SOME SIMPLE MODELS OF CMEA FOREIGN TRADE WITHIN THE LINK PROJECT

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Introduction

During the recent years intensive research work was undertaken by various international organizations and national planning institutes in developing more and more complex mathematical system models of international trade. This was mainly due to the recent political and economic integration and cooperation among countries with similar interests, and therefore a noticeable intensification of world trade caused by the lifting of trade barriers and the considerable improvement of international trade statistics raised interests of many researchers to compare the results of theoretic discussions on the factors determining the international trade flow patterns with the facts.

In view of these facts and as a consequence of recent research on international trade it is now widely accepted that the trade between two countries or regions cannot be explained only by the analysis of bilateral flows but by studying world trade as a whole. The econometric studies of world trade has been extended from the simple equation gravity models gradually to structural share-coefficient trade network models and finally to a complete complex system of world trade model. The research on international trade has also been extended from two-dimensional trade-flow network, that is from a country by country breakdown of world trade, to a three-dimensional network of trade by countries and commodity classes. in due course, considering the inadequacy and nonstandard form of available trade statistics an urgent need of a suitable breakdown of world trade by countries and commodities and an internationally accepted standardisation of commodity classes has arisen. Nevertheless, despite all the statistical difficulties, the

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progress in world trade research seems very encouraging and it has apparently contributed to the elimination of some of the shortcomings of international trade statistics, as well.

Upon these considerations an intensive research programme has been directed into constructing a reasonably complete mathematical system model expressing the interrelationships between national economic magnitudes such as measures of economic activity and prices, on the one hand, and the balance of payments and its components, as well as exchange rates and other determinants of international price relations on the other hand. Such a model of the world economy will be useful for the following purposes :

(1) Since national economies are independent, it will permit improvements in the forecasting of national economic magnitudes in individual countries;

(2) It wil facilitate the forecasting of regional and global developments of trade, payments, and reserves;

(3) It will improve the analysis of a country's alternative policies with respect to the balance of payments by making it possible to take account of the feedback effects emanating from these policy actions as well as the trends in the rest of the world; and

(4) It will be useful for conducting analyses of the effects of international policies or international cooperative measures such as reserve creation, changes in the mechanism of balance of payments adjustment, or changes in the direction of foreign aid on the terms on which it is extended.

To construct such a model of the world economy an international research project, «Project LINK», was started in 1968 under the sponsorship of the Committee on Economic Stability of the Social Science Research Council of the U.S.A. The construction of the world model inevitably started with existing national models by reconstructing the models in order to provide the required connecting points of the linkage. The detailed information on the methodology of the linkage and more generally on the LINK Project may be obtained from (Ball, Hickman, and Moriguchi, 1972) (Klein, 1972, 1974), and (Taplin, 1972).

1. CMEA Countries in the LINK Project

According to an agreement reached among the participant econometricians of the LINK group, the national and regional research teams concentrate on the national macroeconomic models of developed market economies, while the UNCTAD secretariat is assigned the responsibility of model building for the main countries and regions of developing countries and seven socialist countries-CMEA members. After joining in the LINK Project, the UNCTAD secretariat has considerably broadened its experience in quantitative modelling and projecting of the economic performance in developing countries and has brought out a number of studies on the quantitative analysis and assessment of the trade prospects and capital needs of developing countries. The progress of the UNCTAD's study on incorporating the CMEA foreign trade, however, has been rather slow in comparison to the studies on the trade of developing countries. This is mainly because a number of methodological problems are involved in the modelling of CMEA foreign trade as one has to consider the dissimilarities in the socio-political constitution of the CMEA community, and the different criteria and requirements posed by the CMEA governments to the foreign trade exchange and its role in the national economic growth as well as the inadequacy and unreliability of the available foreign trade and national accounts statistics for these countries.

The research into the methodology of foreign trade projections for socialist countries started at the New York Office of UNCTAD with an attempt to solicit the collaboration of the national research bodies of the CMEA countries and of the other U.N. agencies. In particular ECE is engaged in active research on the economies of the CMEA countries, and a reference may be made to the papers and proceedings of the ECE Ad hoc Meeting of Experts on Methods for International Trade Projections (Geneva, 8-12 June, 1970). After a number of international meetings of experts on socialist countries' foreign trade projection techniques and studies undertaken in many international and national research bodies the essential experience has finally been accumulated in mathematical modelling and projecting of CMEA foreign trade. Up to now several works have been published and various methodological approaches are discussed for constructing of CMEA foreign trade projections as a block of the world trade model. However, the author feels that it is now quite necessary first to formulate the main theoretical and methodological problems and then to construct a number of different models of CMEA trade varying in size and complexity but in close relation with each other and in a systematic way so that the needs of the LINK system are fully satisfied and the effective role of each model in the total system of world trade is specifically defined.

The first serious work in UNCTAD was undertaken by B. Famin and P. Tomazewski in 1970 who estimated a model for the CMEA countries consisting of export and import equations, separately for CMEA and non-CMEA trade, with an intra-CMEA trade matrix. Until then, in the LINK system, the imports of the CMEA countries from the rest of the world were used to be taken as fixed from their planning figures in order to solve for non-CMEA world exports. The new CMEA model of UNCTAD then permitted the inclusion of CMEA intra-trade in the world model.

An econometric model of CMEA foreign trade was presented by W. Piaszcynski (1972) at «The Annual LINK Meeting» held in Vienna, 1972. His model was a simple log-linear recursive one with the following endogenous variables :

1. export and import vectors of CMEA intra-trade,
2. total export and import vectors of each CMEA country in the CMEA market,
3. the balance of payments of each CMEA country with the rest of the world,
4. total export and import vectors of the rest of the world countries to and from the CMEA countries.

