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## **PBO's Macroeconomic Forecasting Model (PBOMFM)**

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## Macroeconomic Forecasting Model

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The current design of the Parliamentary Budget Office of Georgia (PBO) Macroeconomic Forecasting Model (PBOMFM) is consistent with the Financial Programming and Policy (FPP) framework that is developed by International Monetary Fund (IMF). The PBOMFM strikes a balance between theory and practice according to its purpose of providing accurate forecasts and policy analysis. The PBOMFM has both long-run (theoretical) and short-run (data-based) dynamics. The econometric estimates of the model's parameters and its short-run dynamics are based on the data analysis and calibration for the Georgian economy. The PBOMFM is a practical and robust tool for economic forecasting in Georgia. PBO's macroeconomic forecasts are publicly available on its website and in print.

A simple description of the PBOMFM allows for four sectors:

- Real Sector
- Fiscal Sector
- External Sector
- Monetary Sector

Linkages among the sectors are crucial for creating a consist framework. The equations in the model represent a set of relationships between different economic variables. These relationships can be broken down into three broad groups:

1. **Accounting Identities:** Equations that specify the identities and definitions in the National Accounts. For example, the Gross Domestic Product (GDP) by definition equals the sum of consumption, investment, government spending and net export.

2. **Econometric Equations:** Econometric models provide a structure for quantification of how the Georgian economy behaved in the past and how it might behave in the future. Econometrically estimated equations provide the foundation for policy studies that inform the parliamentarians and the public of possible options and their impacts on the welfare of the country. For example, the econometric equation for private consumption assumes that consumption expenditure responds to the changes in real GDP and real interest rate. Therefore, in addition to forecasting total consumers' expenditures, econometrically estimated equations allow for assessing the impact of changes in interest rate and income on consumers' demands. For quantification of the underlying relationships in PBOMFM, the following estimation techniques and specifications are used: Ordinary Least Squares (OLS), Autoregressive Integrated Moving Average (ARIMA), Vector Autoregression (VAR), Bayesian Vector Autoregression, Vector Error Correction (VEC), Restricted Vector Error Correction, Error Correction Model (ECM), Autoregressive Distributed Lag (ARDL) and Time Varying Parameter (TVP) framework.

The PBOMFM imposes 51 macro-fiscal variables of which 31 are endogenous (being determined by other variables), 16 exogenous, and 4 are determined by the PBO's expert judgments.

3. **Technical Relationships.** Equations in the model that are neither identity nor econometrically estimated are known as technical relationships. This category includes calibrated relationships based on economic theory or broad historical trends and stylized facts. For example, projection of exports of services bases on the assumption that its value equals to average % share of exports of services in the total exports.

## Model Base

Macroeconomic Forecasting Model uses quarterly macro-fiscal data. The Data are collected from the following sources:

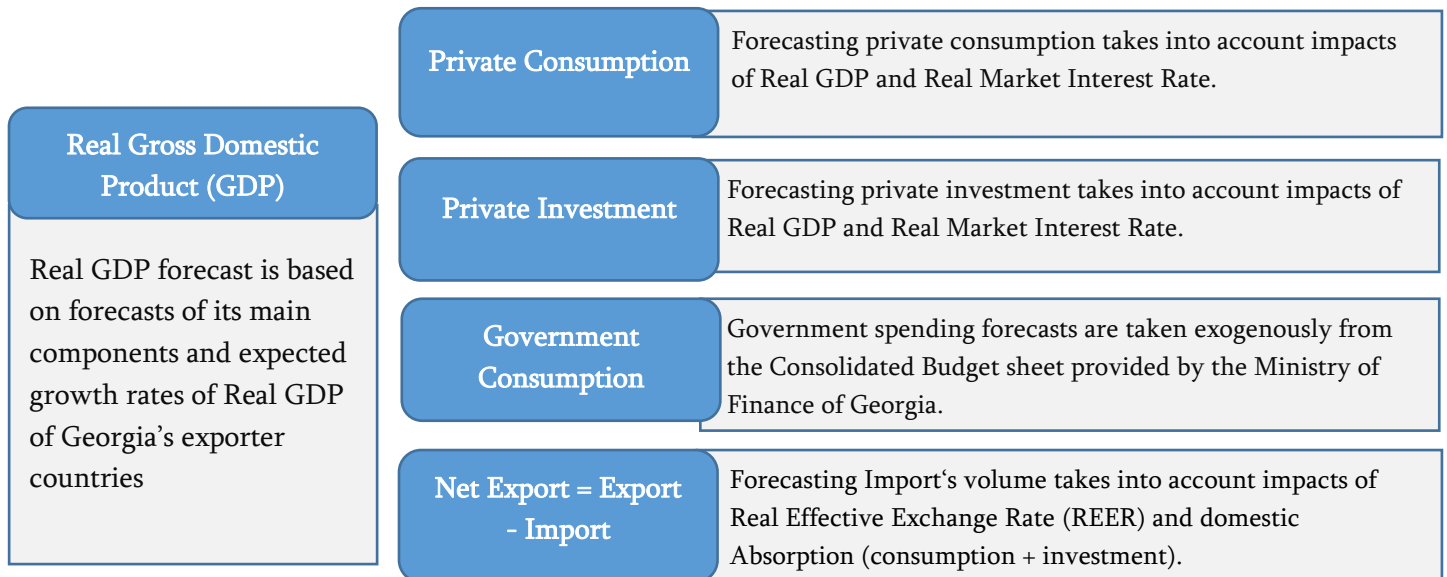
**National Statistics Office of Georgia** – real sector data

