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UZBEK MACROECONOMIC MODEL
With elements of market equilibrium (new edition)

1. Objectives requirements and limits.

The main purpose of model elaboration is- to estimate the feasibility of GDP's growth rate and other macroeconomic indicators in a short and middle term; to explain changes in current macroeconomic policy; to estimate the effectiveness of suggested strategy of macroeconomic adjustment from the disproportion rate decreasing, distortion and disequilibria of the last years in Uzbek economy.

- The model should be oriented to the existed statistic statements. Undevelopment of separate accounts of Uzbekistan SNA (The System of National Accounts), including the absence of Table I-Q does not allow the use existed approaches to the creation of equilibrium macroeconomic models (like CGE, SAM etc.). The short supervision duration (esp. for open economy indicators, whose statistics begins only from 1995 limit the sphere of economic approach using. Because of the present conditions the only reliable approach is an approach, used for elaboration of a small macroeconomic models of China, Viet Nam[*] and the Model of World Bank "1-2-3"[**] . A few stochastic equilibriums (in a small models) are combined with balance and normative ratios, interest rates in direct as well as in inverse correlation allow to represent a separate elements of market self regulation in a model.

- The main features of Uzbekistan economy and sources of economic growth, a big role of agriculture in economic development of the country a role of foreign investments and also the possibilities of rapid production growth in manufacturing industry by better using of existed capacities and creation of necessary conditions for accelerate development of a private sector should be reflected in the model.

- The analytical indicators for estimation of a gap between demand and supply, distortion and disproportion values, existed on macroeconomic level for the separate markets and commodity groups should be included into the line of endogenous variables.

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[*] Modeling & Simulation of Macroeconomic System: use of quantitative Models for Analyzing Macroeconomic Reform Policies With Application to Chine, India & Viet Nom. ESCAP/ 1803 United Nations. New York, 1997.

[**] Policy lessons from a Simple Open. Economy Model. World Bank, IFPRI & University of California at Berkley

- The set of equilibriums and ratios of the model, the scheme of correlation between endogenous and exogenous variables should reflect from one side the

incompletance of market institute creation process and from the other side to include the separate parts of market selfregulation for those directions where the reforms are most feasible. This for example, means the possibility of consumer prices equilibrium value, money, interest rate, exchange rate for estimated period of time receiving or the estimation of calculated values of mentioned indicators deviation from their equilibrium value taking into consideration the possible limitations in the sphere of a currency , monetary, tax, open economy, fiscal regulation and the people's income policy.

2. Structure of the model

Production and allocation of GDP

$$GDPS = VEAGR + VEIND + VESER + ITAX \qquad (1)$$

$$GDP = PC + GC + PI + GI + X_n \qquad (2)$$

$$GAP = (GDP - (1 + \alpha_1 + \alpha_2) \bullet GDPS) / GDP \bullet 100\ \% \qquad (3)$$

Where:

GDPS – GDP from supply side (production);
VEAGR – value added (VA) of agriculture;
VEIND - VA of industry
VESER – VA of services
ITAX – net indirect tax
GDP – GDP from demand side (allocation);
PC – private consumption;
GC – government consumption;
PI – private (nongovernment) fixed investment;
GI – government fixed investment;
GAP – excess of aggregate demand on macroeconomic level
α_1 – share statistic discrepancy in GDP
α_2 – share reducing of inventories in GDP;
X_n – net export;

Necessary comment. Level of GDP can be determine and from expenditure side (identities (1)-supply) and from expenditure side (identities (2) demand). Difference between them reduced by parameters $\alpha_1 - \alpha_2$ show magnitudes

surplus of a aggregate demand.

Agriculture block

$$VEGAS = f(\alpha_5 \bullet XAGR, DP/WP) \qquad (4)$$

$$XAGR = f(QCOT, WAT, SQF) \qquad (5)$$

$$QCOT = \alpha_3 \bullet SQC \bullet DPCOT \qquad (6)$$

$$DPCOT = f(WPCOT, \alpha_4, EXR) \qquad (7)$$

Where:
VEAGR – VA of agriculture;
XAGR – output of agriculture;
α_5 – share of intermediate input in agriculture output;
DP/ WP – ratio domestic and world prices, using in agriculture production and irrigation (fertilized electricity, petrol, agriculture machines and so on);
QCOT – production of cotton;
WAT – waterly of year;
SQF – cultivated area for crops and vegetables;
α_3 - cotton harvest per unit area;
WPCOT – world (export) price of cotton;
α_4 – share of government buyer of cotton;
EXR – official exchange rate (sum / $);
DPCOT – domestic prices on Uzbek cotton;

Necessary comment. The key features of uzbek agriculture is cotton production and its dependent from water resources, as well high macroeconomic distortion (in prices, exchange rate, taxes), which limited production growth in agriculture. All of this reflects in equation (4)-(7) that allows make simulations to evaluate the impact of alternative rates of liberalization on the agriculture.

