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MACROECONOMIC MODEL WITH RATIONAL EXPECTATIONS FOR REPUBLIC OF MOLDOVA

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Abstract A small macroeconomic model [1] was adapted for Republic of Moldova and estimated using annual data. Three goods model with one domestically produced good consumed both at home and abroad and one imported good are examined. The aggregate demand, the aggregate supply, the money market and the government sector are considered. The consumption is the sum of real rate interest, disposable income, lagged consumption term and lagged disposable income term. Consumer disposable income is defined as GDP plus the earnings on net assets held abroad, minus interest paid on domestic debt and taxes. Investment is a linear function of the real interest rate, real output and the beginning-of-period capital stock. Export is a function of the real exchange rate, level of real output abroad, and a lagged export term. Real import is the function of the real exchange rate and real domestic output, a lagged import and a lagged reserve-import ratio.

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A small macroeconomic model based on familiar theoretical considerations [1] was adapted to the national economy reality for Republic of Moldova and estimated using annual data. The goal of the researches consists in the estimation of a set of macroeconomic indicators supposed as a behavioral variable and in solving the obtained system of nonlinear equations and conduct some simulations. For these purposes, the macroeconomic model with widely-accepted developing-country specifications for the key behavioral relationships [1-2] is used .

Three goods model with one domestically produced good consumed both at home and abroad and one imported good is considered. The model is divided

into aggregate demand, aggregate supply, the money market, foreign sector and the government sector.

Aggregate demand. Real aggregate demand for the internal output is considered to be equal to the sum of private consumption, investment, public consumption and net export

$$Y_t = Cp_t + Inv_t + Cg_t + X_t - \frac{e_t P_t^*}{P_t}. \tag{1}$$

The variables from equation (1) are defined as follows: Y_t is the real GDP; Cp_t are real expenditures on private consumption; Inv_t are real gross domestic investments; Cg_t is the real governmental consumption for domestic goods; X_t denotes real exports; e_t is the nominal exchange rate (the price of foreign currency in comparison with national currency); Z_t is real imports, measured in the units of the foreign goods; P_t^* is the import price in foreign currency; P_t is the price of internal output in national currency.

Private consumption, one of the demand components, is specified as behavioral equation in the following matter

$$lnC_t = \alpha_0 + \alpha_1 r_{t-1} + \alpha_2 lnC_{t-1} + \alpha_3 Y_t^d + \epsilon_1, \tag{2}$$

where r_t is real internal interest rate, Y_t^d is real disposable income and α_i are the coefficients that must be estimated.

Consumers disposable income is supposed to be GDP minus internal taxes

$$Y_t^d = Y_t - T_t, \tag{3}$$

where T_t are the real taxes (taxes incomes). On the other hand, the disposable income and consumption expenditures are correlated with the net modifications in the consumers' wealth through the budget restrictions to the private sector

$$Y_t^d = Cp_t + Inv_t + \{(M_t - M_{t-1}) + e_t \Delta Fp_t - (DCp_t - DCp_{t-1})\}/P_t, \tag{4}$$

where M_t denotes the money supply and ΔFp_t are changes in foreign private assets, measured in foreign currency. So the disposable income is allocated in consumption, investments and net changes in financial assets.

Investments, other demand component, are represented as behavioral function depending of the real output and one period lag investments

$$lnInv_t = k_0 + k_1 lnY_t + k_2 Inv_{t-1} + \epsilon_2. \tag{5}$$

The following demand component export is assumed to be a behavioral function of the real world output level (Y^*) and of the one period lag export term, both variables have positive coefficients,

$$lnX_t = \tau_0 + \tau_1 lnY_t^* + \tau_2 X_{t-1} + \epsilon_3. \tag{6}$$

At last, real imports are positively depending on the domestic real output. The term of one period lag import is included in estimated equation in order to obtain partial adjustment behavior. Moreover, because disposability of the foreign exchange often presents a restriction for states in transition, one period lag of reserves is frequently included in the regression for imports behavioral function. So, the imports equation may be written as

$$lnZ_t = \delta_0 + \delta_1 ln\frac{Y_t P_t}{P_t^* e_t} + \delta_2 ln\frac{Rez_{t-1}}{P_{t-1}^* Z_{t-1}} + \delta_3 lnZ_{t-1} + \epsilon_4. \tag{7}$$

