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A simple macroeconomic framework for Madagascar

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Abstract

I present a simple model of macroeconomic accounting framework for the economy of Madagascar. The model is an identity-based framework that inherits the characteristics of the World Bank's Revised Minimum Standard Model and the International Monetary Fund's financial programming. Such models are mostly used for designing the macroeconomic framework of the budget laws of Madagascar.

Keywords: macroeconomic framework, financial programming, accounting framework.

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1 Introduction

The common model for a macroeconomic accounting framework is an interlinking mechanism between the 4 macroeconomic sectors, each of which are represented by an accounting identity expressing a certain equilibrium. The concerned sectors and their corresponding accounts are the real sector (National accounts), the government sector (Fiscal Operations

of the Central Government), the external sector (Balance of payments) and the monetary sector (Monetary accounts). Well-known identity-based framework includes the World Bank's Revised Minimum Standard Model (RMSM) [1, 12, 17] and the International Monetary Fund (IMF)'s financial programming [8, 12, 14]. Although the use of such models is subject to several limitations [1, 8, 17], they are, in a computation and algebraic point of view, useful to study the interaction among assumptions about the behavior of the variables which are supposed to represent the economy.

2 The theoretical accounting framework

Note that due to the interlinking assumption, a variable may appear in more than one account and be denominated differently.

2.1 Real sector

The national accounts balance identity states that total resources available equal total expenditure:

$$y_t + z_t = c_t^g + c_t^p + i_t^g + i_t^p + x_t \quad (\text{real side}), \quad (1)$$

and

$$Y_t + e_t Z_t = C_t^g + C_t^p + I_t^g + I_t^p + e_t X_t \quad (\text{nominal side}). \quad (2)$$

- Total resources in the real side consist of gross domestic product (GDP, y_t) and real imports of goods and non-factor services (z_t). Total expenditure comprises real government consumption (c_t^g), real private consumption (c_t^p), real government investment (i_t^g), real private investment (i_t^p) and real exports of goods and non-factor services (x_t).
- Total resources in the nominal side consist of nominal GDP (Y_t) and nominal imports of goods and non-factor services ($e_t Z_t$), where e_t denotes the period average exchange rate. Total expenditure comprises nominal government consumption (C_t^g), nominal private consumption (C_t^p), nominal government investment (I_t^g), nominal private investment (I_t^p) and nominal exports of goods and non-factor services ($e_t X_t$).

I assume that there exists a set of price indices $\{P_t^y, P_t^z, P_t^{c^g}, P_t^{c^p}, P_t^{i^g}, P_t^{i^p}, P_t^x\}$ such that each real variable in (1) is linked with its nominal counterpart in (2) as follows:

$$(Y_t, Z_t, C_t^g, C_t^p, I_t^g, I_t^p, X_t) = (y_t P_t^y, z_t P_t^z, c_t^g P_t^{c^g}, c_t^p P_t^{c^p}, i_t^g P_t^{i^g}, i_t^p P_t^{i^p}, x_t P_t^x), \quad (3)$$

where P_t^x and P_t^z are price indices in world market.

2.2 Government sector

The Fiscal Operations of the Central Government state that the government deficit is financed by foreign or domestic borrowing:

$$T_t - C_t^g - I_t^g + e_t \Delta F_t^g + \Delta D_t^g + \Delta B_t + e_t \varepsilon_t^g = 0. \quad (4)$$

The government deficit corresponds to government total revenue (T_t) less government total expenditure ($C_t^g + I_t^g$). Total financing comprises change in net foreign borrowing by the government (ΔF_t^g), change in net borrowing from domestic banks (ΔD_t^g), change in net borrowing from the private sector (ΔB_t) and external financing gap (ε_t^g).

2.3 External sector

The accounts of the balance of payments state that the sum of the current account and the capital and financial accounts equals the change in official foreign reserves (ΔR_t):

$$X_t - Z_t + Y_t^f + Y_t^{tr} + \Delta F_t^g + \Delta F_t^p + \varepsilon_t^g = \Delta R_t. \quad (5)$$

The current account balance consists of balance of goods and services ($X_t - Z_t$), net income (Y_t^f) and net current transfers (Y_t^{tr}). The capital and financial accounts consist of change in net foreign financing received by the government (ΔF_t^g), change in net foreign financing received by the private sector (ΔF_t^p) and government external financing gap (ε_t^g).

2.4 Monetary sector

Money market equilibrium is an identity that equates the demand for money (M_t^d) with supply of money (M_t^s):

$$M_t^d = M_t^s, \quad (6)$$

where

$$M_t^d = Q_t + J_t, \quad (7)$$

and

$$M_t^s = E_t R_t + D_t^g + D_t^p + \varepsilon_t^m. \quad (8)$$

The demand for money consists of net foreign assets ($E_t R_t$, where R_t is the net foreign assets expressed in foreign currency, and E_t the end-of-period exchange rate), net credit to the government (D_t^g), net credit to the private sector (D_t^p) and other items net (ε_t^m). The supply of money consists of currency in circulation (Q_t) and total deposits (J_t).

