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Economic Reform, Allocative Efficiency, and Terms of Trade

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FOREWORD

This Working Paper is one of a series embodying the outcome of a workshop and conference on *Economic Structural Change: Analytical Issues*, held at IIASA in July and August of 1983. The conference and workshop formed part of the continuing IIASA program on Patterns of Economic Structural Change and Industrial Adjustment.

Structural change was interpreted very broadly: the topics covered included the nature and causes of changes in different sectors of the world economy, the relationship between international markets and national economies, and issues of organization and incentives in large economic systems.

There is a general consensus that important economic structural changes are occurring in the world economy. There are, however, several alternative approaches to measuring these changes, to modeling the process, and to devising appropriate responses in terms of policy measures and institutional redesign. Other interesting questions concern the role of the international economic system in transmitting such changes, and the merits of alternative modes of economic organization in responding to structural change. All of these issues were addressed by participants in the workshop and conference, and will be the focus of the continuation of the research program's work.

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ECONOMIC REFORM, ALLOCATIVE EFFICIENCY, AND TERMS OF TRADE

Ernö Zalai*

1. INTRODUCTION

This paper addresses various issues related to, and in the framework of, a computable general equilibrium model of an open economy. The particular economy represented by the numerical model is that of Hungary and the model is used, among other things, to highlight some issues connected with economic reform. Foreign trade will be a focal point in our analysis of changing resource allocation patterns under various assumptions.

Ideas for economic reform in Eastern Europe have in recent years developed through several stages; nevertheless, some basic elements have remained practically unchanged. Among these latter is the establishment of economically more sound price systems, the increased role of prices in economic decisions both at the central (macro) and the enterprise (micro) level, and the simultaneous decentralization of decision making. The various suggestions for economic reform have rarely been based on a rigorously developed economic theoretical framework. However, it is probably fair to say that in most cases they have relied on some intuitive model of perfect competition stimulated by individual or group financial/material interest. Hence, we believe that the adoption of a competitive general equilibrium model framework for the analysis of expected outcomes of economic reform measures is justified.

In our analysis attention will be focused on rather specific problems. Within the usual competitive static framework we will evaluate the expected impact of a price reform on the allocation of resources and the consequent gains in economic efficiency. Comparative static analysis involves the basic assumption that the underlying structure of the economy, for example,

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technological conditions and consumer preferences, remains unchanged. This critical feature of the analysis will assume a special meaning in our case and add an important qualification to the interpretation of the results.

One plausible interpretation of the above assumptions is suggested by some ideas especially typical of earlier stages in the formulation of reform concepts. These were concerned mostly with the question of how to improve central planning by means of establishing economically more sound price systems, which would aid planners in allocating resources according to optimal resource use.

Another, somewhat related interpretation can be distilled from the actual reform experience in Hungary. Many observers inside and outside Hungary assert that, because of surviving institutional rigidities and worsening external trade conditions, the economic reform did not produce satisfactory results at the micro (enterprise) level. The enterprises failed to modernize their product structure to a sufficient extent, and consequently the increase in productivity and competitiveness on foreign and domestic markets was smaller than had been expected. Our simulation results suggest that, under such conditions, one can really expect only modest results (if any improvements at all) from the introduction of an equilibrium price system and the corresponding reallocation of resources, i.e., following the rules of a *laissez-faire* market equilibrium.

As mentioned above, we employ here a model of the computable general equilibrium type* to assess the repercussions of the assumed changes in a consistent manner. The basic assumption is that changes in relative prices and costs will be followed by appropriate shifts in the composition of inputs, outputs, consumption, and trade. While the model is intended to capture some elements of the working of an economic or planning system in which prices and market considerations play some role, albeit limited, it should not and cannot be regarded as a fully adequate, descriptive model of the Hungarian or any other real economy. Our basic aim is to test various reform concepts under the conditions outlined above.

Since we are dealing with an open economy, special attention is also paid to foreign trade and the possible effects of trade-liberalization policies. We repeat our comparative static exercise under alternative assumptions concerning export conditions. In some runs we assume (we believe, quite realistically) that, due to our inability to alter the export structure or to unfavorable external conditions, changes in the volume of exports are accompanied by endogenously-induced terms-of-trade changes. We will show that, contrary to some common beliefs, moving closer to a market equilibrium (in such a situation) does not necessarily improve Pareto efficiency. The increase in allocative efficiency will be reduced and may even be completely offset by endogenously-induced terms-of-trade deterioration. The optimum tariff argument suggests that in such cases it might be advantageous to keep some central control over export decisions, since individual exporters may not perceive (or it may not be in their interest to account for) this scale effect.

Finally, the paper also addresses a more general, methodological issue concerning computable general equilibrium modeling. This is the question of the treatment of foreign trade in general, and the so-called Armington assumption in particular. The numerical examples presented will illustrate the effect of alternative assumptions regarding export functions and the size of export

*Models of this type have been developed during the past decade in various places for economic policy analyses. Some representative examples are the work of Johansen (1959), Dervis et al. (1982), Dixon et al. (1982), Kelley et al. (1983), and Scarf and Shoven (1983).

elasticities. It will be argued that the export demand functions and values of elasticities frequently adopted introduce unwanted and unreasonable terms-of-trade effects into the analysis, and that these effects should and can be avoided.

2. THE MODEL: AN OUTLINE

Before presenting a complete mathematical statement of the model, we will give an informal, brief outline for the sake of readers less interested in mathematical formulas. The model in most of its elements follows quite closely what may already be called a "traditional" computable general equilibrium approach. In this outline we will, however, also comment on some less traditional features of our model, which distinguish it from related models developed elsewhere.*

Commodities in the model represent sectoral outputs and, according to one fairly common statistical classification in Hungary, 19 sectors are distinguished. Commodities are further classified into three categories: domestically produced, and competitive and noncompetitive imports. Both imports and exports are also classified in terms of dollar and rouble trading areas, which results in a fairly detailed foreign trade structure. Rouble trade in this version of the model is exogenously given, reflecting the fact that rouble trade flows as a rule are fixed by five-year bilateral agreements and thus are relatively inflexible over the short term. Exports and competitive imports are treated as perfect substitutes for domestic products. This treatment, especially in the case of imports, is a departure from the traditional, neoclassical general equilibrium models, in which imports are usually treated as imperfect substitutes. Nevertheless, we employ formally similar, relative price dependent import share functions, as in the more traditional models, which can be derived on the basis of cost-minimization assumptions and a CES-type substitution function. Our rationale for using these import share functions is, however, different from the neoclassical one (which assumes imperfect substitutability and perfect adjustment). They are intended to simply reflect limited (probably imperfect) adjustments to relative price changes, which may be caused by a variety of factors. (It should be mentioned, though, that the numerical results are not much affected by this change in treatment.) As a result, we have two sets of balance equations for the sectoral commodities: one combined balance for domestically produced goods plus competitive imports, and one for the noncompetitive imports (eqns. 1 and 3, below).

