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A general equilibrium evaluation of trade policy changes in Moldova Republic

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Abstract

Taking into account that the economy of Moldova is open to the international markets, it is necessary to study the macroeconomic actions of the country, that are expressed in the elaboration of structural changes in the trade policy, in the exchange rate, in the evaluation of its influence on the Moldovan producers and consumers, and on the income of the government budget. These questions will be the object of the proposed article.

The present model consists of one small country, two sectors, three products and its goal is to evaluate the influence of the changes in the above mentioned policies, especially on the consumer, the producer, the state budget and the trade balance. In order to do this analysis the following parameters are used: tariffs on imports and exports, direct and indirect taxes, as well as the exchange rate.

The present model contains 31 equations that describe the production, the consumption, the exports, the imports, the state budget, and the trade balance. Both the real and the nominal indicators are calculated.

The General Equilibrium Computable Model (GECM) for trade was used for calculus simulation. The bases of the model are one country, two sectors, and three groups of products, which consist of:

1) the goods produced and commercialized on the domestic market,

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2) the exported goods,

3) the imported goods.

A country with one consumer that receives all the revenues was examined in the model. It is supposed that the world import and export prices are constant under condition that the country plays an insignificant role in the international trade.

The following parts are interacting in the model: the national producer, the national consumer and the rest of the world: CIS, Romania and Other Countries.

The model is presented as a system of equations, that must be solved. In several cases there could appear the need to optimize the objective function. Other components of the model are the balance equalities. The public savings (the deficit of the state budget) represent the balance between the tax revenue, the foreign grants and the government expenditure, that include the public consumption and private transfers (all exogenous variables). The deficit of the current account represents the foreign savings and it is the balance between the imports and the exports in world prices, plus the foreign grants and transfers. Taking into account that the output and the foreign savings are fixed, the model is directed by the use of the savings; the agregate investments are equal to the aggregate savings. As a result we have 31 equations and 30 endogenous variables. In accordance with the Walras Law, the total demand must be equal to the total supply for a certain system of prices. The equation (28) represents the equality between the investments and the savings and it results from the previous ones. That's why it can be omitted.

The most important feature of the model is its simplicity. This offers the possibility to trace how the external interactions and the policy changes are influencing the economy. The model is solved quantitatively, using the common means of the personal computers, an electronic table program. This model is the first step to solve a more complicated multi-sector model. Besides that, as all the indicators in the model are calculated in shares of the GDP, this enables to determine quickly the values of the analyzed indicators.

The reduced volume of input information is a distinctive feature of the model. There is used the information on income, tax revenues, balance of payments for 1996, that is available from official sources. Some omissions were made:

- the GDP was fixed at the base year level,
- the deficit of the balance of payments of the current year is limited to the deficit of the year of base,
- the exchange rate between the national currency and the United States dollar remains at the level of the year of base,
- the above mentioned restrictions may be excluded by providing additional conditions for the model.

The equations of the model are:

RealFlows

$$\bar{X} = G(E, D^S, \Omega) \quad (1)$$

$$Q^S = F(M, D^D, \sigma) \quad (2)$$

$$Q^S = F(M, D^D, \sigma) \quad (3)$$

$$Q^D = C + Z + \bar{G} \quad (4)$$

$$E_cis/D^S = g_2(P^d, P^e_{cis}) \quad (5)$$

$$E_rom/D^S = g_2(P^d, P^e_{rom}) \quad (6)$$

$$E_oth/D^S = g_2(P^d, P^e_{oth}) \quad (7)$$

$$M/D^D = f_1(P^m, P^d) \quad (8)$$

$$M_{cis}/D^D = f_2(P^m_{cis}, P^d) \quad (9)$$

$$M_{rom}/D^D = f_3(P^m_{rom}, P^d) \quad (10)$$

$$M_{oth}/D^D = f_4(P^m_{oth}, P^d) \quad (11)$$

Nominal Flows

$$T = t^m * R * PW^m * M + t^s * P^q * Q^d + t^y * Y - \quad (12)$$

$$t^e * R * PW^e * E$$

$$Y = P^x * \bar{X} + t_r * P^q + r^e * R \quad (13)$$

$$S = \bar{s} * Y + R * \bar{B} + S^g \quad (14)$$

$$C * P^t = (1 - \bar{s} - t^y) * Y \quad (15)$$

Prices

$$P^m = (1 + t^m) * R * PW^m \quad (16)$$

$$P^m_{cis} = (1 + t^m_{cis}) * R * PW^m_{cis} \quad (17)$$

$$P^m_{rom} = (1 + t^m_{rom}) * R * PW^m_{rom} \quad (18)$$

$$P^m_{oth} = (1 + t^m_{oth}) * R * PW^m_{oth} \quad (19)$$

$$P^e = (1 + te) * R * PW^e \quad (20)$$

$$P^e_{cis} = (1 + t^e_{cis}) * R * PW^e_{cis} \quad (21)$$

$$P^e_{rom} = (1 + t^e_{rom}) * R * PW^e_{rom} \quad (22)$$

$$P^e_{oth} = (1 + t^e_{oth}) * R * PW^e_{oth} \quad (23)$$

$$P^t = (1 + t^s) * P^q \quad (24)$$

$$P^x = g_1(P^e, P^d) \quad (25)$$

$$P^q = g_2(P^m, Pd) \quad (26)$$

$$R = 1 \quad (27)$$

Equilibrium Conditions

$$D^D - D^S = 0 \quad (28)$$

$$Q^D - Q^S = 0 \quad (29)$$

$$P^t * Z - S = 0 \quad (30)$$

$$T - P^q * G - t_r * P^q - f_t * R - S^g = 0 \quad (31)$$

Accounting Identities

$$P^x * \bar{X} = P^e * E + P^d * D^S$$

$$P^q * Q^S = P^m * M + P^d * D^D$$

E	-	export of goods
M	-	import of goods
D^S	-	The supply of internal goods
D^D	-	The demand for internal goods
Q^S	-	The supply of composite goods
Q^D	-	The demand for goods
P^e	-	Internal export prices
P^e_{cis}	-	Internal export prices (CIS)
P^e_{rom}	-	Internal export prices (Romania)
qP^e_{oth}	-	Internal export prices (other countries)
Pm	-	Internal import prices
P^m_{cis}	-	Internal import prices (CIS)
P^m_{rom}	-	Internal import prices (Romania)
P^m_{oth}	-	Internal import prices (other countries)
P^d	-	Production prices for the domestic goods
P^t	-	Sales price for domestic goods
P^x	-	The price of the aggregate output
P^q	-	The price of the composite goods
R	-	The exchange rate
T	-	Tax revenues
S^G	-	Governmental savings
Y	-	The aggregate income
PW^m	-	World import prices
PW^m_{cis}	-	World import prices (CIS)
PW^m_{rom}	-	World import prices (Romania)
PW^m_{oth}	-	World import prices (other countries)
PW^e	-	World prices for exports
PW^e_{cis}	-	World prices for exports (CIS)
PW^e_{rom}	-	World prices for exports (Romania)
PW^e_{oth}	-	World prices for exports (other countries)
t^m	-	Import Tariffs
t^m_{cis}	-	Import Tariffs (CIS)
t^m_{rom}	-	Import Tariffs (Romania)
t^m_{oth}	-	Import Tariffs (other countries)

t^e	-	Export Tariffs
t^e_{cis}	-	Export Tariffs (CIS)
t^e_{rom}	-	Export Tariffs (Romania)
t^e_{oth}	-	Export Tariffs (other countries)
t^y	-	The rate of the direct taxation
t^s	-	The rate of the indirect taxation
t_r	-	Governmental Transfers
f_t	-	Foreign Official Transfers
r_e	-	Foreign Private transfers
$\bar{s}$	-	Aggregate savings rate
$\bar{G}$	-	Real government demand
$\bar{B}$	-	Trade balance
Ω	-	Elasticity of the export transformation
σ	-	Elasticity of the import substitution
C	-	Aggregate Consumption
S	-	Aggregate Savings
Z	-	Aggregate Real Investments