He estimated the endogenous variables in his model by relating them to some internal factors of each CMEA country such as net material product or its growth rate, and to external factors such as the level of intra-CMEA trade and the world market. He also introduced import share-coefficient vectors to analyse the structural dependencies in the CMEA - non-CMEA and intra-CMEA trade matrices upon the total turnover volumes of the regions. The basic assumption in his model was that a full balancing of total exports and imports was satisfied within the framework of the CMEA block as well as in the world model as a whole. The investigations of Piaszcynski and his group indicated that the relation assumed in the model had found their confirmation in the statistical material with a proof of rapid convergence of both theoretical and empirical time series. The author, however, feels that in Piaszcynski's work the choice of explanatory variables and the main assumptions accepted in the construction of the functional relationships between the import and export vectors and the internal and external supply and demand factors are far from being satisfactory. Moreover, the methodology adopted in his paper for the determination of the import vectors at such an aggregate level without any commodity breakdown does not provide the necessary inputs to the LINK system.

J. Glowacki (1972, 1973, 1974) of UNCTAD has contributed a great deal to the experience of the LINK group in the modelling of CMEA foreign trade. He constructed a number of models for the LINK Project and some of them were actually implemented in the LINK system. He pointed out strongly that special attention should be given to the important role of the balance of payments with non-CMEA area and, in particular with the «hard currency» countries when explaining imports. In his models a breakdown by a number of commodity groups and many geographical areas was accepted and he computed up to five year projections of the import vectors for each member of the CMEA community both among themselves and with the rest of the world regions for each of the commodity groups.

A similar study was undertaken by the London Business School under the supervision of R.J. Ball. They tried to apply regression analysis for forecasting trade development of individual western industrial states with socialist countries. The computations were made, in particular, for projections over a one-year period by quarterly breakdown of trade between the United Kingdom and the socialist countries (including China). It was assumed that United Kingdom exports to the socialist countries depend on socialist countries' import demand, given the condition that United Kingdom domestic demand is first satisfied. Socialist countries' import demand in turn depends on socialist countries export earnings, which are determined by demand for socialist countries' exports. Being formalized all these dependencies were represented in the following way :

$$UX = f_1 (M, QP, UX_1, Q_s, \mu_1)$$

$$M = f_2 (X, Q_s, \mu_2)$$

$$X = f_3 (OMM, Q_s, \mu_3)$$

where,

UX = U.K exports to the socilaist countries

M = Socialist countries imports from OECD

X = Socialist countries exports to OECD

QP = Positive pressure of demand in the United Kingdom

Q_s = Quarterly seasonal dummies

UX_1 = United Kingdom exports to the socialist countries lagged one period

OMM = OECD imports from the world.

More detailed information on the methodology and the full equations of the model are given in (Ball, Hickman, and Moriguchi, 1972).

2. Explanation of the Notations Used in the Models

s : «CMEA» country, $s \varepsilon S$

S : The CMEA countries including Albania, Bulgaria, Czechoslovakia, German Democratic Republic, Hungary, Poland, Romania, and the USSR, $S = \{1, \ldots, n_s\}$

s′ : «CMEA» country, $s' \varepsilon S$

r : «rest of the world» countr, $r \varepsilon R$, $R = \{1, \ldots, n_r\}$

r′ : «rest of the world» country, $r' \varepsilon R$

T : the set of indexes for all countries, $T = \{1, \ldots, n\}$

k : commodity group, $k \varepsilon K$, $K = \{1, \ldots, m\}$

X_{ijk} : Exports from country i to country j or imports of country j from country i, where $i \varepsilon I$, $j \varepsilon J$ of commodity $k \varepsilon K$

X_{iJk} : Sum of exports of country i to all countries with index $j \varepsilon J$ of of commodity k

X_{Ijk} : Sum of imports of country j from all countries with index $i \varepsilon I$ of commodity k

X_{ijK} : Sum of exports of country i to country j for all commodity groups

Z_{ij} : net invisibles exported by country i to country j and net credits obtained by country i for importing from country j

Y_{ik} : the internal activity k of country i

for commodity k=1 Y_{i1} = agricultural production

k=2 Y_{i2} = industrial production

k=3,4 $Y_{i3,4}$ = net material production

3. Some Specific Features to be Considered for Projections of CMEA Trade

The intra-CMEA trade makes about two-thirds of the total foreign trade turnover of the CMEA countries. Therefore, the projections of CMEA trade with the rest of the world are dependent to a substantial extent upon the developments of trade exchange within the CMEA community. Due to this fact, the main element of projection computations for trade relations of CMEA countries with developed and developing countries is the forecast for the trade within the CMEA community. At the same time shaping of the intra-CMEA trade indicates some specific pecularities typical only for this block of countries. One of the most important features of intra-CMEA trade is that it is an integral part of national economic plans and, being subject to state planning, developes in accordance with the planned programmes of production cooperation within the CMEA. Thus the starting point in CMEA intra-trade projections is national economic plans taken along with programmes of economic cooperation among the members of this community.

The main peculiarity in shaping of trade flows in the CMEA area is the high degree of determination of all variables. Once the basis for trade cooperation among socialist countries is constituted by long-term and annual national economic plans and elaborated by taking into account the specified trade exchange with other socialist countries, the influence of the market forces on the trade performance is substantially limited. Under such circumstances, those elements of market competition are eliminated and chances of breaking the plans due to unpredictable changes are so insignificant that they could be neglected. The closer the methodology of projections comes to planning techniques, the more sound the projections will be. For the reasons cited above, the dynamical input-output tables are considered as one of the most appropriate methods among all methods of quantitative simulation and projecting the CMEA intra-trade.

Another important feature which should be considered is that both the internal system of managing the national economies of the CMEA community and the system of international economic relations among the member countries are based on the relatively stabilized prices agreed and fixed for long periods and not influenced by short-term fluctuations. Furthermore, the price itself in the socialist economy has a more limited influence upon the flows of goods and services than it is the case in the market economies. Thus the economic systems of the CMEA countries form a barrier against short-term boom fluctuations and against transfer of these fluctuations from other countries into the flows of goods and services among the members of CMEA. Therefore, the forecast of business cycles is only of limited significance for the CMEA block, perhaps as an information for the external conditions of CMEA foreign trade with market economies and developing countries. However, in the case when medium to long-term models are required the problem of pricing comes to the foreground, then a special methodology should be elaborated for an analysis of price formations and refining domestic prices from custom duties.