Total use of commodities is split up between production, investment, consumption, and export (if applicable). Use in production and investment is determined through fixed input–output coefficients (Leontief technology). Consumption is treated in a special way, which can be viewed as a generalization of the frequently used Linear Expenditure System (LES). Total consumption (see eqns. 15–17) is made up of a fixed part (identified here with the base consumption) and a variable part (excess consumption). The structure of the latter is fixed (a Leontief or Kantorovich type of preference function), thus leaving only the level of excess consumption to vary. This makes the implicit objective (welfare) function similar to those employed in some linear planning models. Another special advantage of this formulation is that it allows us to measure

*The model employed here was developed by the author, and more elaborate discussion of it can be found in Zalai (1980, 1982). The author wishes to acknowledge the valuable assistance in preparing the numerical version of the model given by his colleagues in the Hungarian Planning Office.

welfare changes in a conceptually very simple way.

Gross investment is defined by eqn. (2) as the sum of replacement and new investment. The former is determined by the variable sectoral capital stocks and fixed replacement coefficients, which are different from the amortization rates. The amount of new (net) investment is exogenously given in this version of the model.

Labor and capital are undifferentiated with respect to their sectoral use: they are assumed to be freely mobile across sectors. The uses of labor and capital in production are specified by Cobb-Douglas production capacity functions (which results in a Johansen-type production technology). Sectors are assumed to minimize the joint cost of labor and capital used. Total available labor and capital are held constant and assumed to be fully utilized (see balance equations 4 and 5).

The rest of the foreign trade relations are modeled as follows. Dollar exports are assumed to adjust to relative (domestic/foreign) price changes and the size of shifts is determined by fixed elasticity coefficients.* This is a normal, but critical treatment. Such a formulation is traditionally supported by Armington's (1969) assumption about regional product differentiation and leads to a downward-sloping export demand function. Conversely it means that the export price is assumed to change with the volume of export. This is a tenable assumption even in the case of a "small" country, but leads to some problems seldom addressed in applied models. We will come back to this point during the discussion of the results. Since rouble trade flows are fixed, we have only one balance-of-payment (current account) constraint in the model for dollar trade. The target deficit level is fixed in the model.

Now we turn to the description of the equilibrium pricing rules. As a basic principle we have tried to follow as closely as possible the so-called two-channel, normative price formation rule, discussed extensively in the literature related to price reform ideas (see, for example, Csikós-Nagy 1975). Equilibrium (domestic producers') prices are, thus, defined as the sum of unit material costs, amortization, wages, and uniformly determined (normative) returns on labor and capital. The normative rates of return on labor and net capital are determined endogenously as equilibrium rates (factor clearing prices). The domestic price of dollar imports is determined through their world market price and the equilibrium exchange rate. The domestic price of rouble imports (since they are fixed) needs special treatment. In the noncompetitive sphere it is assumed to move in proportion to the price of dollar noncompetitive imports, whereas in the competitive sphere it varies proportionally to the average price level of the substitutes. And, finally, since we do not record how large the share of inputs from various sources is in different uses, the same average sectoral prices are used to evaluate the composite input in each area of use.

A complete formal description of the model, including the list of variables and parameters, now follows in Section 3.

*In two sectors (foreign trade and waterworks) we held export constant. In the first case because of accounting problems (some part of export earning is counted in the foreign trade sector, and as a result it shows up as if it were an independent and very profitable exporting activity), and in the second case because of its negligible role and inelastic nature.

3. FORMAL STATEMENT OF THE MODEL

Endogenous Variables

X_j	gross output in sector $j = 1, 2, \ldots, n$
M_{id}	competitive dollar import of commodity $i = 1, 2, \ldots, n$
Z_{id}	dollar export of commodity $i = 1, 2, \ldots, n$
X_{n+1}	total gross investment
$\overline{M}_i, \overline{M}_{id}$	total and dollar noncompetitive import of commodity $i = 1, 2, \ldots, n$
C_i	total private and public consumption of domestic-competitive import commodity $i = 1, 2, \ldots, n$
$\overline{C}_i$	total private and public consumption of noncompetitive import commodity $i = 1, 2, \ldots, n$
K_j	capital used in sector $j = 1, 2, \ldots, n$
k_j	capital coefficient in sector $j = 1, 2, \ldots, n$
L_j	labor employed in sector $j = 1, 2, \ldots, n$
l_j	labor coefficient in sector $j = 1, 2, \ldots, n$
S_j	user cost of labor and capital per unit of output in sector $j = 1, 2, \ldots, n$
W_j	user cost of labor in sector $j = 1, 2, \ldots, n$
W	net rate of return requirement on labor
Q_j	user cost of capital in sector $j = 1, 2, \ldots, n$
R	net rate of return requirement on capital
$\overline{m}_i$	share of rouble import in total noncompetitive import of commodity $i = 1, 2, \ldots, n$
m_{ir}, m_{id}	proportions of competitive rouble and dollar imports of commodity $i = 1, 2, \ldots, n$
P_j	domestic producer's price of commodity $j = 1, 2, \ldots, n$
P_{jd}^E	dollar export price of commodity $j = 1, 2, \ldots, n$
V_d	dollar exchange rate
P_i^D	average price of domestic-import composite commodity $i = 1, 2, \ldots, n$
E	total consumption expenditure
EE	excess expenditure level

