The 2019 Merged model for Madagascar

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THE 2019 MERGED MODEL FOR MADAGASCAR

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Abstract. This document gives the specification of the Merged model for Madagascar. The model is initialized and calibrated based on a 2019 social accounting matrix framework and an auxiliary set of 2018–2019 macroeconomic data.

Keywords: merged model, macroeconomic framework, accounting framework.

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1. Introduction

This document aims to provide a brief illustration on how the Merged model [1, 2, 3] can be adapted to the economy of Madagascar, with the base year set to 2019. The four main sectors of the model include the goods market and private sector budget, the central government budget, the money market, and the balance of payments. The corresponding accounting framework describes a small open economy, and can be read from the real social accounting matrix (RSAM) and the financial social accounting matrix (FSAM) in Table 3 and 4, respectively.

2. The 2019 Merged model specification for Madagascar

2.1. **The model equations.** The main equations of the 2019 Merged model consist of eq. (1) to (33). Variables defined by the intermediate equations (34)–(49) are usually exogenous, but for the purpose of this project, they are defined either by simple behavior equations inherited by former model [4], or by specific accounting rules (e.g.: eq. (41)).

2.1.1. *Goods market and private sector budget equations.*

- Agricultural GDP:
$$AGRGDP_t = (1 + \gamma_{AGR})\, AGRGDP_{t-1}. \tag{1}$$
- Industrial GDP:
$$INDGDP_t = (1 + \gamma_{IND})\, INDGDP_{t-1}. \tag{2}$$
- Service GDP:
$$SVCGDP_t = (1 + \gamma_{SVC})\, SVCGDP_{t-1}. \tag{3}$$
- Indirect Taxes:
$$ITAX_t = (1 + \gamma_{ITAX})\, ITAX_{t-1}. \tag{4}$$
- Real aggregate GDP:
$$GDP_t = AGRGDP_t + INDGDP_t + SCVGDP_t + ITAX_t. \tag{5}$$
- Export demand:
$$X_t = (1 + \gamma_X)\, X_{t-1}. \tag{6}$$
- Investment demand:
$$IV_t = \kappa_0 GDP_{t-1} + \kappa_1 \Delta GDP_t. \tag{7}$$

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- Import demand:

$$\log(M_t) = \mu_0 + \mu_1 \log(GDP_t) + \mu_2 \log\left(e_t MPI_t / PD_t\right). \tag{8}$$

- Aggregate consumption:

$$C_t = CP_t + CG_t \tag{9}$$

- Aggregate investment:

$$IV_t = IVP_t + IVG_t. \tag{10}$$

- Private consumption:

$$P_t CP_t = (1 - \rho_{SP}) GDYP_t. \tag{11}$$

- Nominal GDP:

$$NGDP_t = P_t GDP_t. \tag{12}$$

- Material balance:

$$NGDP_t = P_t(C_t + IV_t) + e_t(X_t XPI_t - M_t MPI_t). \tag{13}$$

- Private disposable income:

$$GDYP_t = NGDP_t + e_t(OTHFSY_t + OTHCTR_t) + INDG_t - TG_t. \tag{14}$$

- Private savings:

$$SP_t = GDYP_t - P_t CP_t. \tag{15}$$

- Private borrowing requirement:

$$BRP_t = P_t IVP_t - SP_t. \tag{16}$$

2.1.2. *Government budget equations.*

- Government current savings:

$$SG_t = GT_t + e_t(NTRG_t - INFG_t) - INDG_t - P_t CG_t. \tag{17}$$

- Government borrowing requirement:

$$BRG_t = P_t IVG_t - SG_t. \tag{18}$$

- Government financing:

$$BRG_t = e_t(KTRG_t + \Delta NFDG_t) + \Delta DCG_t + \Delta BG_t. \tag{19}$$

- Government net foreign debt:

$$NFDG_t = \rho_F X_t XPI_t. \tag{20}$$

- Government net domestic debt:

$$NDDG_t = NDDG_{t-1} + \Delta DCG_t + \Delta BG_t. \tag{21}$$

2.1.3. *Money market equations.*

- Money demand:

$$MD_t = (1/\upsilon_M) NGDP_t. \tag{22}$$

- Money supply:

$$\Delta MS_t = E_t \Delta R_t + \Delta DCG_t + \Delta DCP_t + R_{t-1} \Delta E_t. \tag{23}$$