Industry block

$$VEIND = f(\alpha_6 \bullet XIND) \qquad (8)$$

$$XIND = XINDJ + XINDO \qquad (9)$$

$$XINDJ = f(FI, VPC, EXR) \qquad (10)$$

XINDO = f (si₁ • TFI, EFK, SAR) $\qquad$ *(11)*

where:
VEIND – value added of industry;
XIND – output of industry;
α_6 – share of intermediate input in industry output;
XINDJ – joint venture and enterprises with foreign investment (new industry sector);
XINDO – other industry (old industry sector);
FI – foreign investment;
VPC- volume foreign currency purchases in official currency market;
EXR – official exchange rate;
si_1 – share industrial investment ;
TFI – total fixed investment;
EFK – efficiency use of capacity in old industrial sector;
SAR – share industrial arrears in GDP

Necessary comment. The solicit features of the block are break up industrial in two part new industrial sector, developing on the base of foreign investment and old sector, including uzbek traditional industrial enterprises. Modeling of output determination XINDY, XINDO follows the Cobb-Douglas specification with production relations incorporating variables representing foreign investment, exchange rate, export (for first part) and efficiency use of capacity, profit, arrears (for second part of industry).

Service block

VESER = f (α_7 • XSER) $\qquad$ *(12)*

XSER = f(si₃ • TFI, WMIN, EXRBM / EXR) $\qquad$ *(13)*

where:
VESER - VA of service;
XSER - output of service;
α_7 - share of intermediat input in service output;
si_3 - share services investment in total fixed investment;
TFI – total fixed investment;
WMIN - minimal wages;
EXRBM / EXR - ratio nonofficial (black market) and official exchange rate.

Necessary comment. Compare with other sector economic reform in service is more advenced. Therefore, nonofficial exchange rate and play very important

role here. In additional ratio EXRBM/EXR can use as indicator surplus of currency demand or distortion on exchange rate.

Consumer market and prices (consumption and prices)

$$CS_1 = f(XINDJ, IM_1, CPI) \qquad (14)$$

$$CS_2 = f(XAGR, XIND, IM_2, CPI) \qquad (15)$$

$$CS_3 = f(XSER, CPI) \qquad (16)$$

$$CD = PC = f(DI, CPI) \qquad (17)$$

$$CS(CPI) = CS_1 + CS_2 + CS_3 = CD(CPI) \qquad (18)$$

$$DEFGDP = 0.7 \bullet CPI + 0.3 \bullet PRIM_3 \qquad (19)$$

CS_1, CS_2, CS_3, supply of consumption durable products (index "1"), food ("2"), service ("3").
CPI- consumer price index
XINDJ- output of joint venture and foreign enterprises /new sector industry/.
XAGR- output in agriculture
XSER- output in service
IM_1, IM_2- import of consumer goods, durable (1), food (2)
CD- aggregate demand on consumer market and market of service
PC- private consumption
DEFGDP- GDP deflator
$PRIM_3$- price of import of equipment and capital goods

<u>**Necessary comment**</u>. General purpose examine equilibrium level of consumer prices **CPI^{eq}** on the goods and services markets **$(CPI^{eq} - CPI^{ex})/CPI^{eq}*100\%$**, and its residual at expectation price level in case the government price regulation policy influence on mechanism of price formation /for example, conditions decrease price increase on main social goods and services or limits on money market-see (25)/. The examine of **CPI^{eq}** include strong relations between supply and import consumption products **IM_1, IM_2**, ((14), (15) this reason for formation of demand and supply on the consumer market of Uzbekistan.

Money market and exchange rate

$$M2 = f(GDP, v, BDEF) \qquad (20)$$

$$MO = f(M2, SAV, DI / CPI) \qquad (21)$$

$$CRD = f\ (EXRBM,\ MO) \tag{22}$$

$$CRS = f\ (E,\ \alpha_8\ ) \tag{23}$$

$$CRD\ (EXRBM)^{eq}) = CRS\ (EXRBM)^{eq}) \tag{24}$$

$$CPI = f\ (MO,\ EXRBM^{eq}) \tag{25}$$

where:

M2 - money base;
MO – cash money;
GDP – GDP (on the side of demand) ;
v - money velocity;
BDEF - budget deficit;
SAV - gross saving;
DI - disposable income of household;
CRD - foreign currency demand on "black" market;
CRS - foreign currency supply on "black" market;
E - export;
α_8 - share of implicit foreign currency income purchases
EXRBM - nonofficial exchange rate (sum/$);

Necessary comment. As show results of econometric research M2 does not depend of interest rate. It due to undeveloped finance market in Uzbekistan. More important role play GDP, velocity and budget deficit. Another salient features very high share of MO in M2, more then 50%. This level determined by stimulate to saving and disposable income DI/CPI. Multiply exchange rate system and unconvertible sum reflect administrative method of regulation which realize in condition sharp deficit of foreign currency demand. Market mechanism work in "black" market. Foreign currency supply and demand in those market adjust to equilibrium **EXRBM**^{eq} (condition (24)), which together with MO determine CPI (equation (25)). In contrast to the developed countries where import depend on domestic demand, for Uzbekistan dependence of imports on domestic demand.

