branches of infrastructure (transportation and communications, trade, material and technical supplies and state purchases). For other branches ICN levels are considerably nearer to actual price levels. Thus, ICN of fuel to ICN of engineering and metalworking industry production ratio is two times as large (in 1972-2.4 times) as the ratio of corresponding wholesale prices.

High levels of rent and ICN in extracting industries and agriculture are indicative of considerable reserves for raising efficiency of the national economy consisting in improving interbranch pro-

portions in connection with the transition to **resource-saving technologies**. Such an approach allows to reduce rates of **expanding** primary resources production and refuse from a part of the **least efficient** lands and deposits or to release extra resources for export. At the expense of it, incremental costs level in a number of branches, especially in agriculture, should approach average costs level and the share of rent be reduced. Expansion of the share of atomic power in electric power output planned for the nearest five-year periods which would lead to reducing the difference of incremental and average costs for all the power resources except oil and gas may be **an example** of such a process. These progressive processes may be **essentially accelerated** by means of systematic calculation and using ICN.

The problem of improving actual price levels and relations is considerably more complicated than using ICN in project-and-plan calculations.

At the same time, a considerable difference of relations and aggregate level (with respect to labour payment) of the actual wholesale and purchase prices from ICN may raise distortion of interbranch proportions and drop in efficiency of production structure. The question of improving price systems under the conditions of autonomy expansion of a main profit-and-expenses link of economic control becomes especially important.

Therefore, side by side with the process of reorganization of social production structure leading to reduction of the difference between incremental and average costs (first of all, in agriculture) a strategy of successive approaching actual whole sale prices by their structure and relations to incremental costs norms should be mapped and realized.

For the first stage price system including rent only in oil-and-gas extracting industry was calculated⁽⁶⁾. Prices for other branches are set according to the « self-financing » principle with conservation of the relation between profit minus bonuses from material stimulation funds and net capital investments (1.25). In this case rent may

⁽⁶⁾ This calculation was carried out with the participation of N.J. Petrakov and E.G. Jastin

TABLE 3. — First stage price indices relative to the actual wholesale prices including turnover tax (1) and the share of rent in them in % (2).

Name of branch	(1)	(2)
Iron-ore industry	0.9	0
The rest of ferrous metal industry	0.9	0
Coal industry (Europe)	1.19	0
Coal industry (Asia)	1.19	0
Oil-extraction	2.19	55.1
Oil-processing	1.32	0
Gas-extraction (Europe)	1.19	14.4
Other kinds of fuel	1.18	0
Electric power (Europe)	1.03	0
Electric power (Asia)	1.03	0
Engineering and metal-working industry	0.91	0
Chemical industry	0.96	0
Timber industry	1.04	0
Wood-working and pulp-and-paper industry	0.91	0
Building materials	0.97	0
Light industry	0.64 (*)	0
Food industry	1.06 (*)	0
Other industries	1.14	0
Plant-growing	1.03 (**)	0
Livestock raising	1.09 (**)	0
Forestry	1.2	0
Construction	1.01	0
Transportation and communications	1.09	0
Trade, material and technical supplies and state purchases	1.17	0
Other branches of material production	0.89	0
The whole of the national economy	1.06	5.9 (***)

(*) To retail prices.

(**) To state purchase prices of 1983.

(***) The share of rent in the national income.

be partly constituted at the expense of shifting financial flows — part of turnover tax being raised within production sphere and part of profit. A feasible variant of such a price system was calculated on the basis of the interbranch model (it is named « first stage prices » in Table 3). The level of actual wholesale prices is exceeded in such a variant for 1982 by 6 per cent on the average. It should be noted that under stable retail prices, the value of national income calculated at final consumption prices according to prescribed methods will not be changed. The difference between the corresponding indices

of gross output and national income must be compensated at the expense of cutting turnover tax and raising state subsidies on covering the difference in agriculture produce prices.

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