3 Solving the model

The model is a system made up of identities (2), (4), (5), (6), (7) and (8), and includes 31 variables:

$$\{y_t, c_t^g, c_t^p, i_t^p, i_t^g, x_t, z_t, Y_t, C_t^g, C_t^p, I_t^g, I_t^p, X_t, Z_t, Y_t^f, Y_t^{tr}, e_t, E_t, T_t, F_t^g, F_t^p, B_t, D_t^g, D_t^p, \varepsilon_t^g, M_t^d, M_t^s, Q_t, J_t, R_t, \varepsilon_t^m\}. \quad (9)$$

Solving the model consists first of specifying which variables are endogenous, and which ones are exogenous. An endogenous variable is a variable that depends on other variable within the model. Exogenous variable is one whose value is determined outside the model and is imposed on the model. There are also variables whose values are targeted or imposed by authorities. Those are policy variables. To complete the system, I introduce the so-called behavioral equation which expresses how a variable evolves with respect to another. Finally, I “close” each account by determining which variable is a residual, i.e., which one will absorb movements in the remaining components of the identity. Public or private closure means that the closure operates on government (g) or private (p) superscripted variables, respectively. Policy closure describes the process in which real GDP y_t is endogenous, all other variables are specified and the GDP growth rate $g_t := y_t/y_{t-1} - 1$ is expected to be determined somewhere in the process.

Firstly, I require the following variables to be exogenous:

$$\{Y_t^f, Y_t^{tr}, e_t, E_t, C_t^g, F_t^g, B_t, D_t^g\}. \quad (10)$$

The set of price indices introduced earlier is also an exogenous set:

$$\{P_t^y, P_t^z, P_t^{c^g}, P_t^{c^p}, P_t^{i^g}, P_t^{i^p}, P_t^x\}. \quad (11)$$

Unless otherwise specified, all newly introduced variables outside the set (9) are exogenous.

By (3), (10) and (11), I derive the real government consumption value:

$$c_t^g = \frac{C_t^g}{P_t^{c^g}}. \quad (12)$$

Next, real GDP and real exports of goods and non-factor services are determined using the exogenous growth rates g_t^y and g_t^x , respectively [1]. I have

$$y_t = (1 + g_t^y) y_{t-1} \quad (13)$$

and

$$x_t = (1 + g_t^x) x_{t-1}. \quad (14)$$

The corresponding nominal variables are

$$Y_t = y_t P_t^y \quad (15)$$

and

$$X_t = x_t P_t^x. \quad (16)$$

In the fiscal side, assume that a targeted revenue-to-GDP ratio τ_t is given. Then total revenue is obtained by

$$T_t = \tau_t Y_t. \quad (17)$$

Assume as well that a targeted government deficit in percent of GDP $\delta_t := \frac{T_t - C_t^g - I_t^g}{Y_t}$ is given. In this case, nominal government investment is obtained by

$$I_t^g = (\tau_t - \delta_t) Y_t - C_t^g. \quad (18)$$

The external financing gap is consequently a residual:

$$e_t \varepsilon_t^g = (e_t \Delta F_t^g + \Delta D_t^g + \Delta B_t) - (T_t - C_t^g - I_t^g). \quad (19)$$

In the real side, the value of the real government investment is derived from (18):

$$i_t^g = \frac{I_t^g}{P_t^{i^g}}. \quad (20)$$

Let $i_t := i_t^p + i_t^g$ denote the real gross investment. The World Bank's RMSM introduced a behavioral function which links the real gross investment with real GDP,

$$i_t = \begin{cases} \sigma_t (y_{t+1} - y_t) & \text{if } y_{t+1} - y_t > 0, \\ \rho_t y_t & \text{otherwise,} \end{cases} \quad (21)$$

where σ_t is an incremental capital-output ratio (ICOR) and ρ_t is an elasticity [1]. I deduce the values of real and nominal private investments:

$$i_t^p = i_t - i_t^g \quad (22)$$

and

$$I_t^p = i_t^p P_t^{i^p}. \quad (23)$$

Real imports of goods and non-factor services evolve according to a growth rate g_t^z ,

$$z_t = (1 + g_t^z) z_{t-1}, \quad (24)$$

such that g_t^z is described by the behavioral function

$$g_t^z = \alpha_t g_t^y + \beta_t \left(\frac{i_t^p}{i_{t-1}^p} - 1 \right) + \gamma_t \left(\frac{c_t^p}{c_{t-1}^p} - 1 \right), \quad (25)$$

where α_t , β_t and γ_t are elasticities [1]. Real private consumption is determined by combining (1) and (25):

$$c_t^p = \frac{y_t - c_t^g - i_t - x_t + z_{t-1} \left(1 + \alpha_t g_t^y + \beta_t \left(\frac{i_t^p}{i_{t-1}^p} - 1 \right) - \gamma_t \right)}{1 - \gamma_t \frac{z_{t-1}}{c_{t-1}^p}}. \quad (26)$$

I deduce the value of nominal imports of goods and non-factor services:

$$Z_t = z_t P_t^z. \quad (27)$$

Nominal private consumption is then a residual:

$$C_t^p = Y_t - (C_t^g + I_t^p + I_t^g + e_t X_t - e_t Z_t). \quad (28)$$

Let R_t^* denote the gross official reserve defined as $R_t^* = R_t + L_t$, where L_t denote the official foreign liabilities which is exogenous. Assume that R_t^* is determined through a desired gross official reserves in months of imports of goods and non-factor services $m_t := R_t^*/(Z_t/12)$. Then

$$R_t = m_t \left(\frac{Z_t}{12} \right) - L_t. \quad (29)$$

I deduce the change in foreign financing received by the private sector:

$$\Delta F_t^p = (R_t - R_{t-1}) - (X_t - Z_t + Y_t^f + Y_t^{tr}) - \Delta F_t^g - \varepsilon_t^g. \quad (30)$$