The first equation determines the potential of the internal production. It represents the maximal combination between E and D that the economy can supply. The function will be specified as a constant elasticity of transformation (CET) function with transformation elasticity Ω. The constant X determines the aggregate production. X corresponds to the GDP (gros domestic product) as the intermediary consumption is not taken into account. The assumption of the constancy means that all the production factors are used entirely. The equations (4-7) determine the optimal relations between all the types of exports and the internal output, as a function of relative prices. The second equation determines the optimal relations between the composite goods, consisting of the D (internal) and M (imported) goods, which are used by the single consumer. It is supposed that the import goods and the internal goods are imperfect substitutes (Armington assumption). It means that the composite goods are determined as the constant elasticity of substitution (CES) aggregation function of M and D - σ. The consumption expressed by the function (15) is a goal

function. The equations (8-11) determine the relations between M and D as function of relative prices. The equations (16-23) determine the domestic export and import prices. The equation (25) determines the aggregate output prices which corresponds to the GDP deflator. The equation (26) determines the composite goods prices, and the equation (27) determines the exchange rate. The equation (13) determines the income of the private sector and the equation (14) determines the aggregate savings. The equations (28,29,31) determine the market equilibrium conditions. It means that for D and Q the supply is equal to the demand and that the restrictions of the trade balance are imposed. The equation (30) states that the aggregate savings are equal to the aggregate investments (the Walras Law).

Next, we represent the concrete expressions for the functions $G, F, \{g_1\}_1^5, \{f_1\}_1^5$. The equations 1 and 2, called CETEQ and ARMG in Excel, usually take the following aslgebraic form:

$$\bar{X} = A_1 * [\delta_1 * E^{\delta_1} + (1 - \delta_1) * (D^S)^{\rho_1}]^{1/\rho_1};$$

$$Q^S = A_2 * [\delta_2 * M^{\rho^2} + (1 - \delta_2) * (D^S)^{\rho_2}]^{1/\rho_2},$$

where the (CES) substitution elasticity σ and the (CET) transformation elasticity Ω, which are expressed like: $\sigma = 1/(1 - \rho;$ $-\infty < \rho < +1 \quad ; \sigma = 1/(\rho - 1 \quad ; 1 < \rho < +\infty.$

The equations (4-7) are the export supply function or the first order condition of the CET function and import demand function or the first order condition of the CES function.

$$
\begin{aligned}
E/D^S &= \left[\frac{(1-\delta_1)*P^e}{\delta_1*P^d}\right]^{\Omega};\\
E_{cis}/D^S &= \left[\frac{(1-\delta_1^{cis})*P^e_{cis}}{\delta_1^{cis}*P^d}\right]^{\Omega};\\
E_{rom}/D^S &= \left[\frac{(1-\delta_1^{rom})*P^e_{rom}}{\delta_1^{rom}*P^d}\right]^{\Omega};\\
E_{oth}/D^S &= \left[\frac{(1-\delta_1^{oth})*P^e_{oth}}{\delta_1^{oth}*P^d}\right]^{\Omega};\\
D^D &= \left[\frac{(1-\delta_2)*P^m}{\delta_2*P^d}\right]^{\sigma};\\
M_{cis}/D^D &= \left[\frac{(1-\delta_2^{cis})*P^m_{cis}}{\delta_2^{cis}*P^d}\right]^{\sigma};\\
M_{rom}/D^D &= \left[\frac{(1-\delta_2^{rom})*P^m_{rom}}{\delta_2^{rom}*P^d}\right]^{\sigma};\\
M_{oth}/D^D &= \left[\frac{(1-\delta_2^{oth})*P^m_{oth}}{\delta_2^{oth}*P^d}\right]^{\sigma};\\
P^x &= \frac{P^e*E+P^d*D^S}{\bar{X}};\\
P^q &= \frac{P^m*M+P^d*D^D}{Q^S};
\end{aligned}
$$