Saving-investment and foreign debt block

$$TFI = f\ (PI + GI + FI) \tag{26}$$

$$PI = f\ (r,\ SAV,\ M2 - MO) \tag{27}$$

$$GI = \alpha_9 \bullet GE \qquad\qquad (28)$$

$$SAV = GDP - PC - BDEF - X_n \qquad\qquad (29)$$

$$TSAV = SAV + BDEF + X_n \qquad\qquad (30)$$

$$GAP^I = (TFI - TSAV) / TFI \qquad\qquad (31)$$

$$FD = f (FD(-1), GAP^I, FI) \qquad\qquad (32)$$

where:

TFI – total fixed investment
PI – private investment ;
GI –government investment;
FI – foreign investment;
MO - cash money;
M2 - money base M2;
r - real interest rate;
GE - government expenditures;
α_9 - share of government investment to government expenditures;
SAV - private saving (household and nongovernment sector);
TSAV – total saving;
BDEF – budget deficit*;*
X_n – net export;
GAP^I – gap of saving-investment; (excess of total fixed investment above total saving);
FD – foreign debt

Necessary comment. We distinguish investment by 3 more important sources: foreign government and private. They all receipt about 90-95% of total investment. The foreign investment FI are endogenous variables. Government investment is determined by the its share α_9 in Total government expenditure and private investment as a function of interest rate, saving and money deposits M2-M0. Last variables M2-M0 allow to reflect impact money deposits on private investment, although its share in total investment very small . Besides investment this block allow determined saving- investment unbalance GAP^I , which impact on foreign debt.

Income of household and labor market

$$POPU = 1.015 \bullet POPO\ (-1) \qquad\qquad (33)$$

$$PLBF = 1.015 \bullet PLBF\ (-1) \bullet \alpha_{10} \qquad\qquad (34)$$

$$EMP = 1.008 \bullet EMP\ (-1) \qquad\qquad (35)$$

$$GAP^L = (PLBF - EMP) / PLBF \qquad\qquad (36)$$

$$INC = f\ (WMIN,\ M2,\ GAP^L) \qquad\qquad (37)$$

$$DI = INC - PIT \qquad\qquad (38)$$

$$PC = f\ (DI,\ POPU) \qquad\qquad (39)$$

where:

POPU - population;
PLBF – potential employment;
α_{10} – coefficient of migration;
EMP - employment;
GAP^L – indicator of labor supply (**EMP)** and demand misbalance **(PLBF);**
INC – private sector income (household);
WMIN – minimum wage;
M2 – money base;
DI – disposable private income;
PIT – personal income tax;
PC – private consumption;

Necessary comments.

The features of Uzbek Labour market are following: trend of growth rate of population is stability decrease as well as employment rate (coefficients 1.015; 1.008), the role of migration process, rate of high rate of unemployment. (full employment PLBF and EMP real employment). Indicator GAP[1] represents the degree of unequilibrium between demand and supply on the labour market and with M2 and WMIN to define the dynamics of household income INC.

Budget block

$$GR = f(PIT, ITAX, DTAX) \qquad (40)$$

$$PIT = f(EMP, INC, \alpha_{11}) \qquad (41)$$

$$ITAX = f(VEIND + VESER, \alpha_4, \alpha_{12}) \qquad (42)$$

$$DTAX = f(VEIND + VESER, \alpha_{13}) \qquad (43)$$

$$GE = GI + GRS + GFD + GOTH \qquad (44)$$

$$GI = \alpha_{14} \bullet GDP \qquad (45)$$

$$GRS = f(WMIN) \qquad (46)$$

$$GFD = f(FD, EXR) \qquad (47)$$

$$GOTH = \alpha_{15} \bullet GDP \qquad (48)$$

$$BDEF = (GR - GE) / GDP \bullet 100\% \qquad (49)$$

where:

GR - budget revenue;
PIT - personal income tax;
ITAX – net indirect taxes ;
DTAX - direct taxes (corporate income tax);
α_4 – *share of government purchases on cotton to total production's value*;
α_{11} - average tax rate of personal income tax to average wage (salary);
α_{12} - tax rate of VAT in industry;
α_{13} - tax rate of CIT in industry;
GE - government expenditures;
GI – government investment to fixed capital;
GRS - expenditures to government adjustment, education, medical sphere, science, art;
GFD - expenditure to debt;
GOTH - others items of budget expenditures (social security, subsidies etc)
α_{14} **-** share government investment to GDP;