Let $M_t = M_t^d = M_t^d$ denote the demand for money which is described by the behavioral function

$$M_t = \frac{Y_t}{v_t}, \quad (31)$$

where v_t denotes the velocity of money. Currency in circulation and total deposits are determined by constant proportion with respect to M_t :

$$Q_t = \theta_t M_t \quad (32)$$

and

$$J_t = (1 - \theta_t) M_t. \quad (33)$$

Credit to the private sector is computed from a desired ratio with respect to GDP:

$$D_t^p = \omega_t Y_t. \quad (34)$$

If it is assumed that $\omega_{t-1} = \omega_t$ [12], then

$$\Delta D_t^p = \left(\frac{D_{t-1}^p}{Y_{t-1}} \right) \Delta Y_t. \quad (35)$$

Finally, other items net ε_t^m is a residual:

$$\varepsilon_t^m = M_t - E_t R_t - D_t^g - D_t^p. \quad (36)$$

4 Specification of the model

In this section, I describe a model for the economy of Madagascar. The models used by Madagascar are primarily inspired by the World Bank's RMSM and IMF's financial programming [4, 18]. They are based on an analysis of available regular data and rely on simple projection methods. Some of those methods are included here, and some are borrowed from existing models used in other countries [3, 7, 11, 13]. Nomenclature is that of the IMF for the Republic of Madagascar [10, Table 2., 3a., 4., 5., 6.].

4.1 National accounts

Variables in the real side are expressed at constant prices (base year is 2007 [9]) and those in the nominal side are at current prices, both in local currency (Ariary).

REAL GROSS DOMESTIC PRODUCT (GDP):

$$\text{GDP}_t = \text{CPV}_t + \text{CPB}_t + \text{IPV}_t + \text{IPB}_t + \text{XS}_t - \text{MS}_t, \quad (37)$$

where

- CPV: Real private consumption;
- CPB: Real government consumption;
- IPV: Real private investment;
- IPB: Real government investment;
- XS: Real exports of goods and non-factor services;
- MS: Real imports of goods and non-factor services.

GDP is also determined from a desired growth rate (gdp_g):

$$\text{GDP}_t = \text{GDP}_{t-1} \times (1 + \text{gdp_g}_t). \quad (38)$$

GDP PRICE INDEX (PGDP):

$$\text{PGDP}_t = \text{PGDP}_{t-1} \times (1 + \text{pgdp_g}_t), \quad (39)$$

where pgdp_g is an exogenous growth rate, and

$$\text{PGDP}_{t-1} = n\text{GDP}_{t-1}/\text{GDP}_{t-1}. \quad (40)$$

See (41) for $n\text{GDP}$.

NOMINAL GROSS DOMESTIC PRODUCT (nGDP):

$$\text{nGDP}_t = \text{nCPV}_t + \text{nCPB}_t + \text{nIPV}_t + \text{nIPB}_t + \text{nXS}_t - \text{nMS}_t, \quad (41)$$

where

- nCPV: Nominal private consumption;
- nCPB: Nominal government consumption;
- nIPV: Nominal private investment;
- nIPB: Nominal government investment;
- nXS: Nominal exports of goods and non-factor services;
- nMS: Nominal imports of goods and non-factor services.

Nominal GDP is also equal to real GDP (38) times GDP price index (39):

$$\text{nGDP}_t = \text{GDP}_t \times \text{PGDP}_t. \quad (42)$$

NOMINAL GOVERNMENT INVESTMENT (nIPB):

$$\text{nIPB}_t = \text{CAEX}_t, \quad (43)$$

where CAEX is Capital expenditure (65).

INVESTMENT PRICE INDEX (IPI):

$$\text{IPI}_t = \text{IPI}_{t-1} \times \text{el}_t \times (1 + \text{pgdp}_g), \quad (44)$$

where el is an elasticity which is determined exogenously, and

$$\text{IPI}_{t-1} = (\text{nIPB}_{t-1} + \text{nIPV}_{t-1}) / (\text{IPB}_{t-1} + \text{IPV}_{t-1}). \quad (45)$$

See (39) for pgdp_g.

REAL GOVERNMENT INVESTMENT (IPB):

$$\text{IPB}_t = \text{nIPB}_t / \text{IPI}_t. \quad (46)$$

See (43) and (44) for nIPB and IPI, respectively.

REAL PRIVATE INVESTMENT (IPV):

$$\text{IPV}_t = \text{ICOR}_t \times (\text{GDP}_{t+1} - \text{GDP}_t) - \text{IPB}_t, \quad (47)$$

where ICOR is a targeted incremental capital-output ratio. See (38) and (46) for GDP and IPB, respectively.

NOMINAL PRIVATE INVESTMENT (nIPV):

$$nIPV_t = IPV_t \times IPI_t. \quad (48)$$

See (44) and (47) and for IPI and IPV, respectively.

NOMINAL GOVERNMENT CONSUMPTION (nCPB):

$$nCPB_t = CUEX_t - INT_t, \quad (49)$$

where

- CUEX: Current expenditure (64);
- INT: Interest payments due to the public debt, foreign and domestic (64).

REAL GOVERNMENT CONSUMPTION (CPB):

$$CPB_t = CPB_{t-1} \times (nCPB_t/nCPB_{t-1})/(1 + cpi_g_t), \quad (50)$$

where cpi_g is the average annual inflation rate which is exogenous. See (49) for nCPB.