**Ministry of Finance of Georgia**- fiscal sector data

**National Bank of Georgia** – external and monetary sector data

**International Organizations and others** (such as, the IMF, World Bank, and OECD).

## Real Sector



1.  $Y_t = YR_t * Defi_t$
2.  $YR_t = f(YTP_t, TPSHx_t, VAR_{comp})$
3.  $C_t = C_t^p + C_t^g$
4.  $CR_t = CR_t^p + CR_t^g$
5.  $C_t^g = COE_t + UGS_t$
6.  $C_t^p = CR_t^p * CPI_t$
7.  $CR_t^p = f(YR_t, IRLR_t)$
8.  $CR_t^g = C_t^g * CPI_t$
9.  $I_t = I_t^p + I_t^g$
10.  $I_t^g = ANA_t$
11.  $I_t^p = IR_t^p * CPI_t$
12.  $IR_t^p = f(YR_t, IRLR_t)$
13.  $IMR_t = f(RABS_t, REER_t)$
14.  $REER_t = f(NFA_t, TOT_t)$
15.  $TOT_t = EPI_t / IPI_t$
16.  $EPI_t = Defi_t$
17.  $IPI_t = (C_t^p + C_t^g + I_t^p + I_t^g + EX_t - Y_t) / (CR_t^p + CR_t^g + IR_t^p + IR_t^g + EX_t - YR_t)$
18.  $EXR_t = EX_t / EPI_t$
19.  $RABS_t = ABS_t / CPI_t$
20.  $ABS_t = C_t + I_t$
21.  $IMR_t = CR_t + IR_t + EXR_t - YR_t$
22.  $IM_t^G = \text{average} \left( \frac{IM_{t-1}^G}{IM_{t-1}}, \frac{IM_{t-2}^G}{IM_{t-2}}, \frac{IM_{t-3}^G}{IM_{t-3}}, \frac{IM_{t-4}^G}{IM_{t-4}} \right) * IM_t$
23.  $IM_t^s = IM_t - IM_t^G$
24.  $EX_t = Y_t - C_t - I_t + IM_t$
25.  $EX_t^G = \text{average} \left( \frac{EX_{t-1}^G}{EX_{t-1}}, \frac{EX_{t-2}^G}{EX_{t-2}}, \frac{EX_{t-3}^G}{EX_{t-3}}, \frac{EX_{t-4}^G}{EX_{t-4}} \right) * EX_t$

26.  $EX_t^S = EX_t - EX_t^G$

27.  $YPC_t = Y_t/POP_t$

28.  $POP_{t+1} = POP_t$

## Fiscal Sector

### Consolidated Budget

#### Revenues

#### Tax Revenues

##### Income Tax

Income Tax forecast is made by taking into account impacts of Real GDP and Consumer Price Index (CPI).

##### Profit Tax

Profit Tax forecast is made by taking into account impacts of Real GDP and Consumer Price Index (CPI).