- Foreign exchange reserve accumulation:

$$R_t = (\delta_R/12) M_t MPI_t. \tag{24}$$

- Domestic credit:

$$DC_t = DCG_t + DCP_t. \tag{25}$$

- Money Market equilibrium:

$$MS_t = MD_t. \tag{26}$$

2.1.4. *The balance of payments equations.*

- Resource balance:

$$RESBAL_t = X_t XPI_t - M_t MPI_t. \tag{27}$$

- Net factor service income:

$$NETFSY_t = OTHFSY_t - INFG_t. \tag{28}$$

- Net current transfers:

$$NETCTR_t = OTHCTR_t + NTRG_t. \tag{29}$$

- Current account balance:

$$CURBAL_t = RESBAL_t + NETFSY_t + NETCTR_t. \tag{30}$$

- Balance of payments:

$$\Delta R_t = CURBAL_t + KTRG_t + OTHKTR_t + FDI + \Delta NFDG_t + \Delta NFDP_t. \tag{31}$$

2.1.5. *Interest payments equations.*

- Government domestic interest payments:

$$INDG_t = \iota_D NDDG_{t-1}. \tag{32}$$

- Government foreign interest payments:

$$INFG_t = \iota_F NFDG_{t-1}. \tag{33}$$

2.1.6. *Intermediate equations.*

- GDP deflator:

$$PD_t = (1 + \gamma_{PD}) PD_{t-1}. \tag{34}$$

- Imports price index:

$$MPI_t = (1 + \gamma_{MPI}) MPI_{t-1} \tag{35}$$

- Exports price index:

$$XPI_t = (1 + \gamma_{XPI}) XPI_{t-1}. \tag{36}$$

- End-of-period exchange rate:

$$E_t = (1 + \gamma_E) E_{t-1}. \tag{37}$$

- Period average exchange rate:

$$e_t = (E_t + E_{t-1})/2. \tag{38}$$

- Government domestic revenue:

$$TG_t = TGtoY_t NGDP_t. \tag{39}$$

- Aggregate government investment:

$$IVG_t = (DIVG_t + FIVG_t)/P_t. \tag{40}$$

- Domestic financed capital expenditure:

$$DIVG_t = DIVGtoY_t NGDP_t. \tag{41}$$

- Foreign financed capital expenditure:

$$FIVG_t = e_t \left(KTRG_t + \rho_{PL} \Delta NFDG_t \right). \tag{42}$$

- Government net borrowing from the private sector:

$$\Delta BG_t = \Delta BG_{t-1} (GDYP_t / GDYP_{t-1}). \tag{43}$$

- Other factor service income:

$$OTHFSY_t = OTHFSY_{t-1} (NGDP_t / NGDP_{t-1}) / (e_t / e_{t-1}). \tag{44}$$

- Government net current transfers from abroad:

$$NTRG_t = NTRGtoY_t NGDP_t. \tag{45}$$

- Other current transfers from abroad:

$$OTHCTR_t = OTHCTR_{t-1} (NGDP_t / NGDP_{t-1}) / (e_t / e_{t-1}). \tag{46}$$

- Government net capital transfers from abroad:

$$KTRG_t = KTRG_{t-1} (NGDP_t / NGDP_{t-1}) / (e_t / e_{t-1}). \tag{47}$$

- Other capital transfers from abroad:

$$OTHKTR_t = OTHKTR_{t-1}(NGDP_t/NGDP_{t-1})/(e_t/e_{t-1}). \tag{48}$$

- Foreign direct investment:

$$FDI_t = FDI_{t-1}(IVP_t/IVP_{t-1})(P_t/P_{t-1})/(e_t/e_{t-1}). \tag{49}$$

2.2. **Symbols and values.**

$AGRDGP$: Agricultural GDP — Calculated from eq. (1).
BRG : Government borrowing requirement — Calculated from eq. (18).
BRP : Private borrowing requirement — Calculated from eq. (16).
C : Aggregate consumption — Calculated from eq. (13).
CP : Private consumption — Calculated from eq. (11).
CG : Government consumption — Calculated from eq. (9).
$CURBAL$: Current account balance — Calculated from eq. (30).
DC : Total domestic credit taking — Calculated from eq. (23).
DCG : Government domestic credit taking — Calculated from eq. (19).
DCP : Private domestic credit taking (including other items [net]) — Calculated from eq. (25).
$DIVG$: Domestic financed capital expenditure — Calculated from eq. (41).
$DIVGtoY$: Domestic financed capital expenditure-to-GDP ratio — Exogenous.
e : Period average exchange rate — Calculated from eq. (38).
E : End-of-period exchange rate — Calculated from eq. (37).
FDI : Foreign direct investment (including portfolio investment) — Calculated from eq. (49).
$FIVG$: Foreign financed capital expenditure — Calculated from eq. (42).
GDP : Real aggregate GDP — Calculated from eq. (5).
$GDYP$: Private disposable income — Calculated from eq. (14).
$INDGDP$: Industrial GDP — Calculated from eq. (2).
$INDG$: Government net domestic interest payments — Calculated from eq. (32).
$INFG$: Government net foreign interest payments — Calculated from eq. (33).
$ITAX$: Indirect taxes — Calculated from eq. (4).
IV : Aggregate investment — Calculated from eq. (7).
IVG : Government investment (capital expenditure) — Calculated from eq. (40).
IVP : Private investment — Calculated from eq. (10).
$KTRG$: Government net capital transfers from abroad (capital grant) — Calculated from eq. (47).
M : Imports of goods and non-factor services — Calculated from eq. (8).
$NDDG$: Government net domestic debt — Calculated from eq. (21).
$NETFSY$: Net factor service income — Calculated from eq. (28).
$NFDG$: Government net foreign debt — Calculated from eq. (20).
$NGDP$: Nominal GDP — Calculated from eq. (12).
$NTRG$: Government net current transfers from abroad (current grant) — Calculated from eq. (45).
$NTRGtoY$: Government net current transfers from abroad-to-GDP ratio — Exogenous.
$OTHCTR$: Other current transfers from abroad — Calculated from eq. (46).
$OTHFSY$: Other factor service income — Calculated from eq. (44).
$OTHKTR$: Other capital transfers from abroad — Calculated from eq. (48).
P : Absorption deflator — Calculated from eq. (13).
PD : GDP deflator — Calculated from eq. (34).
R : Net foreign exchange reserve holdings — Calculated from eq. (24).
$RESBAL$: Resource balance — Calculated from eq. (27).
SG : Government savings — Calculated from eq. (17).
SP : Private savings — Calculated from eq. (17).
$SVCGDP$: Service GDP — Calculated from eq. (3).
TG : Government domestic revenue (fiscal and non-fiscal revenue) — Calculated from eq. (39).
$TGtoY$: Government domestic revenue-to-GDP ratio — Exogenous.
X : Exports of goods and non-factor services — Calculated from eq. (6).
ΔDC : Change in total domestic credit taking — Calculated from eq. (23).
ΔDCG : Change in government domestic credit taking — Calculated from eq. (19).
ΔDCP : Change in private domestic credit taking — Calculated from eq. (25).
ΔE : Change in end-of-period exchange rate — Calculated from eq. (37).