α_{15} - share others government expenditures to GDP;
BDEF - budget deficit;

Necessary comment. The main sources of budget revenue are following direct and indirect taxes ITAX, DTAX, PIT (80% of taxation). The forecast base on the econometric equation (41)÷(43) including following specific features: marginal tax rate of PIT (40%), VAT and corporate income tax, value of government purchases on cotton (main indirect taxes for agriculture); except agriculture from factors in equation (42) (loss-marking enterprises of agriculture). The significantly items of government expenditures, in nowadays and in futures are government investment, lays on adjustment (management) and public enterprises in social sphere, services of state debt. They are calculated as econometric (equations (46), (47)) as well as target method (with exogenous variables α_{14}, α_{15}
for (45), (48)).

Export-import block

$$IM = f(IM_1 + IM_2 + IM_3, DI / CPI) \tag{50}$$

$$IM_1 = f(EX, PRIM_1, EXRBM / CPI) \tag{51}$$

$$IM_2 = f(EX, PRIM_2, EXRBM / CPI) \tag{52}$$

$$IM_3 = f(XINDJ, PRIM_3, EXR / DEF) \tag{53}$$

$$EX = f(EXCOT + EXNC, XSER) \tag{54}$$

$$EXCOT = f(QCOT, \alpha_4, EXR, PRCOT) \tag{55}$$

$$EXNC = f(PREX, EXRBM / DEFGDP) \tag{56}$$

where:

IM - total import of goods and services;
IM_i - import of consumer goods (i = 1), food (i = 2), capital goods (i = 3);
DI - disposable income of household;
CPI - consumer price index;
EX - total export goods and services;
$PRIM_i$ - import (world) prices on consumer goods (i = 1), food (i = 2) and capital goods (i = 3);
EXRBM - nonofficial exchange rate (sum/$);
DEFGDP - GDP deflator;

XINDJ – VA of joint venture enterprises and foreign enterprises (new sector of industry);
EXR – official exchange rate;
EXCOT - export of cotton;
α_4 – share of government purchases on cotton to total value of manufacturing;
PRCOT - world prices on Uzbek cotton;
EXNC - non cotton export;
PREX - world price on Uzbek export goods (except cotton).

Necessary comment. The structure of Uzbek export and import include 3 groups of import: consumer, food and investment (capital goods). Each group has specific complex of factors and regulators, with determine dynamics IM_i (i=1,3). Other different specific features of export are following: cotton and non cotton production. It depend on different conditions, particularly, on the cotton export depend on administrative method of regulation and non cotton depend on non official exchange rate and domestic prices.

$\tilde{2}$ Exogenous variables

α_1 – share statistic discrepancy in GDP
$\alpha2$ – share reducing of inventories in GDP;
α_3 **-** cotton harvest per unit area;
α_4 – share of government buyer of cotton;
α_5 – share of intermediate input in agriculture output;
α_6 – share of intermediate input in industry output;
α_7 **-** share of intermediate input in service output;
α_8 **-** share of implicit foreign currency income purchases
α_9 - share of government investment to government expenditures;
α_{10} – coefficient of migration;
α_{11} - average tax rate of personal income tax to average wage (salary);
α_{12} - tax rate of VAT in industry;
α_{13} - tax rate of CIT in industry;
α_{14} **-** share government investment to GDP;
α_{15} **-** share others government expenditures to GDP;
DP/ WP – ratio domestic and world prices, using in agriculture production and irrigation (fertilized electricity, petrol, agriculture machines and so on);
QCOT – production of cotton;
WAT – waterly of year;
SQF – cultivated area for crops and vegetables;
WPCOT – world (export) price of cotton;

EXR – official exchange rate (sum / $);
SQC – cultivated area for cotton;
FI – foreign investment;
VPC- volume foreign currency purchases in official currency market;
si_1 – share industrial investment ;
EFK – efficiency use of capacity in old industrial sector;
SAR – share industrial arrears in GDP
si_3 - share services investment in total fixed investment;
WMIN - minimal wages;
r - real interest rate;
v - money velocity;
PREX - world price on Uzbek export goods (except cotton).
PRCOT - world prices on Uzbek cotton;
$PRIM_i$ - import (world) prices on consumer goods (i = 1), food (i = 2) and capital goods (i = 3);

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PI – private (nongovernment) fixed investment;
GI – government fixed investment;
GAP – excess of aggregate demand on macroeconomic level
XAGR – output of agriculture;
QCOT – production of cotton;
DPCOT – domestic prices on Uzbek cotton;
XIND – output of industry;
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DEFGDP- GDP deflator

M2 - money base;

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