Exogenous Variables and Parameters

s_j	capital replacement rate in sector $j = 1, 2, \ldots, n$
I^o	new investment (at base prices)
δ_j	depreciation rate in sector $j = 1, 2, \ldots, n$
K	total capital stock
L	total labor
$Z_{id}^o, \varepsilon_{id}$	parameters in the dollar export functions
ζ_j, ξ_j	parameters in the production functions
$P_{id}^{WE}, P_{id}^{WI}, \overline{P}_{id}^{WI}$	dollar world market export and import prices of commodity i (competitive-noncompetitive import)
D_d	target surplus or deficit on dollar foreign trade balance
a_{ij}	input coefficient of domestic-import composite commodity $i = 1, 2, \ldots, n$ in sector $j = 1, 2, \ldots, n, n+1$
$M_{ir}^o, \overline{M}_{ir}^o$	rouble competitive and noncompetitive imports of commodity $i = 1, 2, \ldots, n$
Z_{ir}^o	rouble export of commodity $i = 1, 2, \ldots, n$

$\left.\begin{matrix} m_{ir}^o, m_{id}^o \\ \mu_{ir}, \mu_{id} \end{matrix}\right\}$ parameters in the import functions, $i = 1, 2, \ldots, n$

$b_i, \bar{b}_i$ fixed (base) amount of total consumption of commodity $i = 1, 2, \ldots, n$

$c_i, \bar{c}_i$ fixed structure of excess consumption of commodity $i = 1, 2, \ldots, n$

w_j wage coefficient in sector $j = 1, 2, \ldots, n$

$\bar{\nu}_j$ rate of net to gross capital in sector $j = 1, 2, \ldots, n$

Balancing Equations

Intermediate Commodities

$$X_i + M_{id} + M_{ir}^o = \sum_{j=1}^{n+1} a_{ij} X_j + C_i + Z_{id} + Z_{ir}^o \qquad i = 1, 2, \ldots, n \qquad (1)$$

$$X_{n+1} = \sum_{j=1}^{n} s_j K_j + I^o \qquad i = 1, 2, \ldots, n \qquad (2)$$

Noncompetitive Imports

$$\bar{M}_i = \sum_{j=1}^{n+1} \bar{m}_{ij} X_j + \bar{C}_i \qquad i = 1, 2, \ldots, n \qquad (3)$$

Primary Factors

$$K = \sum_{j=1}^{n} K_j \qquad (4)$$

$$L = \sum_{j=1}^{n} L_j \qquad (5)$$

Trade Balance

$$\sum_{i=1}^{n} P_{id}^E Z_{id} - \sum_{i=1}^{n} P_{id}^{WI} M_{id} - \sum_{i=1}^{n} \bar{P}_{id}^{WI} \bar{M}_{id} = D_d \qquad (6)$$

Technological Choice

$$X_j = \zeta_j L_j^{\xi_j} K_j^{1-\xi_j} \qquad j = 1, 2, \ldots, n \qquad (7)$$

$$S_j \frac{\partial X_j}{\partial L_j} = W_j \qquad j = 1, 2, \ldots, n \qquad (8)$$

$$S_j \frac{\partial X_j}{\partial K_j} = Q_j \qquad j = 1, 2, \ldots, n \qquad (9)$$

where

$$S_j = W_j l_j + Q_j k_j \qquad j = 1, 2, \ldots, n$$

(This latter equation is omitted from the model, since, by Euler's theorem, it is a direct consequence of eqns. 7–9.)

Import and Export Functions

Noncompetitive Imports

$$\overline{M}_{id} = \max\,(\overline{M}_i - \overline{M}^o_{ir};\, 0) \qquad i = 1, 2, \ldots, n \qquad (10)$$

$$\overline{m}_i = \min\left[\frac{\overline{M}^o_{ir}}{\overline{M}_i};\, 1\right] \qquad i = 1, 2, \ldots, n \qquad (11)$$

Competitive Dollar Imports

$$m_{id} = m^o_{id}\left[\frac{P_i}{V_d\, P^{WI}_{id}}\right]^{\mu_{id}} \qquad i = 1, 2, \ldots, n \qquad (12)$$

$$M_{id} = m_{id}\,(X_i - Z_i) \qquad i = 1, 2, \ldots, n \qquad (13)$$

Exports

$$Z_{id} = Z^o_{id}\left[\frac{P_i}{V_d\, P^{WE}_{id}}\right]^{\varepsilon_{id}} \qquad i = 1, 2, \ldots, n \qquad (14)$$

Final Demand Equations

$$C_i = b_i + \frac{c_i}{\sum_{i=1}^{n} P^D_i c_i}\, EE \qquad i = 1, 2, \ldots, n \qquad (15)$$

$$\overline{C}_i = \overline{b}_i + \frac{\overline{c}_i}{\sum_{i=1}^{n} \overline{P}^{DI}_i \overline{c}_i}\, EE \qquad i = 1, 2, \ldots, n \qquad (16)$$

$$EE = E - \sum_{j=1}^{n} (P^D_j b_j + \overline{P}^{DI}_j \overline{b}_j) \qquad (17)$$

Prices and Costs

$$W_j = (1 + W)\, w_j \qquad j = 1, 2, \ldots, n \qquad (18)$$

$$Q_j = (\delta_j + \overline{\nu}_j R)\, P_{n+1} \qquad j = 1, 2, \ldots, n \qquad (19)$$

$$P_{n+1} = \sum_{i=1}^{n} P^D_i a_{i,n+1} + \sum_{i=1}^{n} V_d\, \overline{P}^{WI}_{id}\, \overline{m}_{i,n+1} \qquad (20)$$

$$P_j = \sum_{i=1}^{n} P^D_i a_{ij} + \sum_{i=1}^{n} V_d\, \overline{P}^{WI}_{id}\, \overline{m}_{ij} + W_j l_j + Q_j k_j \qquad j = 1, 2, \ldots, n \qquad (21)$$

$$P^D_i = \frac{1}{1 + m_{id}} P_i + \frac{m_{id}}{1 + m_{id}} V_d\, P^{WI}_{id} \qquad i = 1, 2, \ldots, n \qquad (22)$$

$$P^E_{id} = \begin{cases} P^{WE}_{id} & \text{if there is no endogenous export price change assumed} \\ \left[\dfrac{Z_{id}}{Z^o_{id}}\right]^{1/\varepsilon_{id}} P^{WE}_{id} & \text{otherwise} \end{cases} \qquad i = 1, 2, \ldots, n \qquad (23)$$

Price Normalization Rule

$$\sum_{i=1}^{n} P_i^D C_i + \sum \overline{P}_i^{DI} \overline{C}_i = \sum_{i=1}^{n} C_i + \sum_{i=1}^{n} \overline{C}_i \tag{24}$$

4. THE SIMULATION FRAMEWORK AND DATA

The data* for the model presented in the previous sections were mostly obtained from the 1976 official statistical input–output table of the Hungarian economy (see Csepinszky 1982). Where direct observations were not available we had to rely on expert estimates or various rather *ad hoc* methods. Thus, for example, there is no published information available on the area composition of exports and imports. The corresponding data in the model are therefore only rough estimates. Similarly, the initial dollar export prices (expressed in domestic currency units) were also estimated using indirect methods. The division of imports into competitive and noncompetitive parts was derived from more detailed (product group) investigation based on expert estimates.