ΔBG : Change in government net borrowing from the private sector — Calculated from eq. (43).
$\Delta NDDG$: Change in government net domestic debt — Calculated from eq. (21).
$\Delta NFDG$: Change in government net foreign debt — Calculated from eq. (20).
$\Delta NFDP$: Change in private net foreign debt (incl. errors and omission) — Calculated from eq. (31).
ΔR : Change in net foreign exchange reserve holdings — Calculated from eq. (24).

TABLE 1. Parameters and values.

Parameter	Description	Value
γ_{AGR}	Growth rate of Agricultural GDP	0.059*
γ_{IND}	Growth rate of Industrial GDP	0.068*
γ_{SVC}	Growth rate of Service GDP	0.050*
γ_{ITAX}	Growth rate of indirect taxes	−0.075*
γ_X	Growth rate of exports of goods and non-factor services	0.047*
γ_E	Growth rate of end-of period exchange rate	0.011**
γ_{PD}	Growth rate of GDP deflator	0.065**
γ_{MPI}	Growth rate of import price index	0.042**
γ_{XPI}	Growth rate of export price index	0.044**
κ_0	Investment demand parameter with respect to lagged GDP	0.030*
κ_1	Investment demand parameter with respect to GDP growth	4.209**
μ_0	Import demand level parameter	0.495*
μ_1	Import demand elasticity with respect to GDP	0.843**
μ_2	Import demand elasticity with respect to relative import prices	−1.000**
ρ_{SP}	Private average savings propensity	0.160*
ρ_F	Government net foreign debt-to-exports ratio	0.807*
ρ_{PL}	Share of government project loans to $\Delta NFDG$	1.350*
υ_M	Velocity of money circulation	4.031*
ι_D	Government domestic interest rate	0.068*
ι_F	Government foreign interest rate	0.010*
δ_R	Reserve in months of imports of goods and non-factor services	3.170*

* Calibrated based on base year data; ** Estimated/Selected from a reasonable range of values

3. Data sources

Data for 2018 and 2019 are compiled from various official sources which include

- The Central Bank of Madagascar:
  - (balance of payments) https://www.banky-foibe.mg/_rapport-annuel
  - (monetary survey) https://www.banky-foibe.mg/vente_bulletin-de-bfm
- The Ministry of Economy and Finance:
  - (Central government budget account) http://www.tresorpublic.mg/?page_id=214&content=temp&type=ogt
  - (stock of debt) http://www.tresorpublic.mg/?page_id=214&content=temp&type=bsd
- The National Institute of Statistics of Madagascar:
  - (national accounts) https://instat.mg/statistiques/bases-de-donnees/comptes-nationaux

The data must be highly aggregated in order to be consistent with the framework base year. The resulting RSAM and FSAM are shown in Table 5 and 6, respectively. Auxiliary data in Table 7 are also needed in order to initialize some variables and calibrate the parameters (Table 1).