$A_1 = X0/(\delta_1*(E0)^{\rho_1}+(1-\delta_1)*(D^S0)^{\rho_1})^{1/\rho_1};$

$A_2 = Q^S0/(\delta_2*(M0)^{\rho_2}+(1-\delta_2)*(D^D0)^{\rho_2})^{1/\rho_2};$

$\delta_1 = 1/(1+P^d0/P^e0)*(E0/D^S0)^{(\rho_1-1)};$

$$\delta_2 = (P^m 0/P^d 0 * (M0/D^D 0)^{(1+1/\rho_2)})/$$

$$(1 + P^m 0/P^d 0 * (M0/D^D 0)^{(1+\rho_2)});$$

$$\rho_1 = 1/\sigma + 1;$$

$$\rho_2 = 1/\Omega - 1.$$

The variables δ_1^{cis}, δ_1^{rom}, δ_1^{oth}; ρ_1^{cis}, ρ_1^{rom}, ρ_1^{oth}; δ_2^{cis}, δ_2^{rom}, δ_2^{oth}; ρ_2^{cis}, ρ_2^{rom}, ρ_2^{oth}; A_1^{cis}, A_1^{rom}, A_1^{oth}; A_2^{cis}, A_2^{rom}, A_2^{oth} are determined in the same way when Ω^{cis}, σ^{cis}; Ω^{rom}, σ^{rom}; Ω^{oth}, σ^{oth} and base year value of the examined variables are known. In our problem the fiscal policy include: the import and export tariffs t_m, t_m^{cis}, t_m^{rom}, t_m^{oth}; t_e, t_e^{cis}, t_e^{rom}, t_e^{oth}; the rate of the direct taxation t^y and the rate of the indirect taxation t^s.

The Government Savings (state deficit) is the balance between the tax revenues, foreign grants, and the public expenditures, which include the public consumption and Private sector transfers (exogenous data). The deficit of the current account represents the foreign savings and is the difference between the imports and the exports in world prices, plus the grants and the foreign transfers. As it was mentioned earlier, the output and the foreign savings are constant. So, the model is saving drived. The aggregate investments are equal to aggregate savings. In total we have 31 equations and and 30 exogenous variables. Under Walras Law the equation 28, representing the equality between investments and savings, results from other equations. That is why it can be omitted.

The components of the model

Next, we determine the components of the model. To be able to work in Excel it is necessary to accomplish the following steps:

- to declare the parameters and the variables;
- to input the information;

- to determine the primary values for the parameters and the variables;
- to specify the equations.

Finally, the model is represented in the form of a system of equations, which must be solved. In some cases it could be necessary to optimize a function of purpose.

The model is placed in Excel, where the separate columns and blocks are selected for parameters, variables and equations. Also the separate columns are selected for the base and the current years. The input data for endogenous and exogenous variables of the base year are in separate blocks. All the components of the model are placed in one table. When the model for a particular product is examined the input information is taken from the auxiliary table.

The variables and the parameters

The parameters and the variables of the model are placed in the columns $A - I$. The parameters that depend on the elasticity are selected in the separate columns (A, B). These parameters are usually determined on the basis of the statistical information. These are the share δ_1^i, δ_2^i and the scale multipliers A_1^i, A_2^i for the all types of imports and exports $(j = 1, ..., 4)$ (the total imports, CIS, ROM, others), that are involved in the calculations. The column (A) briefly describes each parameter, the column B represents the respective values.

The exogenous variables are described in the column C. They reflect the external policy and the shock policy, included in the private experiment. The diapason of their change is placed in the column E. The base year values are placed in the column D. In the same way the brief description of the endogenous variables is placed in column F. Their values in the base and the current years and the ratio between them are placed in the columns $(G - I)$.

The equations

The separate table represents the equations of the model. The number of the equations is placed in the column (J). The brief equation

description is placed in the column (K). The formulas are placed in the column (L). In the work regime the formulas are hidden and only the current values are shown.

In Excel table the formulas are introduced in cells by writing only the part on right side of the equality sign. In order to complete the equation with the other part on the left side each of the mathematical expressions is marked and equalized to the respective variable.