The assignment of values to the parameters occurring in the technological and behavioral relationships constitutes a very frequently encountered problem. Available econometric estimates are scarce and very unreliable. We have followed the rather common calibration procedure (see, for example, Mansur and Whalley 1983) in which most of these parameters are "guesstimated" on the basis of the available literature and qualitative judgments, combined with single data point estimates. These latter are derived by assuming the initial (base) state of the economy to be, at least partially, one of equilibrium. In this way, the model specification is capable of reproducing the initial position of the economy and comparative static exercises can be performed. Table 1 contains some of the major indicators of the Hungarian economy in 1976 and also a few crucial model parameters.

The specification of and elasticities in the export relationships deserve special attention here, because the sensitivity of the results with respect to these factors is one of the major concerns of this paper. The main role of the export function is to allow some limited shift in the volume of exports in various sectors if relative (foreign/domestic) prices change. In linear programming models of resource allocation the same goal (i.e., allowing for some, but not complete specialization) is achieved by the use of individual bounds on export activities. Here, in the case of relative price dependent export functions, the larger the elasticities of these functions, the larger the scope for taking advantage of international specialization. If, however, they are interpreted as export demand functions, which is often the case, then the foreign price of the exported goods is dependent on their volume. The smaller the elasticities, the larger the size effect of the export volume on prices. The usual size of these elasticities is relatively small (-3; -1.5) both in the available literature on econometric estimates (see, for example, Houthakker and Magee 1969, Sato 1977, or Browne 1982) and in the CGE models using such specifications. These small elasticities, however, imply that endogenously-induced terms-of-trade effects will be rather large, which may be hard to justify on empirical grounds. It will, therefore, be interesting to see how the size of the export elasticities influence the solution of the model. To this end we have repeated each

*The author wishes to acknowledge the invaluable assistance of Gy. Boda and F. Hennelné in furnishing appropriate data for the model.

TABLE 1 Sectoral characteristics of production, export and import (percentage shares), and trade elasticity parameters.

Sector	Share in production	Export/ production	$ Export/ production*	Export elasticity*	Import/ domestic source	$ Competitive import/ domestic source*	Import elasticity*	Net income shares
1. Mining	2.27	3.63	0.84	−2.00	74.63	18.54	0.50	0.250
2. Electricity	1.76	1.63	1.01	−3.00	10.34	0.	–	0.068
3. Metallurgy	4.91	33.01	23.00	−2.50	47.91	7.67	0.50	0.141
4. Machinery	13.44	43.55	13.24	−2.50	80.14	2.12	0.30	0.282
5. Construction materials	1.63	12.29	7.91	−2.50	25.02	3.53	0.30	0.203
6. Chemicals	7.83	20.24	13.05	−2.50	49.18	11.67	0.50	0.301
7. Light industries	8.97	26.81	13.82	−2.50	26.16	7.93	1.25	0.230
8. Other manufacturing	1.11	8.98	4.82	−2.50	4.28	0.	1.25	0.128
9. Food processing	9.96	19.40	13.04	−2.00	15.75	7.05	1.25	0.061
10. Construction	8.20	0.54	0.15	−2.50	0.	0.	–	0.191
11. Agriculture	15.75	12.14	7.79	−2.00	4.62	0.79	2.00	−0.058
12. Forestry and logging	0.60	15.10	14.99	−2.50	26.95	8.66	0.50	0.119
13. Transport and communication	5.31	8.31	5.39	−2.50	4.42	0.	0.30	0.067
14. Domestic trade	6.06	2.76	2.24	−1.25	0.	0.	–	0.533
15. Foreign trade	1.60	26.78	9.97	−2.50	24.04	2.07	0.30	1.058
16. Waterworks	0.90	0.80	0.02	−2.50	0.	0.	–	−0.247
17. Personal and economic services	2.98	0.	0.	–	0.	0.	–	−0.271
18. Health and cultural services	3.63	0.	0.	–	0.	0.	–	−0.160
19. Public administration	3.06	0.	0.	–	0.	0.	–	−0.115
Total	100.00	16.90	8.60		20.70	3.45		

*Hypothetical data.

simulation after doubling the size of the initial export elasticities.

Also, besides the pure export demand specification, we have run the model with two alternative variants. The first of these can be tentatively interpreted as an export supply specification. In this run we assume that the volume of export has no effect on the export price, i.e., that the price is dictated by the world market; other than this, we use the same export functions. In the second case, we have tried to calculate a solution corresponding to the logic of a programming model or, using a term familiar in international trade theory, to an optimal tariff situation. In this run we assume that the terms-of-trade effects are real, but that they are not perceived by the atomistic exporters. We wanted to see how the *planners optimum* (in which the country takes advantage of this market "power" in international trade) would differ from the *laissez-faire* equilibrium (the first case). To obtain the exact results would in general require the solution of a relatively large nonlinear programming problem. Since, however, our model is rather close to a neoclassical formulation, we can approximate this solution by introducing appropriate optimum tariffs into the determination of export revenues (for the analytical and theoretical underpinnings of this approach, see Zalai 1982).

Thus, in effect, we will present in total six runs, which differ partly in terms of export specification (pure demand, supply, and optimum tariff) and partly in terms of the size of the export elasticities.

As indicated earlier, the major thrust of our simulation effort is to estimate the impact of a price reform on the economy, if the relative price changes were followed by appropriate reallocation of resources, including dollar foreign trade. In order to do this we assume that the initial state of the economy is "almost" a general equilibrium one, in which the only major distortion manifests itself in the price system. That is, individual decisions are viewed as roughly economically rational, except that they are based on incorrect price information. (As can be seen in Table 1, sectoral prices include rather different net incomes (profits) in different sectors.) The above assumption is admittedly very bold, though not inconsistent with some (especially earlier) Hungarian reform ideas. More realistic assumptions would require qualitatively different model specifications, for which, for the time being, both theoretical and empirical bases are lacking.