Another important factor in the projections of CMEA foreign trade is that the computations of trade projections should be carried out, if possible, in close relation to payment possibilities for the imports and dynamics of currency reserves of the CMEA countries. Since information relating to payment reserves in CMEA countries is completely classified, the only possible assumption that could be made is that the volume of CMEA imports will depend on the volume of their exports. But such an assumption may cause considerable deviation of the projections from the trajectory of the real performance in some cases.

4. Objectives and Basic Assumptions

The primary objective of the simple models of CMEA trade developed in this paper is to provide short to medium-term multicommodity projections of CMEA imports to non-CMEA area for the Mini-LINK and the preliminary Maxi-LINK computations of the LINK system. Secondly, the projections of intra-CMEA trade in different commodity groups are required. The model of CMEA trade has been presented in three alternative versions, two of which are simple linear or long-linear trend estimations of import share-coefficients of the CMEA trade matrix. The first method projects the CMEA trade by a simple logarithmic time trend estimation. The second method assumes the dependence of imports on total exports and net credits, and the last and best method estimates the CMEA imports including terms depending upon domestic activities and the balance of payments of the CMEA countries.

The basic assumptions of the CMEA trade model are as follows:

(1) The world countries are divided into two major groups: Group S denotes the CMEA countries, and Group R represents the rest of the world.

(2) In this model intra-trade of non-CMEA countries is not considered.

(3) The structure of the CMEA intra-trade is of the type suggested by Beckerman (1956).

(4) Exports of the CMEA countries are both supply and demand determined, but more attention is given to the internal supply factors.

(5) The balance of trade is considered only for the CMEA region.

(6) The CMEA trade network is based on export and import shares.

(7) Imports of CMEA countries are determined by the internal demand as well as payment possibilities.

In the second method of estimation, the share-coefficient matrix computations are made on the basis of past time-series and therefore difficulties may arise when the time-series for individual countries show some drastic fluctuations because of some structural changes in the economies. The share coefficients are therefore subjected to expert analysis and they should be adjusted to the medium-term projection requirements. Also in the third method of estimation, the projections of explanatory variables play an important role in the computations of the import vectors. Therefore, national models of individual CMEA countries may be of great help to the third estimation method.

5. The Trade Matrix and the Aggregation Problem

The relevant aspects of the LINK trade matrix for the CMEA block may be described by Table 1, in which the commodity group index k has been dropped for the convenience in notation and in order to make the basic features of the table clearer. For testing the trade model a uniform decomposition of imports is used by having four main commodity groups for all countries as follows :

Commodity group 1 : SITC 0,1[1]
food, beverages and tobacco

Commodity group 2 : SITC 2,4
crude materials excluding fuels and oils, and fats

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(1) SITC : Standard International Trade Classification.

Commodity group 3 : SITC 3
mineral fuels, lubricants and related materials

Commodity group 4 : SITC 5-9
all manufactured goods

Balances \ Activities		Other Counries 1...r... (n_r)	CMEA Counries ($n_r + 1$) ...s... n	Total
	1			
Other Countries	r′	$X_{r'r}$	$X_{r's}$	$X_{r'T}$
	(n_r)			
	($n_r + 1$)			
CMEA Countries	s′	$X_{s'r}$	$X_{s's}$	$X_{s'T}$
	n			
Total		X_{Tr}	X_{Ts}	X_{TT}

Table 1. The CMEA Countries in the LINK Trade Matrix

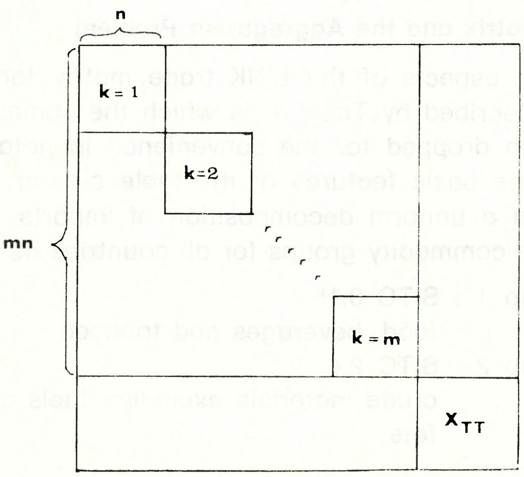

Table 2. The total trade matrix

The matrix shown in Table 1 should be considered separately for every commodity group k=1,...,m. The dimension of the total matrix then becomes mn . mn and the margin of total exports (imports) equals X_{TT} as shown in Table 2.

The total number of countries (regions) is n (i, j=1,...,n), of which R-countries (non-CMEA countries) run from 1 to n_r and S-countries (CMEA countries) from $n - n_s + 1$ ($= n_r + 1$) to n. The matrix n . n for each commodity group k consists of the following submatrices :

a) Submatrix s'.s with zero elements in the main diagonal describes the intra-trade of CMEA countries; the margins of dimension 1.s are total imports and s'.1 total exports.

b) submatrix s'.r describes exports from CMEA countries to non-CMEA area; the margins 1.r are imports to non-CMEA and s'.1-exports from CMEA.

c) submatrix (r'.s) stands for imports from non-CMEA countries to CMEA countries, the margins 1.s are imports to CMEA and (r'.1) exports from non-CMEA.

d) submatrix r'.r is an emty set of flows, representing the non-CMEA countries' intra-trade flows, which means that these flows are not considered in the model.

The Estimation Procedures

1. Estimations of CMEA total imports using time trend only

This is the simplest possible form of estimation and it is made in order to provide a benchmark for assessing the relative advantages and disadvantages of the following more complex procedures.