##### Property Tax

Property Tax forecast is made by taking into account impacts of Real GDP and Consumer Price Index (CPI).

##### VAT

Forecasting VAT takes into account impacts of Real Consumption and Consumer Price Index (CPI).

##### Import Tax

Import Tax forecast is made by taking into account impacts of Import Volume and Real Effective Exchange Rate (REER).

##### Excise

Excise forecast takes into account an impact of Real Consumption.

#### Other Revenues

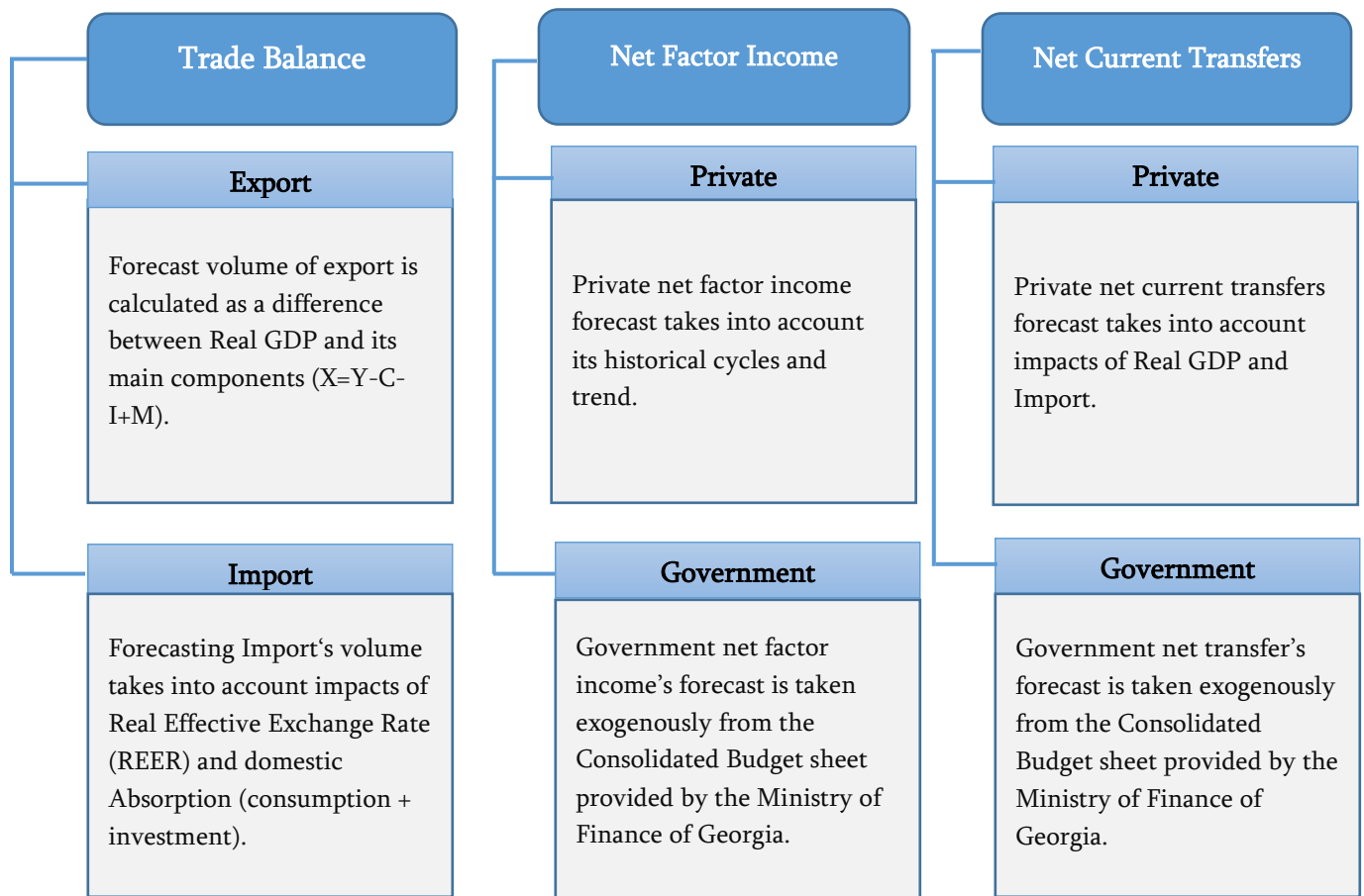
Other Revenues forecast is made by taking into account impacts of Real GDP and Consumer Price Index (CPI).