Thus our model, with a slight change in its specification, reproduces the 1976 situation of the Hungarian economy. The change is in the price formation rule (see eqn. 21). Prices in the base case equal costs, which also include normative net incomes (close to 30 percent on wages and 5 percent on net capital value in 1976), "marked-up" by fixed, but sectorally different profit rates. In the various runs we calculate the effect of the abolition of these profit mark-ups, i.e., the effect of a price reform, where prices are formed according to the principle of uniform (normative) return requirements. The optimum tariff calculation includes, in addition, taxes on exports, which distinguishes it from the other two specifications.

5. THE SIMULATION RESULTS

Table 2 contains the sectoral producers' price indexes calculated in the various runs. These may be of special interest because there are a number of published studies that have calculated normative prices on the basis of input–output tables both in Hungary and elsewhere (see, for example, Ganczer 1962, Bárány and Szakolczai 1975, and Bánhidi 1978, for Hungary). These studies have used a somewhat different methodology; for example, in most cases they rely on exogenously-defined normative return rates on labor and capital. Even where they are endogenous (as in the case of Bánhidi 1978), the method followed is different (a closed Leontief model). What makes our model clearly distinguishable from the previous ones is that some of the input coefficients themselves (like those of labor and capital) change in response to price changes and that the (domestic/import) composition of inputs changes.

TABLE 2 Producers' price indices in various runs.

	Low elasticities			High elasticities		
Sector	Dem	Sup	Opt	Dem	Sup	Opt
1. Mining	81.16	81.28	79.03	81.37	81.45	80.32
2. Electricity	86.99	87.07	86.42	87.17	87.23	86.79
3. Metallurgy	74.28	73.82	85.23	73.52	73.24	77.85
4. Machinery	67.96	67.77	72.68	67.63	67.51	69.43
5. Construction materials	79.40	79.40	80.18	79.41	79.42	79.57
6. Chemicals	65.21	64.66	77.89	64.30	63.98	69.37
7. Light industries	70.22	69.95	76.46	69.74	69.57	72.25
8. Other manu-facturing	86.89	86.99	84.55	87.02	87.08	85.98
9. Food pro-cessing	95.73	95.62	97.66	95.53	95.46	96.38
10. Construction	80.80	80.86	79.66	80.88	80.92	80.29
11. Agriculture	111.39	111.57	107.23	111.67	111.78	109.90
12. Forestry and logging	89.04	89.18	85.96	89.26	89.34	87.93
13. Transport and communication	99.89	100.20	94.87	100.44	100.65	98.07
14. Domestic trade	70.31	70.54	65.25	70.69	70.83	68.53
15. Foreign trade	46.94	46.65	53.94	46.45	46.27	49.19
16. Waterworks	155.33	156.39	136.36	157.26	157.97	148.87
17. Personal and economic services	162.88	164.13	140.32	165.17	166.01	155.23
18. Health and cultural services	128.83	129.34	118.06	129.67	129.98	125.05
19. Public ad-ministration	118.75	118.85	117.11	118.90	118.96	117.96

In spite of these and other differences in methodology, data, or time period studied, our results show remarkable similarity with those of previous calculations. There are striking similarities, not only in general tendencies, such as disproportionality between global industrial, agricultural, and service price levels, but also in the rank order of sectors according to their normative price level. Comparing the different runs one can see that the price indices in four runs (demand and supply at both sets of elasticities) are practically the same; only the optimum tariff solution results in somewhat different prices, especially in the case of low elasticities. This difference can be clearly traced back to the imported input components and to variations in the dollar exchange rate. The latter decreases from its base level by about 20–25 percent in the four runs mentioned above, whereas in the optimum tariff runs it stays basically the same at high elasticities and increases by nearly 35 percent at low elasticities (see Table 3).

TABLE 3 Main indicators (aggregate indices at base prices): First model.

		Low elasticities			High elasticities		
Indicator	Base	Dem	Sup	Opt	Dem	Sup	Opt
GNP	100.00	102.04	101.58	100.58	103.06	102.42	102.37
GDP	100.00	102.11	101.77	100.91	103.27	102.75	102.66
Final consumption	100.00	99.91	101.52	102.68	100.37	102.28	101.03
Excess consumption	0.00	−369.89	5505.71	9730.08	1323.46	8290.52	3711.55
Dollar terms of trade	100.00	93.20	100.00	104.98	92.65	100.00	94.95
Total trade/ GDP ratio	81.10	83.97	82.91	76.66	85.73	84.20	82.07
Total export	100.00	108.40	104.96	94.29	112.95	108.24	106.35
Total import	100.00	103.09	103.13	96.47	105.44	105.14	101.46
Total competitive import	100.00	102.16	103.37	85.09	104.97	105.70	94.94
Total non-competitive import	100.00	103.50	103.02	101.50	105.64	104.89	104.34
Total dollar import	100.00	106.03	106.11	93.11	110.62	110.04	102.85
Total dollar export	100.00	116.51	109.74	88.78	125.44	116.20	112.48
Dollar exchange rate	100.00	80.87	78.53	134.54	76.95	75.52	98.46
Return rate on wages	0.30	0.57	0.58	0.36	0.59	0.59	0.50
Return rate on capital	0.05	0.10	0.10	0.06	0.10	0.10	0.09

One may wonder why the model suggests revaluation rather than devaluation of the Hungarian currency, at least in the pure equilibrium solutions: this seems at first sight in marked contrast with what conventional wisdom would suggest in the case of Hungary. The explanation is in fact rather simple: it is due to the decrease of price level in the major exporting sectors. If the exchange rate remained unchanged or increased, it would in general result in growing exports and decreasing imports, and it would thus violate the trade balance condition. Therefore, the exchange rate has to drop accordingly. Even in this situation, total trade turnover increases and, as expected, relatively more so in the case of higher export elasticities. It is also interesting to see that the increase of exports is larger in the demand than in the supply runs, because in the former, increased exports have to make up for the terms-of-trade deterioration (total imports increase at more or less the same rate in the two types of run).

The optimum tariff cases produce results that are qualitatively different from the other four variants and also from each other in the cases of higher and lower elasticities. Lower elasticities imply stronger international market power, the exploitation of which results in reduced trade volume and improved terms of trade (see Table 3). Thus, quite apart from the increased allocative efficiency, additional welfare gains result from the improving terms of trade. The increased dollar exchange rate (close to a 35 percent devaluation) makes imports decrease. If there were no tariffs on exports, they would increase significantly because of the high exchange rate. The tariffs offset this impetus. The large difference between the exchange rates in the case of pure demand and the optimum tariff run clearly indicates that the tariffs are quite large. Indeed, their size varies between 60 and 100 percent, depending on the size of the export demand elasticity.