REAL EXPORTS OF GOODS AND NON-FACTOR SERVICES (XS):

$$XS_t = XS_{t-1} \times (1 + xs_g_t), \quad (51)$$

where xs_g is an exogenous growth rate.

REAL IMPORTS OF GOODS AND SERVICES (MS):

$$MS_t = MS_{t-1} \times (1 + c1 \times gdp_g_t + c2 \times (CPV_t/CPV_{t-1} - 1) + c3 \times (IPV_t/IPV_{t-1} - 1)). \quad (52)$$

N. Ponty (2018) gave the following estimation: $c1 = 0$, $c2 = 0.808$ and $c3 = 0.310$ [18]. See (38), (47) and (53) for gdp_g , IPV and CPV, respectively.

REAL PRIVATE CONSUMPTION (CPV):

$$CPV = (1/(1 - c2 \times MS_{t-1}/CPV_{t-1})) \times (GDP_t - CPB_t - IPV_t - IPB_t - XS_t + MS_{t-1} \times (1 - c2 + c3 \times (IPV_t/IPV_{t-1} - 1))). \quad (53)$$

See (38), (46), (47), (50) and (51) for GDP, IPB, IPV, CPB and XS, respectively.

NOMINAL EXPORTS OF GOODS AND NON-FACTOR SERVICES (nXS):

$$nXS_t = EXP_t \times ER_t, \quad (54)$$

where EXP is Exports of goods and services in the balance of payments (76), which is expressed in foreign currency. ER denotes the period average exchange rate which is exogenous.

NOMINAL IMPORTS OF GOODS AND NON-FACTOR SERVICES (nMS):

$$nMS_t = IMP_t \times ER_t, \quad (55)$$

where IMP is Imports of goods and services in the balance of payments (77), which is expressed in foreign currency. See (54) for the definition of ER.

NOMINAL PRIVATE CONSUMPTION (nCPV):

$$nCPV_t = nGDP_t - (nCPB_t + nIPB_t + nIPV_t + nXS_t - nMS_t). \quad (56)$$

See (42), (43), (48), (49), (54) and (55) for nGDP, nIPB, nIPV, nCPB, nXS and nMS, respectively.

CURRENT ACCOUNT BALANCE (CAB):

$$CAB_t = nGDP_t + ER_t \times (NETY_t + NTR_t) - nCPV_t - nCPB_t - nIPV_t - nIPB_t, \quad (57)$$

where

- NETY: Net income (74);
- NTRY: Net current transfers (74).

See (42), (43), (48), (49) and (56) for nGDP, nIPB, nIPV, nCPB and nCPV.

4.2 Fiscal Operations of the Central Government

Variables are expressed in Ariary.

TOTAL REVENUE (TREV):

$$TREV_t = TXR_t + NTXR_t + GRT_t. \quad (58)$$

where

- TXR: Tax revenue (59);

- NTXR: Non-tax revenue (60);
- GRT: Grants (61).

TAX REVENUE (TXR):

$$\text{TXR}_t = \text{tax_gdp}_t \times \text{nGDP}_t, \quad (59)$$

where tax_gdp is a desired tax-to-GDP ratio. See (42) for nGDP .

NON-TAX REVENUE (NTXR):

$$\text{NTXR}_t = \text{ntax_gdp}_t \times \text{nGDP}_t, \quad (60)$$

where ntax_gdp is a desired non-tax-to-GDP ratio. See (42) for nGDP .

GRANTS (GRT):

$$\text{GRT}_t = \text{CUGRT}_t + \text{CAGRT}_t, \quad (61)$$

where

- CUGRT: Current grants (exogenous);
- CAGRT: Capital grants (62).

CAPITAL GRANTS (CAGRT):

$$\text{CAGRT}_t = \text{PRJGRT}_t \times \text{ER}_t, \quad (62)$$

where PRJGRT is Project grant (80). See (54) for ER.

TOTAL EXPENDITURE (TOTEX):

$$\text{TOTEX}_t = \text{CUEX}_t + \text{CAEX}_t, \quad (63)$$

where

- CUEX: Current expenditure (64);
- CAEX: Capital expenditure (65).

CURRENT EXPENDITURE (CUEX):

$$\text{CUEX}_t = \text{WASA}_t + \text{INT}_t + \text{GOSE}_t + \text{TRSUB}_t + \text{NTO}_t + \text{ARR}_t, \quad (64)$$

where

- WASA: Wages and salaries (exogenous);

- INT: Interest payments due to the public debt, foreign and domestic (exogenous);
- GOSE: Goods and services (exogenous);
- TRSUB: Transfers and subsidies (exogenous);
- NTO: Net treasury operations (exogenous);
- ARR: Variation of domestic arrears (exogenous).

In practice, Variation of domestic arrears is not part of the current expenditure.

CAPITAL EXPENDITURE (CAEX):

$$CAEX_t = CAEXFF_t + CAEXDF_t, \quad (65)$$

where

- CAEXFF: Foreign financed capital expenditure (66);
- CAEXDF: Domestic financed capital expenditure (67).

FOREIGN FINANCED CAPITAL EXPENDITURE (CAEXFF):

$$CAEXFF_t = CAGRT_t + PRJDR_t \times ER_t, \quad (66)$$

where PRJDR is Project drawings (82). See (54) and (62) for ER and CAGRT, respectively.