*pending, net acquisition of non-financial assets and budget  
by from the official information provided by the Ministry of*

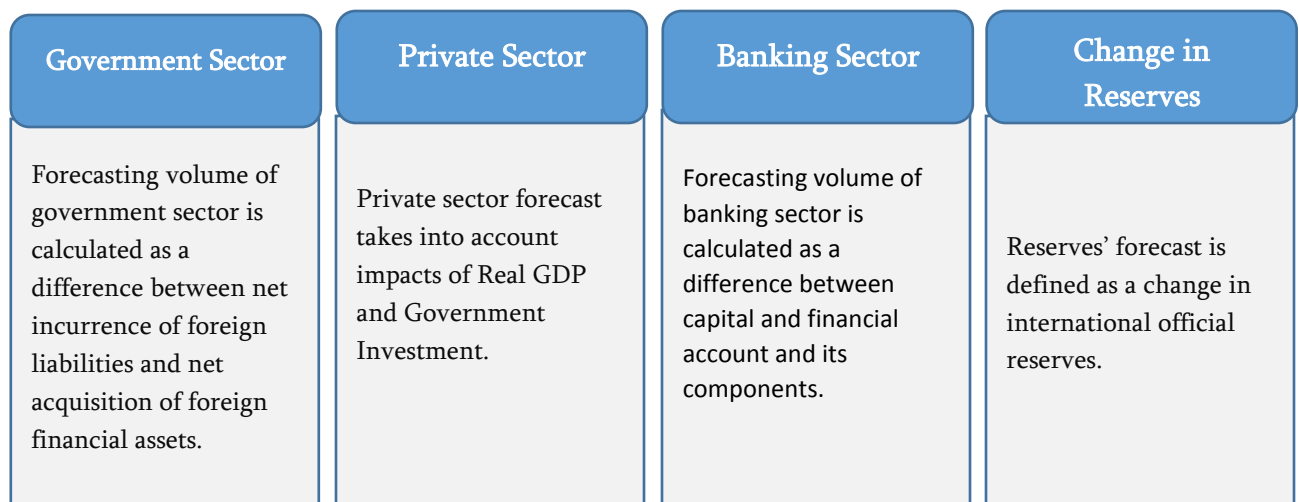
29.  $TRG_t = TR_t + GR_t$
30.  $TR_t = TXR_t + OR_t$
31.  $OR_t = f(YR_t, CPI_t)$
32.  $TR_t = VAT_t + PIT_t + CIT_t + EXT_t + RET_t + ID_t + OT_t$
33.  $VAT_t = f(CR_t, CPI_t)$
34.  $PIT_t = f(YR_t, CPI_t)$
35.  $CIT_t = f(YR_t, CPI_t)$
36.  $EXT_t = f(CR_t, )$
37.  $RET_t = f(YR_t, CPI_t)$
38.  $ID_t = f(IM_t, REER_t)$
39.  $OT_t = f(YR_t, CPI_t)$
40.  $EXP_t = COF_t + UGS_t + INT_t + SUB_t + GRA_t + SB_t + OE_t$
41.  $INT_t = INT_t^d + INT_t^e$
42.  $NOB_t = TRG_t - EXP_t$
43.  $NANA_t = ANA_t + DNA_t$
44.  $NLB_t = NOB_t - NANA_t$
45.  $NAFA_t = NAFA_t^d + NAFA_t^f$
46.  $NIL_t = NIL_t^d + NIL_t^f$
47.  $NCSC_t = NCSC_t^{cb} + NCSC_t^{com}$
48.  $NCSC_t^{cb} = NLB_t - NAFA_t + NIL_t - NCSC_t^{com}$