When the elasticities are higher, the scope for increasing allocative efficiency becomes larger, whereas the terms-of-trade effects become significantly smaller. In fact, it proves to be advantageous to utilize the reallocation possibilities even to the extent where the general level of the terms of trade actually deteriorates. The size of the tariffs becomes, of course, much smaller in this case (20–35 percent) and as a result of these interacting forces, the exchange rate remains practically unchanged.

Readers interested in more detailed results of the simulation runs can find additional tables in the Appendix. These include percentage changes in dollar exports and competitive imports in different sectors, and the price terms that explain the direction of change in dollar exports and competitive import shares, as well as detailed statistics on changes in production and employment of the two primary resources, labor and capital. The analysis of these data is left to the reader. In the remaining part of the paper we will restrict ourselves to an analysis of various general features of our results and draw some broad conclusions on the basis of the summary Table 3.

The main aggregates measuring the output level of the national economy, gross (total) national production as well as GDP, show only a modest increase resulting from the reallocation of resources. This is a common phenomenon frequently encountered in similar resource allocation exercises. More significant changes can naturally be seen in the export and import activities. Except for one case, our calculations interestingly reproduce the historical observation that imports grow faster than output. This is a direct consequence of increased international specialization. As one can see, the measure of the openness of the economy, total trade/GDP, increases in all cases but one. The exception is the optimum tariff solution at low elasticities, which suggests that more specialization and increased foreign trade need not necessarily be beneficial for an economy. As we know, this is the case where export prices react rather sensitively to changes in export volumes.

One surprising result of our numerical simulations may be that in one of the runs the move toward a perfect equilibrium situation from a distorted one results in welfare loss. However, this may only be surprising because we tend to associate competitive equilibrium with Pareto optimality. This is, however, not the case when the economy is open and faces imperfectly elastic export demand. In such a situation the optimal policy is a kind of monopolistic rather than pure competitive equilibrium, as is known from the theory of optimum tariff. This solution is approximated, as indicated earlier, by the optimum tariff run. As we can see, the difference in terms of welfare between the pure competitive (*laissez-faire*) and the optimum tariff (*planners' optimum*) solutions is close to three percent of total consumption.

We can further characterize the trade-off possibility between allocative efficiency and terms-of-trade efficiency by means of the supply run. This latter approximates the potential allocative efficiency gain, i.e., the gain that would be achieved in the absence of terms-of-trade changes. As we can see, this potential allocative efficiency gain, at low elasticities, is approximately 1.6 percent of total consumption. This potential efficiency gain is offset by the simultaneous terms-of-trade deterioration in the demand run. In the optimum tariff run it is not fully utilized, but in that case the additional gain from the terms-of-trade improvement is significantly larger than the possible loss from not utilizing fully the allocative efficiency potential.

Most of our analysis so far has been concerned with the usual low elasticity case. As we have seen, the terms-of-trade effects brought into the numerical simulation through the downward-sloping export demand functions are quite significant, and seem to be quite unrealistic. The same runs repeated with the sizes of these elasticities doubled clearly exemplify the dilemma that the builders of computable general equilibrium models face. Larger elasticities will significantly increase the resource reallocation possibilities and reduce the effect of the terms-of-trade changes. Thus, for example, even in the optimum tariff run, it proves to be advantageous to utilize the resource reallocation potential, even to the extent of incurring a deterioration in the terms of trade. As can be seen, the *laissez-faire* and *planners' optimum* solutions do not differ so much as in the previous case. These solutions can, however, be criticized because they allow for unrealistically large shifts in the allocation of resources, primarily in exports.

One may believe that our results, especially the welfare loss occurring after a shift toward equilibrium, have to do with our departure from neoclassical assumptions. The consumption structure is fixed, and thus adjustment on the consumers' part is excluded. Also, as mentioned, import share changes are treated in a nonneoclassical fashion. It is, therefore, interesting to check how sensitive the simulation results are to these changes. To this end we repeated our exercise with a model strictly in line with neoclassical assumptions. In these runs imports were treated as imperfect substitutes and the usual cost minimization assumption was invoked. In the case of consumption we assumed that five percent of total consumption can be readjusted to changing prices in accordance with a Cobb-Douglas-type utility function. Thus we employed an LES-type demand structure. The main indicators of these runs are summarized in Table 4. They clearly indicate that the results are qualitatively the same, and even the quantitative differences are negligible.

6. CONCLUDING REMARKS

Although there are admittedly many speculative elements in our simulations, we can still draw some conclusions that may be interesting from the economic-policy point of view. First, the phenomenon discussed above seems to capture some elements of what actually happened in Hungary in the 1970s. It is very likely that a large part of the terms-of-trade deterioration that Hungary suffered over the past ten years was endogenously induced. To offset the effects of external terms-of-trade changes and to compensate for increasing imports, Hungary had to export more and more. The inability to build up new, more efficient export capacities added an endogenously-induced terms-of-trade

TABLE 4 Main indicators (aggregate indices at base prices): Second model.

		Low elasticities			High elasticities		
Indicator	Base	Dem	Sup	Opt	Dem	Sup	Opt
GNP	100.00	102.35	101.95	100.98	103.41	102.86	102.70
GDP	100.00	102.33	102.05	100.93	103.51	103.09	102.87
Final consumption	100.00	100.00	101.87	102.56	100.56	102.68	101.23
Variable consumption	18217.80	18078.81	24846.64	26875.50	20060.96	27781.74	22558.44
Implicit welfare function	18217.80	17470.37	23987.86	26142.79	19352.47	26783.46	21895.67
Dollar terms of trade	100.00	92.77	100.00	104.59	92.44	100.00	94.79
Total trade/ GDP ratio	81.10	84.16	83.04	76.90	85.95	84.40	82.21
Total export	100.00	109.05	105.45	94.70	113.62	108.90	106.83
Total import	100.00	103.38	103.54	96.69	105.84	105.69	101.77
Total competitive import	100.00	102.25	103.62	85.37	105.24	106.11	95.20
Total non-competitive import	100.00	103.88	103.51	101.69	106.11	105.50	104.68
Total dollar import	100.00	106.61	106.92	93.55	111.41	111.11	103.46
Total dollar export	100.00	117.78	110.70	89.60	126.75	117.49	113.43
Dollar exchange rate	100.00	81.58	79.24	136.06	77.44	76.12	99.11
Return rate on wages	0.30	0.58	0.59	0.35	0.59	0.60	0.50
Return rate on capital	0.05	0.10	0.10	0.06	0.10	0.10	0.08

deterioration to the external one.