DOMESTIC FINANCED CAPITAL EXPENDITURE (CAEXDF):

$$CAEXDF_t = TREV - CUEX_t - CAEXFF_t - gbal_gdp_t \times nGDP_t, \quad (67)$$

where gbal_gdp is a targeted (government) overall-balance-to-GDP ratio. See (42), (58), (64) and (66) for nGDP, TREV, CUEX and CAEXFF, respectively.

OVERALL BALANCE (GBAL):

$$GBAL_t = TREV_t - TOTEX_t. \quad (68)$$

See (58) and (63) for TREV and TOTEX, respectively.

TOTAL FINANCING (TOTFIN):

$$TOTFIN_t = FOBO_t + DOBO_t + FGAP_t, \quad (69)$$

where

- FOBO: Foreign borrowing (71);
- DOBO: Domestic borrowing (72);
- FGAP: Financing gap (73);

Total financing is also given by

$$\text{TOTFIN}_t = -\text{GBAL}_t. \quad (70)$$

FOREIGN BORROWING (FOBO):

$$\text{FOBO} = \text{FOFIG}_t \times \text{ER}_t, \quad (71)$$

where FOFIG is Foreign financing received by the government (82). See (54) for ER.

DOMESTIC BORROWING (DOBO):

$$\text{DOBO}_t = \text{BANK}_t + \text{NBANK}_t + \text{ODSRC}, \quad (72)$$

where

- BANK: Borrowing from monetary sector (exogenous);
- NBANK: Borrowing from non-monetary sector (exogenous);
- ODSRC: Borrowing from other domestic sources (exogenous).

FINANCIAL GAP (FGAP):

$$\text{FGAP}_t = -\text{GBAL} - \text{FOBO}_t - \text{DOBO}_t \quad (73)$$

See (68) and (69) for GBAL and TOTFIN, respectively.

4.3 Balance of payments

Variables are expressed in SDRs.

CURRENT ACCOUNT BALANCE (CAB\$):

$$\text{CAB\$}_t = \text{TRB}_t + \text{NETY}_t + \text{NTRY}_t. \quad (74)$$

where

- TRB: Trade balance (75);
- NETY: Net income (exogenous);

- NTRY: Net current transfers (exogenous).

TRADE BALANCE (TRB):

$$\text{TRB}_t = \text{EXP}_t - \text{IMP}_t, \quad (75)$$

where

- EXP: Exports of goods and services (76);
- IMP: Imports of goods and services (77).

EXPORTS OF GOODS AND SERVICES (EXP):

$$\text{EXP}_t = \text{XS}_t \times \text{XPI}_t, \quad (76)$$

where XPI is Exports price index in world market which is determined exogenously in the model. See (51) for XS.

IMPORTS OF GOODS AND SERVICES (IMP):

$$\text{IMP}_t = \text{MS}_t \times \text{MPI}_t, \quad (77)$$

where MPI is Imports price index in world market which is determined exogenously in the model. See (52) for MS.

CAPITAL AND FINANCIAL ACCOUNT BALANCE (KFAB):

$$\text{KFAB}_t = \text{KAB}_t + \text{FAB}_t, \quad (78)$$

where

- KAB: Capital account balance (79);
- FAB: Financial account balance (81).

CAPITAL ACCOUNT BALANCE (KAB):

$$\text{KAB}_t = \text{GOUV}_t + \text{OTHS}_t, \quad (79)$$

where

- GOUV: General government (80);
- OTHS: Other sectors (exogenous).

GENERAL GOVERNMENT (GOUV):

$$\text{GOUV}_t = \text{PRJGRT}_t + \text{OKTR}_t, \quad (80)$$

- PRJGRT: Project grant (exogenous);
- OKTR: Other capital transfers, net (exogenous).

FINANCIAL ACCOUNT BALANCE (FAB):

$$FAB_t = FDPI_t + FOFIG_t + FOFIPV_t + FOFIBK_t, \quad (81)$$

where

- FDPI: Foreign direct and portfolio investment (exogenous);
- FOFIG: Foreign financing received by the government (82);
- FOFIPV: Foreign financing received by the private sector (83);
- FOFIBK: Foreign financing received by the banking sector (exogenous).

FOREIGN FINANCING RECEIVED BY THE GOVERNMENT (FOFIG):

$$FOFIG = PRJDR_t + BDGS_t + AMORT_t, \quad (82)$$

where

- PRJDR: Project drawings (exogenous);
- BDGS: Budgetary support (exogenous);
- AMORT: Amortization (exogenous).

FOREIGN FINANCING RECEIVED BY THE PRIVATE SECTOR (FOFIPV):

$$FOFIPV_t = -BOPFIN_t - CAB_t - KAB_t - FDPI_t - FOFIG_t - FOFIBK_t, \quad (83)$$

where BOPFIN is the financing of the balance of payments (85). For simplicity, FOFIPV is a residual and includes the “Errors and omissions” entry. See (74), (79), (81), (82) and (85) for CAB, KAB, FDPI, FOFIG (FOFIBK, as well) and BOPFIN, respectively.

BALANCE OF PAYMENTS (BOP):

$$BOP_t = CAB\$_t + KFAB_t. \quad (84)$$

See (74) and (78) for CAB\$ and KFAB, respectively.