## External Sector

### Current Account



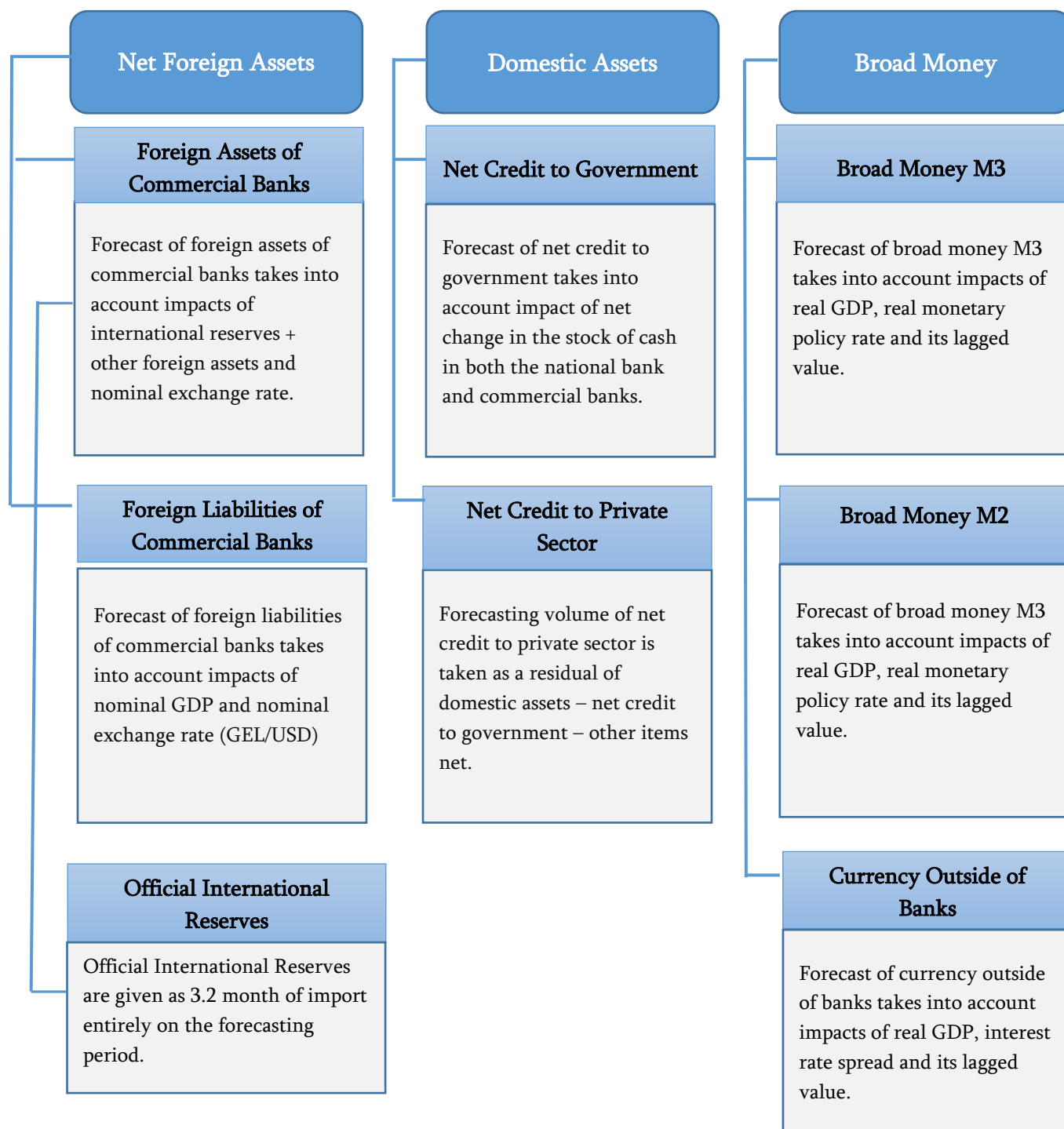
### Capital and Financial Account



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49.  $TB_t = EX_t - IM_t$
  50.  $NFI_t = NFI_t^p + NFI_t^g$
  51.  $NFI_t^g = INT_t^e$
  52.  $NFI_t^p = f(\text{ARMA})$
  53.  $TRI_t = TRI_t^p + TRI_t^g$
  54.  $TRI_t^g = GR_t - GRA_t$
  55.  $TRI_t^p = f(YR_t, IM_t)$
  56.  $CAB_t = TB_t + NFI_t + TRI_t$
  57.  $CAB_t = KB_t$
  58.  $KB_t = NCF_t^p + NCF_t^g + NCF_t^{bs} + \% \Delta R_t$
  59.  $NCF_t^p = f(YR_t, I_t^g)$
  60.  $NCF_t^g = NIL_t^f$
  61.  $\% \Delta R_t = f(\text{GIR}_t)$
  62.  $NCF_t^{bs} = KB_t - NCF_t^p + NCF_t^g - \% \Delta R_t$