4. Simulating the model in R

The following script requires that the RSAM, FSAM and the auxiliary data are saved as comma-separated values (csv) files.

```
rm(list = ls(all = TRUE))
T = 7 # (2019 to 2025)
RSAM <- read.table("RSAM.csv", row.names = 1, header = TRUE, sep = ";")
FSAM <- read.table("FSAM.csv", row.names = 1, header = TRUE, sep = ";")
```

```r
AUX  <- read.table("AUXDATASET.csv", row.names = 1, header = TRUE, sep = ";")

AER <- vector(length = T)
BRG <- vector(length = T)
BRP <- vector(length = T)
CN  <- vector(length = T)
CNG <- vector(length = T)
CNP <- vector(length = T)
CURBAL <- vector(length = T)
D_NFDP <- vector(length = T)
D_BG <- vector(length = T)
DC  <- vector(length = T)
DCG <- vector(length = T)
DCP <- vector(length = T)
DIVG <- vector(length = T)
DIVG_Y <- vector(length = T)
EER <- vector(length = T)
FDI <- vector(length = T)
FIVG <- vector(length = T)
g_gdp <- vector(length = T)
GDP <- vector(length = T)
GDP_AGR <- vector(length = T)
GDP_IND <- vector(length = T)
GDP_SVC <- vector(length = T)
GDYP <- vector(length = T)
INDG <- vector(length = T)
INFG <- vector(length = T)
ITAX <- vector(length = T)
IV  <- vector(length = T)
IVG <- vector(length = T)
IVP <- vector(length = T)
KTRG <- vector(length = T)
MD  <- vector(length = T)
MGS <- vector(length = T)
MPI <- vector(length = T)
NDDG <- vector(length = T)
NETCTR <- vector(length = T)
NETFSY <- vector(length = T)
NFDG <- vector(length = T)
NGDP <- vector(length = T)
NTRG <- vector(length = T)
NTRG_Y <- vector(length = T)
OTHFSY <- vector(length = T)
OTHKTR <- vector(length = T)
OTHNTR <- vector(length = T)
PA <- vector(length = T)
PD <- vector(length = T)
RES <- vector(length = T)
RESBAL <- vector(length = T)
SG <- vector(length = T)
SP <- vector(length = T)
TG <- vector(length = T)
TG_Y <- vector(length = T)
XGS <- vector(length = T)
XPI <- vector(length = T)
```

```
g_AGR  <- AUX['GDP_AGR','B2019']/AUX['GDP_AGR','B2018'] - 1
g_IND  <- AUX['GDP_IND','B2019']/AUX['GDP_IND','B2018'] - 1
g_SVC  <- AUX['GDP_SVC','B2019']/AUX['GDP_SVC','B2018'] - 1
g_ITAX <- AUX['ITAX','B2019']/AUX['ITAX','B2018'] - 1
g_XGS  <- AUX['XGS','B2019']/AUX['XGS','B2018'] - 1
g_PD   <- 0.065
g_XPI  <- 0.044
g_MPI  <- 0.042
g_EER  <- 0.011
k1 <-  4.209
m1 <-  0.843
m2 <- -1.000

for (i in 1:T) {
  if (i == 1) {
    for (iterations in 1:10) {
      # Reading the SAM and the FSAM
      CNG[i] <- RSAM['COM','STAT']/PA[i]
      CNP[i] <- RSAM['COM','PRV']/PA[i]
      IVG[i] <- RSAM['COM','GCAP']/PA[i]
      IVP[i] <- RSAM['COM','PCAP']/PA[i]
      XGS[i] <- RSAM['COM','ROW']/(AER[i]*XPI[i])
      NGDP[i] <- RSAM['PRV','COM']