FINANCING OF THE BALANCE OF PAYMENTS (BOPFIN):

$$BOPFIN_t = \Delta NFA_CBK\$_t + FGAP\$_t, \quad (85)$$

where

- $\Delta NFA_CBK\$_t$: Change in net foreign assets of the Central bank (92);
- $FGAP\$$: Financing gap (88).

CHANGE IN NET FOREIGN ASSETS OF THE CENTRAL BANK ($\Delta NFA_CBK\$$):

$$\Delta NFA_CBK\$_t = -\Delta GOR_t + \Delta IMFCRD, \quad (86)$$

where

- ΔGOR : Change in gross official reserves / Other assets, net (87);
- $\Delta IMFCRD$: Change in short and long term loans / Use of IMF credit, net (exogenous).

CHANGE IN GROSS OFFICIAL RESERVES (ΔGOR):

$$\Delta GOR_t = mms_t \times (IMP/12) - GOR_{t-1}, \quad (87)$$

where mms is a targeted gross official reserves in months of imports of goods and non-factor services. See (77) for IMP .

FINANCING GAP ($FGAP\$$):

$$FGAP\$_t = FGAP_t/ER_t, \quad (88)$$

See (73) for $FGAP$.

4.4 Monetary accounts

Variables are measured in local currency at the end of period.

BROAD MONEY ($M3$):

$$M3_t = NFA_t + NDA_t, \quad (89)$$

where

- NFA : Net foreign assets (91);
- NDA : Net domestic assets (94).

Broad money is also given as the ratio of the nominal GDP (42) and a targeted velocity of money (vel):

$$M3_t = nGDP_t/vel_t. \quad (90)$$

See (42) for $nGDP$.

NET FOREIGN ASSETS (NFA):

$$NFA_t = NFA_CBK_t + NFA_BK_t, \quad (91)$$

where

- NFA_CBK: Net foreign assets of the Central Bank (92);
- NFA_BK: Net domestic of commercial banks (93).

NET FOREIGN ASSETS OF THE CENTRAL BANK (NFA_CBK):

$$NFA_CBK_t = (NFAB_CBK\$_{t-1} + \Delta NFAB_CBK\$_t) \times eopER_t, \quad (92)$$

where NFA_CBK\$ is the net foreign assets of the Central Bank which is expressed in foreign currency, and eopER is the end-of-period exchange rate (exogenous). See (86) for $\Delta NFAB_CBK\$$.

NET FOREIGN ASSETS OF COMMERCIAL BANKS (NFA_BK):

$$NFA_BK_t = (NFA_BK\$_{t-1} + FOFIBK_t) \times eopER_t, \quad (93)$$

where NFA_BK\$ is the net foreign assets of commercial banks which is expressed in foreign currency. See (81) and (92) for FOFIBK and eopER, respectively.

NET DOMESTIC ASSETS (NDA):

$$NDA_t = NCG_t + CRDE_t + OIN_t, \quad (94)$$

where

- NCG: Net credit to government (95);
- CRDE: Credit to the economy (96);
- OIN: Other items, net (97).

NET CREDIT TO GOVERNMENT (NCG):

$$NCG_t = NCG_{t-1} + BANK_t + OTC_t, \quad (95)$$

where OTC is Other credits which is exogenous. See (72) for BANK.

CREDIT TO THE ECONOMY (CRDE):

$$CRDE_t = crde_gdp_t \times NGDP_t, \quad (96)$$

where crde_gdp is a targeted credit-to-the-economy-to-GDP ratio which is determined by policy. See (42) for nGDP.

OTHER ITEMS NET (OIN):

$$\text{OIN}_t = \text{M3}_t - \text{NFA}_t - \text{NCG}_t - \text{CRDE}_t. \quad (97)$$

See (90), (91), (95) and (96) for M3, NFA, NCG and CRDE, respectively.

CURRENCY IN CIRCULATION (CUCI):

$$\text{CUCI}_t = \text{cuci_m3}_t \times \text{M3}_t, \quad (98)$$

where cuci_m3 is a desired currency-in-circulation-to-M3 ratio. See (90) for M3.

TOTAL DEPOSIT (TOTDEP):

$$\text{TOTDEP}_t = \text{M3}_t - \text{CUCI}_t, \quad (99)$$

See (90) and (98) for M3 and CUCI, respectively.

5 Data and simulation

5.1 Data sources

The National Institute of Statistics of Madagascar (INSTAT) provides the national accounts data for the period from 2007 to 2020 [9]. The General Directorate of Economy and Plan are in charge of the estimation for the current year, as well as a short term projection of the real sector data which are available in their annual economic and financial report [5]. The General Directorate of Treasury are responsible for the conception of the Fiscal Operations of the Central Government [6]. Monetary survey is published by the Central Bank of Madagascar [2]. Note that in practice, the data are not necessarily consistent with the interrelation because of the difference in accounting methods by the different entities.

5.2 Simulation

In this subsection, I partially replicate the tables relating to Madagascar's macroeconomic framework for the initial budget law (LFI) of 2022 [15, p. 16–21]. I retrieve the exogenous parameters and variables, and then I compute the endogenous variables as indicated in section 4. For the national accounts, in particular, I use mobile average to forecast the price elasticity in the investment price index (44) as well as the growth rate of the exports of goods and non-factor services (51), see Table 1. The real private investments are determined as follows: the values of the incremental capital-output ratio (ICOR) are projected by targeting the private investment share in nominal GDP in the LFI (I assume

that $\text{gdp_g}_{2024} = \text{gdp_g}_{2025}$ so that by (38), formula (47) can be properly applied for $t = 2024$). The Fiscal Operations of the Central Government are given in Table 2. Note that the aggregate values in the Balance of payments (Table 3) and in the Monetary accounts (Table 4) are reported differently compared to those in the LFI of 2022 because of an accounting method which is specific to a particular external financing [16].