The preparation of data

The reduced volume of input information is a distinctive feature of the model. There is used the information on revenues, tax incomes, the account of the balance of payments that is available from official sources. The input information for base year is placed in the coresponding table. The brief description of the indicators is presented in columns N and R and their values in thousands lei - in columns O and S. Afterwards the information is scaled according to the output, which act is noted in the columns P and T.

The table is divided in four parts. Part 1 is The National Account, in which are presented such macro-indicators as the added value, the salaries and the GDP in market prices, with the distinction between the private and government consumption, investments, exports and imports. Part 2 is The Tax Revenues that include the VAT, the excise tax, other direct taxes, the import and export revenues, the tax on income of natural persons and other indirect taxes. Part 3 is The State Budget that includs articles of current revenues and expenditures, the capital expenditures and the balance of payments deficit. The tax revenues and non-tax revenues are assigned to the current revenues. The goods, services, payments, transfers and subsidies are assigned to the current expenditures. Part 4 is The Balance of Payments that reflects the import - export balance (the trade balance) and the net revenues and dividends, the net private transfers, the net public transfers and the current account deficit.

The calculations of the variables are represented in the separate tables. The exogenous variables for the basic and current years are calculated, the variables for the basic year and the parameters.

The values of the parameters and the variables are added to the base year data. So, the calculus of the input information is effectuated every time the elasticity and the values for the basic year are introduced. The calculations of the level indicators (ρ_1^i, ρ_2^i; $i = 1, ..., 4$) is represented in the cells $B23 - B26$; $B36 - B39$. Having the values for the basic year for exports $E0$, for imports $M0$, for the internal demand D^S0 and supply D^D0 the weight parameters (δ_1^i, δ_2^i; $i = 1, ..., 4$) may be calculated, using the formulas from the cells $B19 - B22$ and $B32 - B35$, that are determined respectively from the demand and supply formulas (3-7). The scale multipliers (A_1^i, A_2^i; $i = 1, ..., 4$) are determined respectively from formulas for $\bar{X}$, Q^S,in the cells $B15 - B18$ and $B28 - B31$.

The calculations on the model

The calculations on the model are accomplished using Solver, a mean of Excel that enables to solve non-linear equations systems. Excel may solve the problem as an optimization or as a programming one. We choose the target variable that corresponds to the consumption ($L17$). This fact is not influencing the results of the model, because the number of equations are equal to the numbers of variables. If the model is settled correctly a solution may be found that will be equal to the variable values in the year of base for a given approximation. It is important to give an acceptable initial approximation before the Solver is launched.

Four types of experimental calculations were accomplished:

(1) the determination of the influence of custom duties on imports and on the macroeconomic indicators in conditions when Gross Output (GO) and Balance of Payment (BP) are constants;

(2) the determination of the influence of the exchange rate on the basic macroeconomic indicators

(3) the determination of the influence of custom duties on imports and on the macroeconomic indicators in the conditions of the increase of the GO;

(4) the determination of the influence of custom duties on imports and on the macroeconomic indicators in the conditions of the decrease of the deficit of the BP.

The influence of the customs duty of 0%, 5%, 10%, 15% and 20% in conditions when GO and BP are constants on a range of quantitative and qualitative indicators was examined on the first stage. The results of the calculations are displayed in four tables. The first table presents the changes of the rs related to GDP. The second one fixes the changes of different prices. The third - presents the rhythm of increase of the selected indicators and the fourth enables to follow the changes of the indicators in nominal values.

The influence of the customs duty of 0%, 5%, 10%, 15% and 20% in conditions of the increase of the GO and of the decrease of the deficit of the BP on a range of quantitative and qualitative indicators was examined on the third stage

The forth type of calculations is supposed to determine the changes of the exchange rate (MD lei/Us dollar) for a conditions of the increase of the GO and the decrease of the deficit of the BP at a constant quota on imports (5%). The grows of the exchange rate from 4% to 20% was taken into account.

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