The basic relationship is assumed to be of the form,

$$X_{Tsk} = a_{Tsk} b_{Tsk}^{t} \quad (1)$$

or

$$\log X_{Tsk} = \log a_{Tsk} + t \log b_{Tsk} \quad (2)$$

or

$$\log X_{Tsk} = f_{Tsk} + g_{Tsk} t \quad (3)$$

where

$$f_{Tsk} = \log a_{Tsk} \text{ or } 10^{f_{Tsk}} = a_{Tsk}$$

and

$$g_{Tsk} = \log b_{Tsk} \text{ or } 10^{g_{Tsk}} = b_{Tsk}$$

2. Estimation of CMEA imports assuming them to be dependent on total exports and net credits only

(i) Methodology

The country s total export earnings from all commodity groups may be denoted by

$$X_{Tsk} = \sum_{i=1}^{n} \sum_{k=1}^{m} X_{sik} \qquad (4)$$

The country s net export of invisibles and net credits obtained for imports from all countries can be denoted by Z_{sT}. It is assumed that the total imports of country s of commodity k is a proportion of its total export earnings of all commodities, and net export of invisibles and net credits obtained from all countries of the world.

$$X_{Tsk} = a_{Tsk} (X_{sTk} + Z_{sT}) \qquad (5)$$

or

$$X_{Tsk} = a_{Tsk} X_{Tsk}$$

The values of coefficients a_{Tsk} can be estimated using time trend for projection purposes such as

$$a_{Tsk} = p_{Tsk} + q_{Tsk} t \qquad (6)$$

Then Eq. (5) becomes

$$X_{Tsk} = p_{Tsk} X_{TsK} + q_{Tsk} X_{TsK} t \qquad (7)$$

The total sum of imports from all countries and of all commodities must sum to the total export earnings and credits, i.e.,

$$\sum_{k=1}^{m} X_{Tsk} = \sum_{k=1}^{m} a_{Tsk} X_{TsK} \qquad (8)$$

it follows that

$$\sum_{k=1}^{m} a_{Tsk} = a_{TsK} = 1.0$$

It is also assumed that the trade among the CMEA economies in commodity k is a fraction of total export earnings and credits;

$$X_{s's k} = a_{s' sk} (X_{sTK} + Z_{sT}) \qquad (9)$$

or

$$X_{s'sk} = a_{s'sk} X_{TsK}$$

and

$$a_{s'sk} = p_{s'sk} + q_{s'sk} t \qquad (10)$$

It should be checked that all coefficients satisfy

$$a_{s,sk} \leqslant a_{Tsk} \tag{11}$$

as otherwise it leads to assuming negative imports from the remaining countries of the particular trade flow considered.

(ii) Special estimation procedure to account for the condition

$$\sum_{k=1}^{m} a_{Tsk} = 1$$

In the case when some difficulties arise in satisfying the constraint (8), the data will have to be put up in the following way. To achieve better clarity, the first two indexes $_{Ts}$ of X_{Tsk} and a_{Tsk}, and the three indexes $_{Tsk}$ of X_{Tsk} have been omitted.

The desired regression equations are for m = 4 :

$$x_1 = a_1x \quad x_2 = a_2x \quad x_3 = a_3x \quad x_4 = a_4x \tag{12}$$

and

$$a_1 + a_2 + a_3 + a_4 = 1 \tag{13}$$

The last expression is used to eliminate a_4 and the following is obtained :

$$\begin{aligned} x_1 &= a_1x + a_20 + a_30 \\ x_2 &= a_10 + a_2x + a_30 \\ x_3 &= a_10 + a_20 + a_3x \\ x_4\text{-}x &= a_1(-x) + a_2(-x) + a_3(-x) \end{aligned} \tag{14}$$

The regression coefficients a_1, a_2, a_3 can be obtained by single equation least squares estimation using the data series indicated below. The required coefficient is $a_4 = 1 - a_1 - a_2 - a_3$.

$$\begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 - x \end{bmatrix} = a_1 \begin{bmatrix} x \\ 0 \\ 0 \\ -x \end{bmatrix} + a_2 \begin{bmatrix} 0 \\ x \\ 0 \\ -x \end{bmatrix} + a_3 \begin{bmatrix} 0 \\ 0 \\ x \\ -x \end{bmatrix} \tag{15}$$

(Iii) The determination of total exports for the CMEA countries

The final estimation equations for total CMEA imports need the unknown values of X_{sTK} which can be obtained from the definition of the total sum of exports of both regions;

$$X_{sTK} = \sum_{k=1}^{m} X_{sTk} = \sum_{k=1}^{m} (X_{sRk} + X_{sSk}) = \sum_{k=1}^{m} (X_{sRk} + \sum_{s'=1}^{n_s} X_{ss'k}) \quad (16)$$

$X_{ss'k}$ can be eliminated using (9) and adding Z_{sT} both sides, therefore it follows that

$$X_{sTK} + Z_{sT} = \sum_{k=1}^{m} X_{sRk} + \sum_{k=1}^{m} \sum_{s'=1}^{m} a_{ss'k} (X_{sTK} + Z_{sT}) + Z_{sT} \quad (17)$$

or

$$(X_{sTK} + Z_{sT}) (1 - \sum_{k=1}^{m} \sum_{s'=1}^{n_s} a_{ss'k}) = \sum_{k=1}^{m} X_{sRk} + Z_{sT} \quad (18)$$

or

$$X_{sTK} + Z_{sT} = (\sum_{k=1}^{m} X_{sRk} + Z_{sT}) / (1 - \sum_{k=1}^{m} \sum_{s'=1}^{n_s} a_{ss'k}) \quad (19)$$

which is then inscribed into equation (5) to give the final formula for the import determination. Thus,

$$X_{Tsk} = a_{Tsk} (\sum_{k=1}^{m} X_{sRK} + Z_{sT}) / (1 - \sum_{k=1}^{m} \sum_{s'=1}^{n_s} a_{ss'k}) \quad (20)$$

or using equations with time trend (6) and (10)

$$X_{Tsk} = (p_{Tsk} + q_{Tsk}\, t) (\sum_{k=1}^{m} X_{sRk} + Z_{sT}) / [1 - \sum_{k=1}^{m} \sum_{s'=1}^{n_s} (p_{ss'k} + q_{ss'k}\, t)] \quad (21)$$

3. Estimation of CMEA imports assuming them to be dependent upon domestic activities and the balance of payments

(i) Estimation of CMEA imports from the rest of the world

The exports from all countries R to the CMEA country s of commodity k is assumed to be a constant plus a term depending upon one main explanatory factor (total production of the country concerned in different sectors for different commodity groups), and a term proportional to the remaining surplus in the balance of payment, once the cost of the previous goods have been covered.