## Monetary Sector



## Inflation

### GDP Deflator

GDP deflator forecast takes into account impacts of real GDP gap, real exchange rate of GEL/USD, monetary policy rate and backward-looking component of its value.

### CPI Inflation

CPI inflation forecast takes into account impacts of real GDP gap, real exchange rate of GEL/USD, and backward looking component of its value.

63.  $NFA_t = FAB_t - FLB_t$
64.  $FAB_t = f((GIR + OAF)_t, ER_t)$
65.  $FLB_t = f(Y_t, EER_t)$
66.  $ER_{t+1} = ER_t$
67.  $EER_{t+1} = EER_t$
68.  $NFA\_NBG_t = GIR_t / GIR_{t-1} * NFA\_NBG_{t-1}$
69.  $NFA\_RoE_t = NFA_t - NFA\_NBG_t$
70.  $DA_t = M3_t - NFA_t$
71.  $M3_t = RM3_t * CPI_t$
72.  $M2_t = RM2_t * CPI_t$
73.  $Cob_t = RCob_t * CPI_t$
74.  $NCG_t = f(NCSC)$
75.  $NCP_t = DA_t - NCG_t - NCP_t$
76.  $OIN_t = f(ARMA)$
77.  $RM3_t = f(YR_t, RMPR_t, RM3_{t-1})$
78.  $RM2_t = f(YR_t, RMPR_t, RM2_{t-1})$
79.  $RCob_t = f(YR_t, IRS_t, Cob_{t-1}, Add\_Factor_t)$
80.  $RMPR_t = ((1 + \% \Delta MPR_t) / (1 + \% \Delta CPI_t) - 1) * 100$
81.  $IRS_t = IRLR_t - IRDR_t$
82.  $IRLR_t = f(ARMA)$
83.  $DCD_t = M2_t - Cob_t$
84.  $FCD_t = M3_t - M2_t$
85.  $Inf_t = f(Inf_{t-1}, Y_t^{gap}, RER_t)$
86.  $RER_t = \% \Delta RER_t$
87.  $Y_t^{gap} = \% \Delta YR_t - \% \Delta YR_t^p$
88.  $Def_t = f(Def_{t-1}, Y_t^{gap}, RER_t, MPR_t)$
89.  $GIR_t = IM_t * (RIM/12)$
90.  $MV3_t = Y_t / M3_t$
91.  $MV2_t = Y_t / M2_t$
92.  $CD_t = FCD_t / (DCD_t + FCD_t)$
93.  $CPI_t = CPI_{t-1} * (1 + Inf_t / 100)$
94.  $Defi_t = Defi_{t-1} * (1 + Def_t / 100)$

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## Definition of Used Abbreviations

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Add Factor – Additional Factor  
ANA- Acquisition of Non-Financial Assets  
ARMA- Auto-regressive Moving Average Model  
C – Total Consumption  
CAB- Current Account Balance  
CD – Dollarization Coefficient  
C<sup>G</sup> – Government Consumption  
CIP – Profit Tax  
Cob – Currency Outside of banks  
COF- Compensation of Employees  
C<sup>P</sup> – Private Consumption  
CPI- Consumer Price Index  
CR – Total Real Consumption  
CR<sup>G</sup> - Government Real Consumption  
CR<sup>P</sup> - Private Real Consumption  
DA – Domestic Assets of Banks  
DCD – Domestic Currency Deposits  
DEF - % Change in GDP Deflator  
DEF<sub>*i*</sub> - GDP Deflator Index  
DNA- Disposal of Non-Financial Assets  
EER – GEL/USD Exchange Rate (average period)  
EPI- Export Price Indices  
ER – GEL/USD Exchange Rate (end of period)  
EX – Export of Goods and Services  
EX<sup>G</sup> – Export of Goods  
EXP- Expenses  
EXR – Real Export of Goods and Services  
EX<sup>S</sup> - Export of Services  
EXT - Excise  
FAB – Foreign Assets of Banks  
FCD – Foreign Currency Deposits  
FLB – Foreign Liabilities of Banks  
GIR – Official International Reserves  
GR –Grants (revenue side)