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	2019	2020	2021	2022	2023	2024
	Actual		Est.*	Projections		
<i>(Billions of Ariary)</i>						
<i>Real side</i>						
GDP at constant prices	21880.9	20318.5	21038.3	22164.0	23937.1	25971.7
Consumption	16706.8	17302.3	16903.9	14813.7	9197.0	21568.0
Government	1022.6	972.1	1287.9	1249.3	1222.7	1335.8
Private	15684.2	16330.2	15616.1	13564.3	7974.3	20232.2
Investment	7496.4	6977.8	9912.4	12725.7	16775.0	17976.7
Government	2123.1	3472.7	3678.1	4525.1	5894.9	6313.7
Private	5373.3	3505.1	6234.3	8200.6	10880.1	11663.0
Net exports	-2322.3	-3961.7	-5778.1	-5375.4	-2034.9	-13573.0
Exports of goods and non-factor services	10097.8	6398.4	6721.4	7021.6	7492.2	8000.1
Imports of goods and non-factor services	12420.1	10360.0	12499.5	12397.0	9527.1	21573.1
<i>Nominal side</i>						
GDP at current prices	51035.2	49453.2	54327.1	60261.8	68616.8	78387.6
Consumption	43891.7	47050.7	48383.1	49519.1	51792.7	57924.8
Government	4845.2	4353.1	6114.3	6311.0	6564.4	7610.3
Private	39046.5	42697.6	42268.8	43208.2	45228.4	50314.5
Investment	10079.3	6716.5	10786.5	15561.5	23317.1	28219.5
Government	2854.6	3342.7	4002.4	5533.5	8193.8	9911.1
Private	7224.7	3373.9	6784.1	10028.1	15123.3	18308.4
Net exports	-2935.8	-4314.0	-4842.6	-4818.8	-6493.0	-7756.7
Exports of goods and non-factor services	14506.5	9957.4	12586.3	15390.9	18076.7	20946.0
Imports of goods and non-factor services	17442.3	14271.4	17429.0	20209.7	24569.8	28702.7
<i>(Percent change, unless otherwise indicated)</i>						
<i>Memorandums items</i>						
GDP at constant prices	4.4	-7.1	3.5	5.4	8.0	8.5
Exports at constant prices	10.9	-36.6	5.0	4.5	6.7	6.8
GDP price index	6.5	4.4	6.1	5.3	5.4	5.3
Average annual inflation rate	5.6	4.2	6.0	6.4	6.3	6.1
Investment price index	14.3	-28.4	13.1	12.4	13.7	12.9
ICOR (no unit)	-4.8	9.7	8.8	7.2	8.2	8.1
Current account balance (percent of GDP)	-3.3	-4.9	-5.5	-4.8	-6.4	-7.3

**Est.: Estimation*

Table 1: National accounts 2019–2024.

	2019	2020	2021	2022	2023	2024
	Actual		Est.	Projections		
	<i>(Billions of Ariary)</i>					
Total revenue	7359.0	6320.7	6978.3	8741.9	10794.2	13641.4
Tax revenue	5627.9	4898.2	5889.0	7282.0	9565.9	12445.6
Non-tax revenue	144.3	179.8	164.9	174.6	185.7	214.5
Grants	1586.8	1242.7	924.4	1285.3	1042.6	981.3
Current grants	365.1	434.7	0.4	47.3	0.0	0.0
Capital grants	1221.7	808.0	924.0	1238.0	1042.6	981.3
Total expenditure	8055.8	8057.3	10550.9	12394.9	15386.3	18111.5
Current expenditure	5201.2	4714.6	6548.4	6861.4	7192.5	8200.4
Wages and salaries	2489.6	2785.9	3048.8	3510.9	3758.3	4341.1
Interest payments due to the public debt	356.0	361.6	434.1	550.4	628.1	590.1
Goods and services	314.0	338.3	448.6	513.9	537.4	620.8
Transfers and subsidies	1584.1	1891.9	1882.6	1839.2	1837.9	2122.9
Net treasury operations	332.3	-443.6	647.2	417.0	400.8	495.5
Variation of domestic arrears*	125.2	-219.5	87.0	30.0	30.0	30.0
Capital expenditure	2854.6	3342.7	4002.4	5533.5	8193.8	9911.1
Domestic financed	748.7	1449.9	1396.3	1947.5	3717.2	4716.6
Foreign financed	2105.9	1892.8	2606.1	3586.0	4476.6	5194.5
Overall balance	-696.8	-1736.6	-3572.5	-3653.0	-4592.1	-4470.1
Total financing	696.8	1736.6	3572.5	3653.0	4592.1	4470.1
Foreign borrowing	655.1	885.4	1849.0	1910.0	2748.8	3391.8
Domestic borrowing	41.7	851.2	1723.5	1743.0	333.3	-117.1
Bank	-31.0	596.6	1772.5	1744.6	306.2	-121.9
Non-bank	-13.0	-72.1	-49.0	-1.6	27.1	4.8
Other domestic borrowing	85.7	326.7	0.0	0.0	0.0	0.0
Financing gap	0.0	0.0	0.0	0.0	1510.0	1195.5
	<i>(Percent of GDP)</i>					
<i>Memorandums items</i>						
Tax revenue	11.0	9.9	10.8	12.1	13.9	15.9
Non-tax revenue	0.3	0.4	0.3	0.3	0.3	0.3
Overall balance	-1.4	-3.5	-6.6	-6.1	-6.7	-5.7

Table 2: Fiscal Operations of the Central Government, 2019–2024.