$$X_{Rsk} = a_{Rsk} + b_{Rsk} Y_{sk} + c_{Rsk} [X_{sRK} + Z_{sR} - \sum_{\substack{k'=1 \\ k' \neq k}}^{m} (a_{Rsk'} + b_{Rsk'} Y_{sk'})] \qquad (22)$$

$s \varepsilon S$, and where

$$X_{sRK} + Z_{sR} = X_{Rsk}$$

and

$$\sum_{k=1}^{m} c_{Rsk} = c_{Rsk} = 1$$

(ii) Estimation of CMEA internal trade

The exports from all the CMEA countries s' to the CMEA country s of commodity k is assumed to be

$$X_{s's k} = a_{s's k} + b_{s's k} Y_{sk} + c_{s' sk}' [X_{ss'K} + Z_{s's} - \sum_{\substack{k' = k \\ k' \neq k}}^{m} (a_{s' sk'}' + b_{s' sk'}' Y_{sk'})] \qquad (24)$$

$s', s \varepsilon S$ and where

$$X_{ss'K} + Z_{s's} = X_{s'sK}$$

and

$$\sum_{k=1}^{m} c_{s'sk} = c_{s'sK} = 1 \qquad (25)$$

(iii) Estimation of the explanatory variables

The values of Y_{sk} need to be projected to obtain an actual estimate of X_{Tsk}. The following approaches could be employed for this purpose :

a) National plan data : — This certainly depends on statistical information which can be obtained from the CMEA countries.

b) ECE projections : — As given in ECE Economic Survey and DESA World Economic Survey.

c) A complete econometric model for each one of the CMEA countries.

d) Simple linear or log-linear trend projections of the explanatory variables or their growth rates : — This method could be employed initially for checking purposes.

(iv) Estimation of balance of trade for the socialist countries.

The past behavior of the variables Z_{sT}, Z_{sR}, $Z_{s's}$ can be obtained from their definitions.

$$Z_{ss'} = X_{s'sk} - X_{ss'K} \tag{26}$$

$$Z_{sR} = X_{RsK} - X_{sRK}$$

$$Z_{sT} = X_{TsK} - X_{sTK}$$

Projections can be obtained by assuming a simple exponential time trend, if necessary, such as

$$Z = a\, b^t \tag{27}$$

(v) Estimation of the parameters

The assumed system for the third estimation method for the CMEA imports can be summarized as follows where the index $_{Rs}$ or $_{s's}$ is omitted in the following equations :

$$X_k = a_k + b_k Y_k + c_k \left[X_K - \sum_{\substack{k'=1 \\ k' \neq k}}^{m} (a_{k'} + b_{k'} Y_{k'}) \right] \tag{28}$$

In the above equation X_k, Y_k, X_K are given by the statistical tables. The parameters a_k, b_k, and c_k are to be found for each country and m commodity groups. The equation (18) can be put in the following form;

$$X_k^* = a_k + b_k Y_k + c_k X_K \tag{29}$$

where

$$X_k^* = X_k + c_k \left[\sum_{\substack{k'=1 \\ k' \neq k}}^{m} (a_{k'} + b_{k'} Y_{k'}) \right] \tag{30}$$

If the sum of (28) for k = 1,....m is taken, then the following condition is obtained :

$$\sum_{k=1}^{m} c_k = 1 \tag{31}$$

The equation (29) can be represented by matrix notations as follows :

$$\underline{X_k}^* = \underline{e}\, a_k + \underline{Y_k} + \underline{X_K}\, c_k \qquad (32)$$

where e, X_k^*, Y_k, X_K are column vectors of n elements (n is the number of observations), e is a unit vector, and a_k, b_k, c_k are scalars for commodity group k of the region investigated.

The following approach was suggested by R. Stone (1954) for the solution of a similar system.

If the parameters, c_k, for m commodity groups in equation (31) are assumed to be zero, then the equation of the system reduces to

$$\underline{X_k}^* = \underline{e}\, a_{k,o} + \underline{Y_k}\, b_{k,o} \qquad (33)$$

But X_k^* also reduces to X_k in the identity (30) since all $c_k = 0$. Hence the parameters $a_{k,o}$ and $b_{k,o}$ can be computed from equation (33) by using the ordinary least squares method. Then the computed values of $\{ a_{k,o}, b_{k,o} \}$ k = 1,...,m are substituted in equation (28) and the m commodity equations of the system are once more regressed so that a solution in the first iteration with computed parameters $\{ a_{k,1}, b_{k,1}, c_{k,1} \}$ k = ,...,m is obtained. In the second iteration, the system is resolved with the known initial values of the parameters, i.e., the computed values of $\{ a_{k,1}\ b_{k,1} \}$ k=1,...,m in the first iteration, and the parameter vectors $\{ a_{k,2}\ b_{k,2}\ c_{k,2} \}$ k=1,...,m are computed. Successive iterations are done until the parameter vectors converge to stable values and the condition (30) is satisfied.

Alternatively, the Gauss-Seidel method provides a convenient precedure for obtaining a computer solution of the multicommodity trade model. The computer algorithm designed is briefly as follows :

Consider the system of equations given in (32) in which X_k^* is defined as in the identity (30). Choose a set of suitable initial values (arbitrarily) for the parameters of the system as $\{ a_{k,o}', b_{k,o}', c_{k,o} \}$ k=1,...,m so that $X^*_{k,1}$ is computed from the following expression for n=1,

$$X^*_{k,n}(t) = X_k(t) + c_{k,n-1} \left[\sum_{\substack{k'\neq k \\ k'=1}}^{m} a_{k'n-1} + Y_{k'}(t) \right] \qquad (34)$$

where k=1,...,m : commodity groups

$t = t_o, \ldots, t_o + T$: time

T is the number of observations in the sample period

t_o is the base year

$n = 1, \ldots, N$: the iteration number

N is the number of iterations needed for acceptable converence Substitute the computed values $X^*_{k,1}$ (t) in the following vector equation for n=1,

$$\underline{X}^*_{k,n} = \underline{e}\, a_{k,n} + \underline{Y}_k\, b_{k,n} + \underline{X}_K\, c_{k,n} \qquad (35)$$

where k = 1, ..., m.

