Macroeconomic Model for MITICA: Aggregate and Sectoral Approach

1 Aggregate Approach (Without Sectors)

We define total GDP (Y) as the sum of its demand-side components:

$$Y = C + I + G + (X - M) \tag{1}$$

where:

- C = Consumption (household spending).
- I = Investment (private and public capital formation).
- G = Government spending (public expenditures).
- $X - M$ = Net exports (exports - imports).

1.1 Consumption Function

Consumption is modeled as a function of:

$$C = \alpha(Y - T) + \beta P \tag{2}$$

where:

- α = Marginal propensity to consume (parameter).
- T = Total taxes (optional, exogenous).
- β = Sensitivity of consumption to population size.

1.2 Investment Function

Investment depends on:

$$I = \gamma - \delta r + \mu g \tag{3}$$

where:

- γ = Autonomous investment component.
- δ = Sensitivity of investment to interest rate (r).
- g = Expected economic growth.
- μ = Sensitivity of investment to expected growth.

2 Sectoral Approach: Disaggregating GDP into Primary, Secondary, and Tertiary Sectors

Now, we extend the aggregate approach by breaking GDP into sectoral components:

$$Y = Y_a + Y_i + Y_s \tag{4}$$

where:

- Y_a = Primary sector (agriculture, extractives).
- Y_i = Secondary sector (industry, manufacturing, construction).
- Y_s = Tertiary sector (services, trade, administration).

Each sector is modeled as a function of consumption, investment, government spending, and net trade balance:

$$Y_a = \lambda_a C + \theta_a I + \psi_a G + \omega_a (X - M) \tag{5}$$

$$Y_i = \lambda_i C + \theta_i I + \psi_i G + \omega_i (X - M) \tag{6}$$

$$Y_s = \lambda_s C + \theta_s I + \psi_s G + \omega_s (X - M) \tag{7}$$

2.1 Consumption Impact per Sector

Consumption is broken into sectoral effects:

$$C_a = \alpha_a (Y - T) + \beta_a P \tag{8}$$

$$C_i = \alpha_i (Y - T) + \beta_i P \tag{9}$$

$$C_s = \alpha_s (Y - T) + \beta_s P \tag{10}$$

Thus, total consumption remains:

$$C = C_a + C_i + C_s = \alpha (Y - T) + \beta P \tag{11}$$

where:

$$\alpha = \alpha_a + \alpha_i + \alpha_s, \quad \beta = \beta_a + \beta_i + \beta_s \tag{12}$$

2.2 Investment Impact per Sector

Investment is similarly decomposed:

$$I_a = \gamma_a - \delta_a r + \mu_a g \tag{13}$$

$$I_i = \gamma_i - \delta_i r + \mu_i g \tag{14}$$

$$I_s = \gamma_s - \delta_s r + \mu_s g \tag{15}$$

$$I = I_a + I_i + I_s = \gamma - \delta r + \mu g \tag{16}$$

where:

$$\gamma = \gamma_a + \gamma_i + \gamma_s, \quad \delta = \delta_a + \delta_i + \delta_s, \quad \mu = \mu_a + \mu_i + \mu_s \tag{17}$$

2.3 Final Sectoral GDP Equation

Summing up the sectoral GDP equations:

$$Y = C(\lambda_a+\lambda_i+\lambda_s)+I(\theta_a+\theta_i+\theta_s)+G(\psi_a+\psi_i+\psi_s)+(X-M)(\omega_a+\omega_i+\omega_s) \quad (18)$$

3 Key User-Defined Variables for Projections

For the projected period, users can define key macroeconomic variables to drive the model's estimations. If users do not provide these values, they will be estimated based on historical data. The main projection variables include:

- **Interest Rate (r)**: Affects investment via capital costs.
- **Population Growth Rate (g_P)**: Influences labor supply and consumption.
- **Government Spending (G)**: Direct impact on total GDP.
- **Tax Rate (T)**: Affects disposable income and consumption.
- **Expected Growth Rate (g)**: Drives investment expectations.
- **Net Exports ($X - M$)**: Determines trade balance effects on GDP.

If users choose not to define these projections, machine learning techniques will estimate them using historical trends and relationships between macroeconomic variables.