Aggregate supply represents the GDP and is considered to be a function of Cobb-Douglas type depending on two production factors - labor and capital

$$Y_t = \theta_0 K_t^{\theta_1} L_t^{\theta_2}, \tag{8}$$

where K_t and L_t are the stocks of aggregate capital and labor, and θ_i, $i = 0, 1, 2$ are the coefficients which must be estimated. Since aggregate capital stock data possess some developing countries, estimation of supply implies a serious problem. Thus, in order to obtain aggregate capital stock data, similar to [1], the following procedure will be applied. The solution of the differential equation $K_t = (1-\rho)K_{t-1} + Inv_t$, where ρ is the depreciation rate, may be written as

$$lnK_t \approx ln2 + \frac{1}{2} ln \sum_{i=0}^{t-1} (1-\rho)^i Inv_{t-1} + \frac{t}{2} ln(1-\rho) + \frac{1}{2} K_0, \tag{9}$$

where K_0 is the initial capital stock. So,

$$lnY_t = ln\theta_0 + \theta_1 lnK_t + \theta_2 lnL_t = \theta_0^{'} + \theta_1 K_t^{'} + \theta_2 lnL_t, \tag{10}$$

where $\theta_0^{'} = \ln\theta_0 + \frac{\theta_1}{2}K_0$,

$$K_t^{'} = \ln 2 + \frac{1}{2}\ln\sum_{i=0}^{t-1}(1-\rho)^i Inv_{i-1} + \frac{t}{2}\ln(1-\rho). \tag{11}$$

Establishing constant returns to the scale ($\theta_1 + \theta_2 = 1$), dividing (9) by lnL_t we obtain

$$ln(\frac{Y_t}{L_t}) = \theta_0^{'} + \theta_1(K_t^{'} - lnL_t). \tag{12}$$

Finally the specifications lagged variable $\ln(\frac{Y_{t-1}}{L_{t-1}})$ and a time trend t were introduced as additional variables. So, empirical production function takes the form

$$ln(\frac{Y_t}{L_t}) = \theta_0^{'} + \theta_1(K_t^{'} - lnL_t) + g\cdot t + \theta_3 ln(\frac{Y_{t-1}}{L}_{t-1}). \tag{13}$$

In the assumption of the complete wage-price flexibility equation (13) represents the aggregate supply function of the economy.

Money market (M_t) in economy consists of reserves (Rez_t), internal credits (DC_t) and other components (Oth_t)

$$M_t = e_t Rez_t + DC_t + Oth_t. \tag{14}$$

Reserves are endogenously determined by the balance of payments, while internal credits accorded to private sector (DCp_t), and to public sector (DCg_t) are determined by the government policy:

$$DC_t = DCp_t + DCg_t. \tag{15}$$

Money demand is usually supposed to be positively correlated with the income level, while negatively related to nominal interest rate with the introduction of partial adjustment mechanism for obtaining lagged reactions

$$ln\frac{M_t}{P_t} = \beta_0 + \beta_1 lnY_t + \beta_2 i_t + \beta_3 lnY_{t-1} + \beta_4 ln\frac{M_{t-1}}{P_{t-1}} + \epsilon_6. \tag{16}$$

Foreign sector. Balance of payment identity is

$$e_t\Delta R_t = CA_t - e_t(\Delta Fg_t + \Delta Fp_t) - \Delta Oth_t, \tag{17}$$

where

$$CA_t = P_t X_t - e_t P_t^* Z_t + i_t^* e_t(Fp_{t-1} + Fg_{t-1} + R_{t-1}), \tag{18}$$

the authorities may obtain the accepted level of private capital flows, ΔFp_t conditioned by current account CA_t and public capital flows ΔFg_t.

Real interest rate is given by the equation

$$r_t = i_t - \frac{E_t P_{t+1} - P_t}{P_t}, \tag{19}$$

meaning that the real interest rate is the nominal rate minus expected inflation rate, where $E_t P_{t+1}$ is the expectation in year t of the $t+1$ year price.

Public sector. Dynamic specification of the model is completed with the description of the non-financial public sector behavior. The public sector borrows from external markets (ΔFg_t), as well as from the internal banking sector (ΔDCg_t). Its revenues consist of tax receipts and interest on foreign asset. Expenditures (Cg_t) consist of purchases of domestic goods for consumption purposes and interest payments on domestic debt. Combining these elements, the governmental budget restriction may be written as

$$e_t \Delta Fg_t - \Delta DCg_t = P_t(T_t - Cg_t) + i_t^* e_t Fg_{t-1} - i_t DCg_{t-1}. \tag{20}$$

Model equations estimation

Further the estimations of some model equations will be presented.