Compute the parameter vectors $\{ a_{k,1}, b_{k,1}, c_{k,1} \}$ k = 1,...,m by the OLS method from the regression equation (35) and store the computed values to be used in the second iteration. Start the second iteration if the results of the tests for previously defined convergence criteria are not satisfactory. In the second iteration, again first compute $X^*_{k,2}$ (t) for $t=t_o \ldots, t_o + T$ and k=1,...,m with the initial values of parameters $\{ a_{k,1}, b_{k,1}, c_{k,1} \}$ and then resolve the system of vector equations of (35) to obtain the second stage parameter vectors $\{ a_{k,2}, b_{k,2}, c_{k2} \}$ k = 1,...,m. Stop the iterations when the following criteria of convergence are satisfied :

(1) Convergence of the parameter values

$$\frac{a_{k,n+1} - a_{k,n}}{a_{k,n+1}} < \varepsilon_a, \quad k=1,\ldots,m \qquad (36)$$

$$\frac{b_{k,n+1} - b_{k,n}}{b_{k,n+1}} < \varepsilon_b, \quad k=1,\ldots,m \qquad (37)$$

$$\frac{c_{k,n+1} - c_{k,n}}{c_{k,n+1}} < \varepsilon_c, \quad k=1,\ldots,m \qquad (38)$$

where ε_a, ε_b, and ε_c are pre-assigned small positive numbers.

(2) Convergence of Σc_k

$$\left| \sum_{k=1}^{m} c_{k,n} - 1 \right| < \delta \qquad (39)$$

where δ is a small positive number. In the computations $\delta = 0.001$ has been accepted as a suitable value of convergence.

The number of iterations clearly depends on the choice of the initial parameter values, $\{ a_{k,o}, b_{k,o}, c_{k,o} \}$ $k = 1,\dots,m$. This choice is also crucial in another sense. It is possible that two different sets of starting values of the parameter vectors result in two different sets of solutions. One might argue that the system of equations given in (28) allows for a finite number of different solutions. This finite number might be one, but that need not be the case. It is also possible that for a given set of starting values, no solution is obtained, i.e., successive differences in the parameter values or $[\Sigma c_k - 1]$ grow rather than diminish. This lack of convergence can be remedied by the choice of another set of starting values. If that does not help, then some suitable correcting procedures should be included in the computer programmes.

Some Computational Results

1. Data

As the data for the trade flows with a SITC commodity breakdown is available starting from 1955 upto 1969, this period has been accepted as the sample period for the estimations. As in the LINK Project, four SITC commodity groups are distinguished; SITC 0,1, SITC 2,4, SITC 3, and SITC 5-9. The CMEA countries are divided into two economic regions due to the inadequate multicommodity trade statistics. The USSR is taken as a region itself and the other CMEA countries are taken as the second region. The rest of the world countries are accepted as the third region as a whole. Therefore, the trade matrix is very simpliifed with $n=3$, $s=2$, and $r=1$.

The data for the regional multicommodity export-import vectors are obtained from the Handbook of International Trade and Development Statistics (UN, 1972). The time-series of the trade data is given in current U.S. dollars and on an annual basis. Therefore, the number of observations, T, is 15.

For the third method of estimations the net material product and sectoral production statistics are obtained from the Yearbook of National Accounts Statistics published by the United Nations, for each individual CMEA country in its own currency and relative to current prices. The statistics for individual countries are subsequently converted to current U.S. dollars by using annual exchange rates derived from comparisons of the modified GNPs in current domestic currencies (Biray, 1973) with the corresponding current dollar values of the GNPs estimated on the basis of the 1967 GNP dollar values and the extended GNP indexes as shown in (Alton, 1970). The converted statistics are then aggregated to give the regional data.

2. Estimation of Parameters

The computation of parameters for the first and second estimation methods are straight-forward. In the first method the estimation procedure is a simple log-linear trend computation and the parameters in the second method actually represent the share coefficients of imports in different commodity groups in terms of the total trade flows and in this case the single-equation OLS method is used to estimate the parameter vectors.

In the third method, however, a special OLS estimation procedure with a suitably designed Gauss-Seidel computer algorithm has been followed and a number of experiments were undertaken with different sets of initial parameter values. It was generally observed that ten iterations were sufficient to produce very stable values of parameters also satisfying the main convergence criterion.

Some of the selected results of the computed parameter values of all the three models are tabulated in Table 3. The t-ratio statistics are also given for the parameters of the third model. However, the computed standard errors do not have much meaning in the context of statistical significance of the curve fitting procedure.

As a check of the goodness of fit, the coefficient of determination, R^2, and to test the serial correlation of the disturbance term the Durbin-Watson statistics, DW are tabulated in Table 4 for each bilateral commodity equation of the first and second models. These statistical measures are also given for the equations of the third model. However, the parameters of the third model are non-linear in nature and therefore the significance of these statistical tests will be in very much doubt. Nevertheless, as the explanatory variables can all be taken exogenously in the estimations, it is assumed that R^2 tests provide some information in order to make rough comparisons of the predictive power of the third method with the other two. Otherwise, tests on the basis of asymptotic properties for the third method would hardly be relevant with a sample period containing only fifteen observations. Nevertheless, Monte Carlo simulations could provide some useful information on the statistical significance of the projections obtained by the third model.