Second, a general lesson that can be learned is that economic reforms that do not reach and genuinely affect the micro decision level can produce only modest, if any improvement in overall economic efficiency. Unless there are major changes in the micro structure of production, leading to more efficient use of resources at the enterprise level and more profitable and exportable products, a price reform followed by a rational reallocation of resources will not produce satisfactory results.

Third, the simulation results also suggest that a complete decentralization of foreign trade, especially the export activity, may not be advantageous if export demand is imperfectly elastic. Domestic firms may not perceive the opportunities arising and may therefore behave as atomistic price takers. Therefore there is some room for the central planning authorities to guide individual decisions in more generally beneficial economic directions.

Fourth, and partly related to the above issue, it is interesting to note that general price distortions may result in welfare improvement, similar, but not equal to the effect of optimal tariffs. Thus, if some international agreements, such as those of GATT, exclude the possibility of applying tariffs on exports, it is, at least in theory, possible to use general taxes on production as a second-best solution.

And finally, as a methodological observation, we may conclude from our analysis that in computable general equilibrium models it seems crucial to distinguish and separate the envisaged changes in the export prices (terms of trade) from those in the speed of export adjustment. One crude and pragmatic solution might be to use one set of relatively small elasticities in the export functions, and another set of relatively larger elasticities in the determination of export prices (see Zalai 1982 for details of this solution). Needless to say, the degree of freedom in reallocating resources in an open economy depends greatly on the potential for foreign trade. Thus, it is crucial in such exercises to represent this potential properly. At present it appears that neither the techniques used in linear programming nor those in computable general equilibrium models are fully adequate for handling this problem.

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APPENDICES

TABLE A1 Percentage changes in dollar exports.

Sector	Low elasticities			High elasticities		
	Dem	Sup	Opt	Dem	Sup	Opt
1. Mining	99.28	93.35	72.46	79.99	73.93	71.42
2. Electricity	80.32	73.37	111.80	47.33	42.11	71.37
3. Metallurgy	123.65	116.73	87.30	125.62	116.59	106.01
4. Machinery	154.43	144.55	130.04	190.64	175.14	187.90
5. Construction materials	104.68	97.29	101.73	85.41	77.75	95.04
6. Chemicals	171.28	162.55	109.37	245.36	229.23	188.78
7. Light industries	142.30	133.57	114.55	163.48	150.76	154.03
8. Other manufacturing	83.57	77.44	89.06	54.05	49.07	64.53
9. Food processing	71.36	67.45	47.45	42.09	39.18	34.45
10. Construction	100.21	92.96	103.38	77.93	70.82	90.84
11. Agriculture	52.71	49.54	39.36	22.54	20.84	20.38
12. Forestry and logging	78.60	72.76	85.46	47.61	43.16	57.68
13. Transport and communication	58.96	54.39	66.80	26.39	23.79	33.41
14. Domestic trade	119.10	114.35	33.04	123.63	117.40	68.98
15. Foreign trade*	100.00	100.00	100.00	100.00	100.00	100.00
16. Waterworks*	100.03	100.03	100.03	100.03	100.03	100.03
17. Personal and economic services	–	–	–	–	–	–
18. Health and cultural services	–	–	–	–	–	–
19. Public administration	–	–	–	–	–	–
Total	116.51	109.74	88.78	125.44	116.20	112.48

*Exogenously fixed.

TABLE A2 Percentage changes in competitive dollar imports.

	Low elasticities			High elasticities		
Sector	Dem	Sup	Opt	Dem	Sup	Opt
1. Mining	106.10	106.79	81.20	112.74	112.48	98.10
2. Electricity	–	–	–	–	–	–
3. Metallurgy	104.48	103.83	82.80	110.27	108.45	98.82
4. Machinery	98.28	98.64	85.21	101.64	101.45	95.01
5. Construction materials	99.61	100.40	85.79	100.86	101.34	93.81
6. Chemicals	92.24	92.85	78.15	94.81	94.99	86.82
7. Light industries	88.11	90.83	53.29	94.32	96.07	73.57
8. Other manu- facturing	–	–	–	–	–	–
9. Food pro- cessing	119.55	124.71	68.62	125.18	129.42	95.65
10. Construction	–	–	–	–	–	–
11. Agriculture	180.86	193.01	61.95	194.78	203.99	116.97
12. Forestry and logging	106.63	107.69	83.31	109.02	109.48	97.28
13. Transport and communication	–	–	–	–	–	–
14. Domestic trade	–	–	–	–	–	–
15. Foreign trade	88.98	89.11	78.00	92.30	91.94	86.06
16. Waterworks	–	–	–	–	–	–
17. Personal and economic services	–	–	–	–	–	–
18. Health and cultural services	–	–	–	–	–	–
19. Public ad- ministration	–	–	–	–	–	–
Total	103.98	106.20	72.57	109.13	110.49	90.70

TABLE A3 Relative price terms in the export and import functions.