Private consumption

The equations were estimated with T.S.L.S., using as instruments exogenous variables and lagged values of exogenous and endogenous variables

$Cp_t = exp(-4.1197 - 0.5955 * r_{t-1} + 2.1792 * lnY^d t - 0.6904 * lnCp_{t-1})$

σ	(0.86)	(0.13)	(0.35)	0.28)
t	(-4.79)	(-4.48)	(6.18)	(-2.49)

$R^2 = 0.99$; $F = 112.22$; $DW = 2.21$.

All coefficients have the anticipated signs, conforming well to theory and estimations available in the literature. The coefficient of r_{t-1} is negative, showing an inverse dependence between private consumption and one lag term real interest rate. The short term semi elasticity is -0.59. Real interest rate influences consumption in the long-run with the elasticity of -0.35. Private consumption positively depends on disposable income, with a short-run elasticity of 2.18 and long-run elasticity of 1.29. The coefficient of the lagged consumption is -0.69, negative, the response to the change in the lagged interest

rate and in the disposable income is not prolonged over time. All coefficients are significant and the variables connection is very strong. The values of the t-Student test point out the lack of multi collinearity. The h-D*urbin* test is equal to $-0.41 > -1.96$, thus there is no residuals autocorrelation.

Exports

$$X_t = exp(-1.0639 + 0.1707 * lnY^* + 0.5993 * lnX_{t-1} - 0.1892 * DUM)$$

σ	(1.35)	(0.06)	(0.12)	(0.04)
t	(-0.79)	(3.05)	(5.20)	(-5.12)

$R^2 = 0.96$; $F = 41.21$; $DW = 2.07$.

The DUMMY variable takes value 1 in years 1998 and 2000. The estimated equation has all the coefficients significant and with anticipated signs. The export positively depends on the world GDP, with the short-run elasticity of 0.17. The coefficient of the lagged export is equal to 0.59, thus the effect of relative prices and world GDP modification will not be prolonged over time. All coefficients are significant for an $\alpha = 0.01$, the variables are strongly correlated. The test h-D*urbin* has the value $0.013 < 1.96$ the hypothesis of residuals autocorrelation is rejected.

Imports

$$Z_t = exp(1.1775 + 0.5791 * ln\tfrac{Y_t P_t}{P_t^* e_t} + 0.0726 * ln\tfrac{Rez_{t-1}}{P_{t-1}^*} + 0.2661 * lnZ_{t-1})$$

σ	(0.43)	(0.07)	(0.06)	(0.01)
t	(2.76)	(8.10)	(4.42)	(9.12)

$R^2 = 0.99$; $F = 147.89$; $DW = 2.23$.

The import positively depends on real domestic GDP measured in foreign currency (USD), with a short-run elasticity of 0.58 and that of the long-run of 0.79. We may say that the GDP impact on the import is not significant. The reserve-import ratio influences the import positively and significantly, with an elasticity of 0.07 in the short-run and 0.09 in the long-run. The lagged import coefficient is 0.27, this caused the reduced effects of the variables on the import in the long-run. All the coefficients are significant for $\alpha = 0.01$, the variables are correlated very strong, confirmed by a big F-statistic value. The test h-D*urbin* $= -0.33 < -1.96$; there is no residuals autocorrelation.

One scenario of macroeconomic development for Republic of Moldova (years 2005-2010)

This scenario is based on the forecasting calculations taking into account the following assumptions:

- Increasing of the world economy growth indexes.
- Maintaining of the slow dollar depreciation and euro appreciation on the world markets.
- Macroeconomic stability oriented state policy.
- Improvement of the enterprisers management.
- Relatively favorable climate conditions.

In the forecast the following values for exogenous and policy variables were selected:

- World GDP will increase annually with the average modification, calculated for years 1999-2005.
- World price values are extrapolated using O.S.L.S..
- Domestic nominal interest rate is extrapolated using average growth index and will represent 17%; 15%; 14%;12% and 11% in 2006-2010.
- Domestic currency exchange rate at the end of year 2010 is supposed to be 12 lei for 1 USA dollar, thus for years 2006-2009 it will register the following values 13.13; 12.85; 12.57 and 12.28 lei for 1 USA dollar.
- Governmental consumption is constant, equal to the year 2005 level: 1406.12 mil.lei in constant prices.
- Public credits increase with 3% per year.
- Private credits increase with 10% per year.
- Other monetary components were extrapolated using average modification for years 1995-2005.

The main goal of the forecast effectuated on the basis of the examined model consists in obtaining of the macroeconomic dynamics starting with specified exogenous variables and giving policy variables that assures model solution.

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