      INDG[i] <- RSAM['PRV','DFIN']
      OTHNTR[i] <- RSAM['PRV','ROW']/AER[i] - OTHFSY[i]
      TG[i] <- RSAM['STAT','PRV']
      NTRG[i] <- RSAM['STAT','ROW']/AER[i]
      SG[i]  <- RSAM['GCAP','STAT']
      BRG[i] <- RSAM['GCAP','ACAP']
      SP[i]  <- RSAM['PCAP','PRV']
      BRP[i] <- RSAM['PCAP','ACAP']
      CURBAL[i] <- -RSAM['ACAP','ROW']/AER[i]
      INFG[i] <- RSAM['FFIN','STAT']/AER[i]
      MGS[i] <- RSAM['ROW','COM']/(AER[i]*MPI[i])
      MD[i]  <- AUX['MD','B2018'] + FSAM['DFIN','PFIN']
      RES[i] <- AUX['RES','B2018'] + FSAM['FFIN','DFIN']/EER[i]
      FDI[i] <- FSAM['FFDI','FFIN']/AER[i]
      DCG[i] <- AUX['DCG','B2018'] + FSAM['GFIN','DFIN']
      NFDG[i] <- AUX['NFDG','B2018'] + FSAM['GFIN','FFIN']/AER[i]
      D_BG[i] <- FSAM['GFIN','PFIN']
      KTRG[i] <- FSAM['GFIN','CAPGAIN']/AER[i]
      NDDG[i] <- AUX['NDDG','B2018'] + FSAM['GFIN','DFIN'] + D_BG[i]
      DCP[i]  <- AUX['DCP','B2018'] + FSAM['PFIN','DFIN']
      D_NFDP[i] <- FSAM['PFIN','FFIN']/AER[i]
      OTHKTR[i] <- FSAM['GFIN','CAPGAIN']/AER[i] - KTRG[i]

      # Goods market and private sector budget
      GDP_AGR[i] <- AUX['GDP_AGR','B2019']
      GDP_IND[i] <- AUX['GDP_IND','B2019']
      GDP_SVC[i] <- AUX['GDP_SVC','B2019']
      ITAX[i] <- AUX['ITAX','B2019']
      GDP[i]  <- GDP_AGR[i] + GDP_IND[i] + GDP_SVC[i] + ITAX[i]
      PD[i] <- NGDP[i]/GDP[i]
      IV[i] <- IVG[i] + IVP[i]
      CN[i] <- CNG[i] + CNP[i]
      g_gdp[i] <- AUX['GDP','B2019']/AUX['GDP','B2018'] - 1
```

```
    k0 <- IV[i]/AUX['GDP','B2018'] - k1*g_gdp[i]
    m0 <- log(MGS[i]) - m1*log(GDP[i]) - m2*log(MPI[i]*AER[i]/PD[i])
    GDYP[i] <- SP[i] + PA[i]*CNP[i]
    s_SP    <- 1 - PA[i]*CNP[i]/GDYP[i]

    # Balance of payments
    RESBAL[i] <- XGS[i]*XPI[i] - MGS[i]*MPI[i]
    OTHFSY[i] <- AUX['OTHFSY','B2019']
    NETFSY[i] <- OTHFSY[i] - INFG[i]
    NETCTR[i] <- NTRG[i] + OTHNTR[i]

    # Government budget
    DIVG[i] <- AUX['DIVG','B2019']
    FIVG[i] <- AUX['FIVG','B2019']
    rho_PL  <- (FIVG[i] - KTRG[i]*AER[i])/FSAM['GFIN','FFIN']
    TG_Y    <- seq(TG[i]/NGDP[i], 0.155, length = T)
    DIVG_Y <- seq(DIVG[i]/NGDP[i], 0.033, length = T)

    # Money market
    DC[i] <- DCP[i] + DCG[i]
    d_RES <- RES[i]/(MGS[i]*MPI[i]/12)
    v_MD  <- NGDP[i]/MD[i]

    # Stock of debt and interest payments
    irdg  <- INDG[i]/AUX['NDDG','B2018']
    irfg  <- INFG[i]/AUX['NFDG','B2018']
    rho_F <- NFDG[i]/(XGS[i]*XPI[i])

    # Deflators and exchange rates
    EER[i] <- AUX['EER','B2019']/1000
    AER[i] <- AUX['AER','B2019']/1000
    MPI[i] <- AUX['MPI','B2019']/100
    XPI[i] <- AUX['XPI','B2019']/100
    PA[i]  <- AUX['PA','B2019']/100