	Low elasticities				High elasticities			
			Opt*				Opt*	
Sector	Dem	Sup	Exp	Imp	Dem	Sup	Exp	Imp
1. Mining	100.36	103.50	117.48	58.74	105.74	107.84	108.78	81.58
2. Electricity	107.58	110.87	96.35	64.23	113.28	115.50	105.78	88.15
3. Metallurgy	91.86	94.00	105.58	63.35	95.54	96.98	98.84	79.07
4. Machinery	84.04	86.30	90.03	54.02	87.89	89.40	88.15	70.52
5. Construction materials	98.19	101.11	99.32	59.59	103.20	105.16	101.02	80.82
6. Chemicals	80.63	82.34	96.48	57.89	83.57	84.71	88.07	70.45
7. Light industries	86.34	89.07	94.71	56.83	90.64	92.12	91.72	73.38
8. Other manufacturing	107.45	110.77	104.74	62.85	113.09	115.30	109.16	87.33
9. Food processing	118.38	121.76	145.17	72.58	124.15	126.40	130.53	97.90
10. Construction	99.92	102.96	98.68	59.21	105.11	107.14	101.94	81.55
11. Agriculture	137.74	142.07	159.40	79.70	145.12	148.00	148.83	111.62
12. Forestry and logging	110.11	113.56	106.48	63.89	116.00	118.30	111.63	89.31
13. Transport and communication	123.53	127.59	117.52	70.51	130.53	133.27	124.51	99.61
14. Domestic trade	86.95	89.83	242.50	48.50	91.86	93.78	116.01	69.61
15. Foreign trade	58.05	59.40	100.00	40.09	60.36	61.26	100.00	49.96
16. Waterworks	192.09	199.14	100.00	101.35	204.37	209.17	100.00	151.21
17. Personal and economic services	201.42	209.00	100.00	104.29	214.65	219.81	100.00	157.66
18. Health and cultural services	159.31	164.70	100.00	87.75	168.52	172.11	100.00	127.01
19. Public administration	146.85	151.34	100.00	87.04	154.51	157.51	100.00	119.81

*The difference between the export and import price terms is due to the export tariffs.

TABLE A4 Percentage changes in production.

	Low elasticities			High elasticities		
Sector	Dem	Sup	Opt	Dem	Sup	Opt
1. Mining	105.69	104.73	105.51	109.12	107.80	108.06
2. Electricity	103.23	102.84	101.78	104.77	104.17	103.81
3. Metallurgy	111.48	108.60	99.78	114.48	110.60	108.84
4. Machinery	109.21	107.65	105.39	115.19	112.73	114.75
5. Construction materials	100.51	99.84	100.31	98.76	98.08	99.60
6. Chemicals	111.47	110.02	103.39	121.94	119.43	114.33
7. Light industries	109.59	108.29	107.87	113.65	111.74	113.57
8. Other manufacturing	101.31	101.06	101.39	101.05	100.76	101.46
9. Food processing	93.71	93.75	95.10	88.84	89.30	90.02
10. Construction	100.42	100.47	100.29	100.54	100.59	100.47
11. Agriculture	92.21	92.23	93.10	87.36	87.79	88.41
12. Forestry and logging	98.17	96.82	101.41	93.19	92.04	96.16
13. Transport and communication	99.11	99.04	99.42	98.08	98.09	98.22
14. Domestic trade	101.08	101.76	100.32	101.77	102.53	100.76
15. Foreign trade	103.48	103.07	101.91	105.42	104.76	104.38
16. Waterworks	100.52	100.78	100.66	100.84	101.13	100.72
17. Personal and economic services	100.48	101.51	101.99	101.11	102.31	101.34
18. Health and cultural services	100.18	101.62	102.59	100.77	102.47	101.31
19. Public administration	100.16	101.58	102.53	100.73	102.40	101.25
Total	102.04	101.58	100.58	103.06	102.42	102.37

TABLE A5 Percentage changes in employment.

Sector	Low elasticities			High elasticities		
	Dem	Sup	Opt	Dem	Sup	Opt
1. Mining	101.36	100.39	104.29	104.64	103.36	104.68
2. Electricity	100.86	100.57	101.45	102.73	102.26	102.21
3. Metallurgy	109.41	106.63	99.41	112.54	108.80	107.41
4. Machinery	108.04	106.51	105.14	114.04	111.63	113.86
5. Construction materials	99.49	98.90	100.22	97.97	97.37	98.96
6. Chemicals	108.28	106.90	102.72	118.67	116.30	111.95
7. Light industries	108.94	107.68	107.79	113.08	111.23	113.12
8. Other manufacturing	101.23	101.00	101.41	101.02	100.75	101.43
9. Food processing	92.47	92.54	94.86	87.78	88.27	89.18
10. Construction	99.74	99.79	100.12	99.88	99.94	99.96
11. Agriculture	91.15	91.18	92.87	86.43	86.88	87.68
12. Forestry and logging	97.08	95.75	101.15	92.21	91.10	95.38
13. Transport and communication	100.44	100.52	100.19	99.79	99.93	99.48
14. Domestic trade	100.89	101.60	100.34	101.66	102.44	100.67
15. Foreign trade	102.61	102.21	101.73	104.59	103.96	103.75
16. Waterworks	109.25	109.95	104.15	110.52	111.17	108.07
17. Personal and economic services	111.14	112.78	106.24	112.92	114.65	110.34
18. Health and cultural services	101.19	102.72	103.09	101.98	103.76	102.23
19. Public administration	101.17	102.67	102.99	101.89	103.63	102.14
Total	100.00	100.00	100.00	100.00	100.00	100.00

TABLE A6 Percentage changes in capital used.

Sector	Low elasticities			High elasticities		
	Dem	Sup	Opt	Dem	Sup	Opt
1. Mining	114.33	113.40	107.84	118.06	116.64	114.70
2. Electricity	104.12	103.69	101.90	105.54	104.88	104.41
3. Metallurgy	114.51	111.49	100.31	117.31	113.25	110.93
4. Machinery	114.03	112.35	106.39	119.93	117.25	118.39
5. Construction materials	101.99	101.22	100.43	99.91	99.12	100.53
6. Chemicals	114.46	112.93	104.00	125.00	122.35	116.54
7. Light industries	112.31	110.86	108.22	116.02	113.91	115.44
8. Other manu-facturing	102.28	101.84	101.12	101.46	100.97	101.85
9. Food pro-cessing	96.56	96.53	95.65	91.28	91.66	91.94
10. Construction	107.82	107.89	102.12	107.74	107.72	105.93
11. Agriculture	96.18	96.15	93.97	90.87	91.22	91.15
12. Forestry and logging	102.94	101.49	102.52	97.46	96.17	99.54
13. Transport and communication	97.69	97.47	98.59	96.29	96.16	96.88
14. Domestic trade	102.36	102.88	100.20	102.54	103.12	101.41
15. Foreign trade	108.20	107.71	102.91	109.89	109.09	107.79
16. Waterworks	96.24	96.31	98.88	96.12	96.25	97.08
17. Personal and economic services	96.30	97.11	100.24	96.51	97.52	97.77
18. Health and cultural services	96.37	97.47	100.70	96.25	97.61	97.86
19. Public ad-ministration	94.08	95.06	99.74	93.79	95.04	95.90
Total	100.00	100.00	100.00	100.00	100.00	100.00