GRA- Grants (expense side)  
I – Total Investment  
ID – Import Tax  
I<sup>G</sup> – Government Investment  
IM – Import of Goods and Services  
IM<sup>G</sup> - Import of Goods  
IMR - Real Import of Goods and Services  
IM<sup>S</sup> - Import of Services  
INF – CPI Inflation  
INT- Expense of Interest  
INT<sup>D</sup>- Expense of Domestic Interest  
INT<sup>E</sup>- Expense of Foreign Interest  
IPI- Import Price Indices  
I<sup>P</sup> – Private Investment  
IR – Real Total Investment  
IRDR – Market Interest Rate on Deposits  
IRLR- Market Interest Rate on Loans  
IR<sup>P</sup> – Private Real Investment  
IRS – Interest Rate Spread  
KB- Capital and Financial Account balance  
M2 – Broad Money M2  
M3 – Broad Money M3  
MPR – Monetary Policy Rate  
MV2 – Velocity of M2  
MV3 – Velocity of M3  
NAFA- Net Acquisition of Financial Assets  
NAFA<sup>D</sup>- Net Acquisition of Domestic Financial Assets  
NAFA<sup>F</sup>- Net Acquisition of Foreign Financial Assets  
NANA- Net Acquisition of Non-Financial Assets  
NCFBS- Net Capital Inflow of Banking Sector  
NCFG- Net Capital Inflow of Government Sector  
NCFP- Net Capital Inflow of Private Sector  
NCG – Net Credit to Government  
NCP - Net Credit to Private Sector  
NCSC- Net Change in the Stock of Cash

NCSC<sup>CB</sup>- Net Change in the Stock of Cash in National Bank  
NCSC<sup>COM</sup>- Net Change in the Stock of Cash in Commercial Banks  
NFA – Net Foreign Assets of Banks  
NFA\_NBG - Net Foreign Assets of National Bank  
NFA\_RoE - Net Foreign Assets of the Rest of Economy  
NFIG- Government Net Factor Income  
NFIP- Private Net Factor Income  
NFI- Net Factor Income  
NIL<sup>D</sup>- Net Incurrence of Domestic Liabilities  
NIL<sup>F</sup>- Net Incurrence of Foreign Liabilities  
NIL- Net Incurrence of Liabilities  
NLB- Overall Budget Balance  
NOB- Net Operating Balance  
OE- Other Expenses  
OFA – Other Foreign Assets  
OIN – Other Items, Net  
OR- Other Revenues  
OT – Other Taxes  
POP - Population  
PIT – Income Tax  
RCob – Real Currency Outside of Banks  
REER- Real Effective Exchange Rate Index  
RER – Growth Rate of Real GEL/USD Exchange Rate  
RER<sub>*i*</sub> - Real GEL/USD Exchange Rate Index  
RET – Property Tax  
RIM – Reserves in Month of Import  
RM2 – Real Broad Money M2  
RM3 - Real Broad Money M3  
RMPR – Real Monetary Policy Rate  
SB- Social Benefits  
SUB - Subsidies  
TB- Trade Balance  
TPShX- 9 Core Trading Partners' Exports ratio in Total Export  
TOT- Term of Trade  
TR – Total Revenues  
TRG – Total Revenues and Grants

TRIP- Private Net Transfers Income

TRIPG- Government Net Transfers Income

TRI- Net Transfers Income

TXR- Tax Revenues

UGS- Purchases of Goods and Services

VAR<sup>comp</sup>- Influences of GDP Components Estimated by Vector Auto-Regression

VAT – Value Added Tax

Y- Nominal GDP

*Y<sup>gap</sup>* - GDP GAP

YPC – GDP Per Capita

YR<sup>p</sup>- Potential Real GDP Measured by Kalman Filter

YR- Real GDP

YTP- 9 Core Trading Partners' Real GDP Growth Forecasts

$\Delta R$ - Change in Reserves.