	2019	2020	2021	2022	2023	2024
	Actual		Est.	Projections		
	<i>(Millions of SDRs)</i>					
Current account balance	-233.6	-481.6	-543.5	-518.9	-768.6	-979.3
Trade balance	-482.3	-839.8	-882.5	-856.4	-1131.7	-1328.1
Exports of goods and services	2926.3	1845.9	2293.6	2735.4	3150.7	3586.4
Imports of goods and services	-3408.5	-2685.7	-3176.0	-3591.8	-4282.4	-4914.6
Net income	-329.2	-275.6	-235.5	-252.9	-273.6	-333.6
Net current transfers	577.8	633.8	574.5	590.4	636.7	682.5
Capital and financial account	147.7	350.6	709.6	404.1	499.9	828.2
Capital account	244.4	153.3	168.4	220.0	181.7	168.0
General government	244.4	153.3	168.4	220.0	181.7	168.0
of which: Project grant	244.4	153.3	168.4	220.0	181.7	168.0
Other sectors	0.0	0.0	0.0	0.0	0.0	0.0
Financial account	-96.7	197.3	541.2	184.1	318.2	660.1
Foreign direct and portfolio investment	270.1	172.1	177.4	203.4	246.5	363.6
Government	131.0	168.0	336.9	339.5	479.1	580.8
Project drawings	176.9	205.8	306.5	417.3	598.5	721.4
Budgetary support	1.1	14.6	99.7	26.7	0.0	0.0
Amortization	-46.9	-52.4	-69.3	-104.5	-119.4	-140.7
Commercial banks	11.9	-94.5	22.1	0.0	0.0	0.0
Private sector (incl. err. and omm.)	-509.7	-48.4	4.7	-358.7	-407.4	-284.2
Overall balance	-85.9	-131.0	166.1	-114.8	-268.7	-151.1
Financing	85.9	131.0	-166.1	114.8	268.7	151.1
Central bank	85.9	131.0	-166.1	114.8	5.5	-53.6
Use of IMF credit, net	58.6	274.9	86.9	26.9	11.7	-10.0
Other assets, net	27.3	-143.9	-253.0	88.0	-6.2	-43.6
Financing gap	0.0	0.0	0.0	0.0	263.2	204.7
	<i>(Units as indicated)</i>					
<i>Memorandums items</i>						
Gross official reserves (millions of SDRs)	1193.9	1337.8	1590.8	1502.9	1509.0	1552.6
Months of imports of goods and non-factor services	4.2	6.0	6.0	5.0	4.2	3.8
Short and long terms loans (millions of SDRs)	409.8	684.8	771.7	798.5	810.2	800.2
Period average exchange rate (Ariary/SDR)	4998.9	5270.0	5487.7	5626.6	5737.4	5840.3

Table 3: Balance of payments, 2019–2024.

	2019	2020	2021	2022	2023	2024
	Dec.	Dec.	Dec.	Dec.	Dec.	Dec.
	Actual		Est.	Projections		
	<i>(Billions of Ariary)</i>					
Broad Money	12659.3	14190.3	16718.4	19868.3	21885.1	23965.0
Currency in circulation	3314.8	3570.2	3853.7	4146.9	4449.1	4912.8
Total deposits	9344.6	10620.1	12864.6	15721.4	17436.0	19052.2
Net foreign assets	4614.2	4876.3	5762.6	5169.0	5239.1	5647.6
Central bank	3925.0	3597.3	4586.5	3981.6	4028.3	4415.1
Commercial banks	689.2	1279.1	1176.1	1187.4	1210.8	1232.5
Net domestic assets	8045.1	9314.0	10955.8	14699.3	16646.1	18317.4
Net credit to the government	2074.2	2893.0	4691.0	5051.5	5357.7	5235.8
Bank	2012.6	2608.5	4380.9	4741.4	5047.6	4925.7
Other credit	61.5	284.6	310.1	310.1	310.1	310.1
Credit to the economy	7050.6	7792.3	8910.5	10247.1	11815.9	13639.4
Other items, net	-1079.7	-1371.3	-2645.8	-599.3	-527.6	-557.8
	<i>(Units as indicated)</i>					
<i>Memorandums items</i>						
Velocity of money	4.0	3.5	3.2	3.0	3.1	3.3
Credit to the economy (percent of GDP)	13.8	15.8	16.4	17.0	17.2	17.4
Currency in circulation (percent of M3)	26.2	25.2	23.1	20.9	20.3	20.5
Total deposits (percent of M3)	73.8	74.8	76.9	79.1	79.7	79.5
End-of-period exchange rate (Ariary/SDR)	5006.2	5508.8	5599.4	5653.2	5764.5	5867.9
	<i>(Millions of SDRs)</i>					
Net foreign assets	921.7	885.2	1029.2	914.3	908.8	962.4
Central bank	784.0	653.0	819.1	704.3	698.8	752.4
Commercial banks	137.7	232.2	210.0	210.0	210.0	210.0

Table 4: Monetary Accounts, 2019–2024.