Model	Importing Regions / Exporting Regions		The U.S.S.R., s = 1				The other CMEA countries, s = 2			
	Commodity Groups, k = 1,...,4		1	2	3	4	1	2	3	4
1	All the countries in the world	a_{Tsk}	434.5	831.8	237.7	1607.0	972.2	1225.0	435.5	1666.0
		$(b_{Tsk})^t$	$(1.090)^t$	$(1.007)^{-t}$	$(1.016)^{-t}$	$(1.115)^t$	$1.039)^t$	$(1.039)^t$	$(1.081)^t$	$(1.127)^t$
		p_{Tsk}	0.1415	0.2346	0.0715	0.5410	0.2057	0.2835	0.1056	0.4040
2		q_{Tsk}	0.0010	-0.0112	-00040	0.0156	-.0051	-0.0103	-0.0125	0.0173
		a_{Rsk}	0.0891	0.5502	-0.0088	-0.5806	-0.0712	0.5618	-0.0120	0.1991
			(1.53)	(6.70)	(-0.81)	(-3.46)	(-0.85)	(5.21)	(-1.44)	(1.38)
3	Rest of the world countries	b_{Rsk}	0.0045	0.0013	0.0001	-0.0022	0.0400	0.0023	0.0006	-0.0318
			(0.61)	(0.92)	(0.45)	(-0.91)	(1.71)	(0.79)	(0.90)	(-3.19)
		c_{Rsk}	0.1143	0.0268	0.0007	0.8647	0.0415	0.0356	-0.0006	0.9334
			(1.10)	(0.90)	(0.17)	(5.32)	(0.64)	(0.32)	(-0.16)	(6.54)
2		p_{1sk}	—	—	—	—	0.0377	0.0697	0.0701	0.3378
	The U.S.S.R.,	q_{1sk}	—	—	—	—	0.0011	-0.0041	-0.0039	0.0137
		a_{1sk}	—	—	—	—	0.3880	0.0999	-0.2942	-0.9458
							(2.03)	(2.97)	(-1.89)	(-4.65)
3	s = 1	b_{1ks}	—	—	—	—	-0.0232	0.0248	0.0065	0.0170
							(-0.74)	(5.03)	(0.92)	(1.73)
		c_{1sk}	—	—	—	—	0.1123	0.0161	0.1822	0.7121
							(3.76)	(1.80)	(1.77)	(4.17)
		p_{2sk}	0.0935	0.1212	0.0383	0.1745	0.0416	0.0326	0.0682	0.1395
		q_{2sk}	-0.0046	-0.0038	0.0021	0.0049	-0.0002	-0.0013	-0.0037	0.0055
2	The other CMEA countries,	a_{2sk}	-0.4414	0.2625	0.1538	-0.5684	0.8091	0.3189	0.3505	-0.6720
			(-9.93)	(18.35)	(5.28)	(-6.44)	(8.74)	(4.22)	(1.39)	(2.20)
		b_{2sk}	0.0128	-0.0043	0.0007	0.0018	-0.0691	-0.0082	0.0013	0.0102
3	s = 2		(11.47)	(-4.72)	(0.99)	(1.72)	(-4.73)	(-0.81)	(0.71)	(0.84)
		c_{2sk}	0.0502	0.0868	-0.0189	0.8652	0.2480	0.0745	-0.0372	0.7062
			(2.26)	(4.28)	(-0.95)	(13.57)	(5.65)	(1.36)	(-0.49)	(2.92)

Table 3. — Computed parameters of the models

Exporting Regions \ Importing Regions		The U.S.S.R.								Other CMEA							
		1		2		3		4		1		2		3		4	
Model	Commodity Groups	R^2	DW^2	R^2	DW	R^2	DW	R^2	DW	R^2	DW	R^2	DW	R^2	DW	R^2	DW
1	All the Countries inn	0.824	0.841	0.087	1.380	0.342	1.647	0.940	0.498	0.858	2.152	0.908	0.675	0.947	0.697	0.897	2.391
2	the World	0.240	0.871	0.933	1.698	0.826	0.522	0.895	0.570	0.746	2.575	0.979	2.167	0.875	1.618	0.002	1.981
3	Rest of the Wordl Countries	0.795	0.919	0.519	0.867	0.387	1.272	0.981	0.931	0.768	1.187	0.654	0.917	0.601	1.341	0.963	0.800
2		—	—	—	—	—	—	—	—	0.806	1.392	0.907	0.621	0.951	2.033	0.557	2.131
3	The U.S.S.R.	—	—	—	—	—	—	—	—	0.882	1.514	0.992	1.567	0.918	2.161	0.989	1.101
2	Other CMEA	0.615	2.426	2.220	1.069	0.033	1.779	0.842	0.860	0.815	0.552	0.716	2.272	0.628	2.908	0.933	1.152
3	Countries	0.993	2.273	0.713	1.945	0.263	1.099	0.998	1.598	0.954	1.060	0.663	1.140	0.048	2.694	0.988	2.445

Table 4. — Some of the results of statistical tests

3. Projections

Firstly, static simulations with all the three models are evaluated in the sample period 1955-1969 to test the behavior of each model as a one-period-ahead predictor. Secondly, dynamic simulations are performed in the periods 1960-1965 and 1964-1969 to test the predictive accuracy in medium-term. The results clearly showed that the balance of payments model is definitely superior to the other two simple trade models.

Lastly, the trade flows of the CMEA countries in different commodity groups are projected for 1970. The CMEA trade matrix for 1970 is given Table 5. Every element X_{ijk} has been projected by the second and third models successively providing two variants for each regional trade flow. The total imports of the CMEA countries are also projected by the first model, thereby giving a third variant for the total trade flows. The projections are then compared with the actual values of aggregated trade flows[1] ($\sum_{k=1}^{m} X_{ijk}$), obtained from, (UN, 1972), in Table 5.

Conclusions

The three models developed for the CMEA foreign trade within the LINK system were generally found to be reasonably satisfactory for short-term projections. However, due to their oversimplicity they have various disadvantages if medium-term forecasts are required. The third model seemed to be much more powerful and attractive than the other two for the purposes of the LINK project. The investigations also indicated that the explanatory power of the third model could be considerably improved by employing some more suitable explanatory variables than the ones presently employed in the model. The main advantage of the third model lies in the fact that it includes the effects of the balance of payments which play an important role in the projections of CMEA trade in most commidity groups. Therefore, further research is proposed to improve the balance of payments model to the following specitifications :

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(1) The actual multicommodity trade flows for 1970 will be available when (UN, E/F. 72 II-D-3, 1975) is published.

Method	Importing Region → / Exporting Region ↓	U.S.S.R.						Other Eastern European Countries					
	Commodity Group	1 Projected	2 Projected	3 Projected	4 Projected	Total Projected	Total Actual	1 Projected	2 Projected	3 Projected	4 Projected	Total Projected	Total Actual
1	All of the countries in	1723.0	755.1	184.9	9221.0	11884.0	11400.0	2081.0	2256.0	1509.0	11320.0	17166.0	17370.0
2		1923.4	917.4	220.2	9665.1	12726.0		2392.8	2537.4	1567.4	12558.0	18657.0	
3		1748.4	1063.8	273.3	8617.1	11703.0		2011.8	2690.2	1397.7	11023.4	17123.0	
2	Rest of the World Countries	1192.0	783.5	18.5	3272.2	4995.0	5340.0	1180.2	969.9	54.9	3482.7	5688.0	4950.0
3		1066.9	939.6	35.5	2920.0	4960.0		903.1	952.4	32.8	2913.8	4802.0	
2	U.S.S.R.	—	—	—	—	—	—	510.5	1268.6	1170.4	4889.4	7839.0	6760.0
3		—	—	—	—	—	—	432.0	1578.1	1042.6	4463.5	7516.0	
2	Other Eastern European Countries	731.4	133.9	201.6	6392.9	7460.0	6060 0	695.8	298.3	342.2	4185.9	5523.0	5660.0
3		681.5	124.2	239.8	5607.1	6743.0		676.7	159.7	322.3	3646.1	4805.0	

Table 5. — Projections of CMEA imports for 1970 (in millions of current U.S. dollars).

(i) The balance of payments terms should be excluded from the expression for the trade flow in food and beverages (SITC 0+1). The experience of UNCTAD has also indicated that the trade on food should be examined separately.

(ii) Further analysis should be undertaken in finding more suitable explanatory variables.

(iii) The number of explanatory variables should be increased to explain the trade flows in some commodities.

(iv) The methods of estimation should be improved considering that the final form of the model will be in a from of a linear interdependent system.

(v) Some dummy variables should be introduced in the system to indicate some important policy changes of the CMEA economies.

(vi) The explanatory part of the model which mainly consists of the domestic activities of the CMEA countries should somehow be linked to the CMEA national models for the internal consistency of the model.

With the improvements outlined above the balance of payments model would be very suitable for a possible application in the LINK project for short to medium-term projections.

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ÖZET

LINK PROJESİ KAPSAMINDA BAZI BASİT CMEA DIŞ TİCARET MODELLERİ

LINK Projesi 1968 yılında oniki büyük endüstri ülkesinin ekonometri uzmanlarının ve bazı uluslararası ekonomik kuruluşların işbirliği ile başlatılmıştır. Projenin amacı bugünedek geliştirilmiş ulusal veya bölgesel makroekonometrik modellerin sistematik bir şekilde bir dünya ekonomik modeli çerçevesinde birleştirilmesidir. Böyle bir yaklaşımın dünya ekonomisindeki dalgalanmaların ve ulusal ekonomiler üzerindeki etkilerinin incelenmesi ve gerek ulusal, gerekse uluslararası tutarlı ekonomik tahminlerin geliştirilebilmesi olanaklarını sağlayacağı düşünülmektedir.

LINK grubu kısa zamanda özellikle endüstri ülkeleri olmak üzere birçok ülkenin LINK sistemine uygulanabilecek yapıda olan ekonometrik modellerini toplayabilmiştir. Bununla beraber, üçüncü dünya ülkeleri ve sosyalist ülkeler için LINK Projesi gereksinmelerini karşılayabilecek ayrıntılı ulusal modeller henüz elde edilemediğinden LINK grubu tarafından bu ülkeler için geçici olarak basit bölgesel ekonomik modeller geliştirilmiştir.

CMEA topluluğu (SSCB ve Doğu Avrupa ülkeleri) ülkelerinin de LINK sisteminin gereksindirdiği ayrıntıları içeren ulusal veya bölgesel modelleri henüz geliştirilememiştir. Çünkü bu ülkelerin ekonomik modellerinin yapımında değişik sosyo-politik yapılarından ve dolayısı ile oldukça değişik dış ticaret politikalarından doğan çeşitli güçlükler ile karşılaşılmaktadır. Ayrıca CMEA ülkelerine ait dış ticaret ve iç ekonomik faaliyet istatistiklerinin yetersiz oluşu ayrıntılı ekonometrik çalışmalara olanak vermemektedir.

Bu yazıda LINK sistemindeki CMEA bloku ihracat girdileri boşluğunu şimdilik doldurabilecek, böylece Mini-LINK çözümünde ve Maxi-LINK ön çözümlerinde rahatlıkla kullanılabilecek üç basit model sunulmaktadır. Bunların birincisinde logaritmik-doğrusal trend analizi yöntemi kullanılmaktadır. İkinci modelde, CMEA ülkelerinin çok ürünlü (multicommodity) ithalâtları tüm görünen ve görünmeyen ihracat gelirleri ve net krediler toplamının hesaplanan belirli oranları alınarak bulunmaktadır. Üçüncü modelde ise, CMEA ülkelerinin

sektörel üretim ve tüketimleri ile CMEA bloku dış ticaretinde oldukça önemli bir rol oynayan dış ödemeler dengesi çok ürünlü ithalatların hesaplanmasında açıklayıcı faktörler olarak ele alınmıştır.

Bu çalışmada CMEA ülkeleri, SSCB bir bölge ve Doğu Avrupa ülkeleri diğer bölge olmak üzere iki bölgeli bir ayırım dahilinde incelenmiş ve diğer bütün dünya ülkeleride üçüncü bir bölge olarak ele alınmıştır. Bu şekilde bir ayırım üç bölgeli basit bir dünya ticaret modeli örneğinin incelenebilmesini sağlamıştır. Geliştirilen modellerin parametreleri onbeş yıllık (1955-69) bir süre içinde yıllık verilere dayanılarak hesaplanmıştır. Modeller statik ve dinamik simulasyonlar ile bu süre içinde denenmiş ve 1970 yılı için CMEA ithalat projeksiyonları hesaplanmıştır. Üçüncü model basit bir sistem dahilinde çözülmesine rağmen elde edilen sonuçlar modelin diğer iki modele göre olan üstünlüğünü açıklıkla kanıtlamıştır. Yazının son kısmında bu modelin belirtilen bazı yönlerde geliştirilmesi halinde ulusal CMEA ekonometrik modelleri geliştirilene kadar LINK sistemi gereksinmelerini yeterli bir ölçüde karşılayabileceği tezi savunulmuştur.