  }
  # Government net current transfers from abroad (in percent of GDP)
  NTRG_Y <- seq(NTRG[i]*AER[i]/NGDP[i], 0.0, length = T)
}
else {
  for (iterations in 1:10) {
    # Deflators and exchange rates
    EER[i] <- (1 + g_EER)*EER[i-1]
    AER[i] <- (EER[i] + EER[i-1])/2
    PD[i]  <- (1 + g_PD)*PD[i-1]
    MPI[i] <- (1 + g_MPI)*MPI[i-1]
    XPI[i] <- (1 + g_XPI)*XPI[i-1]

    # Interest payments
    INFG[i] <- irfg*NFDG[i-1]
    INDG[i] <- irdg*NDDG[i-1]

    # Sectoral GDP
    GDP_AGR[i] <- (1 + g_AGR)*GDP_AGR[i-1]
    GDP_IND[i] <- (1 + g_IND)*GDP_IND[i-1]
    GDP_SVC[i] <- (1 + g_SVC)*GDP_SVC[i-1]
    ITAX[i]    <- (1 + g_ITAX)*ITAX[i-1]
```

```
# Real aggregate GDP
GDP[i] <- GDP_AGR[i] + GDP_IND[i] + GDP_SVC[i] + ITAX[i]

# Real GDP growth
g_gdp[i] <- GDP[i]/GDP[i-1] - 1

# Nominal GDP
NGDP[i] <- GDP[i]*PD[i]

# Export demand
XGS[i] <- (1 + g_XGS)*XGS[i-1]

# Investment demand
IV[i] <- k0*GDP[i-1] + k1*(GDP[i] - GDP[i-1])

# Import demand
MGS[i] <- exp(m0 + m1*log(GDP[i]) + m2*log(AER[i]*MPI[i]/PD[i]))

# Aggregate consumption
CN[i] <- GDP[i] - IV[i] - AER[i]*(XGS[i] - MGS[i])

# Absorption deflator
PA[i] <- (NGDP[i] - AER[i]*(XGS[i]*XPI[i] - MGS[i]*MPI[i]))/(CN[i] + IV[i])

# Government investment
IVG[i] <- (DIVG[i] + FIVG[i])/PA[i]

# Private investment
IVP[i] <- IV[i] - IVG[i]

# Private disposable income
GDYP[i] <- NGDP[i] + AER[i]*(OTHFSY[i] + OTHNTR[i]) - TG[i] + INDG[i]

# Private consumption
CNP[i] <- (1 - s_SP)*GDYP[i]/PA[i]

# Government consumption
CNG[i] <- CN[i] - CNP[i]

# Private savings
SP[i] <- GDYP[i] - PA[i]*CNP[i]

# Private borrowing requirement
BRP[i] <- PA[i]*IVP[i] - SP[i]

# Government domestic revenue
TG[i] <- TG_Y[i]*NGDP[i]

# Domestic financed capital expenditure
DIVG[i] <- DIVG_Y[i]*NGDP[i]

# Foreign financed capital expenditure
FIVG[i] <- AER[i]*(KTRG[i] + rho_PL*(NFDG[i] - NFDG[i-1]))

# Government savings
SG[i] <- TG[i] + AER[i]*(NTRG[i] - INFG[i]) - INDG[i] -  PA[i]*CNG[i]
```

```
# Government borrowing requirement
BRG[i] <- PA[i]*IVG[i] - SG[i]

# Government net borrowing from  the private sector
D_BG[i] <- D_BG[i-1]*(GDYP[i]/GDYP[i-1])

# Government net foreign debt
NFDG[i] <- rho_F*XGS[i]*XPI[i]

# Government domestic credit
DCG[i] <- DCG[i-1] + BRG[i] - AER[i]*(KTRG[i] + NFDG[i] - NFDG[i-1]) - D_BG[i]

# Government net domestic debt
NDDG[i] <- NDDG[i-1] + (DCG[i] - DCG[i-1]) + D_BG[i]

# Money Demand
MD[i] <- (1/v_MD)*NGDP[i]

# Net foreign exchange reserve
RES[i] <- (d_RES/12)*(MGS[i]*MPI[i])

# Total domestic credit
DC[i] <- MD[i] - EER[i]*RES[i]

# Private domestic credit
DCP[i] <- DC[i] - DCG[i]

# Resource balance
RESBAL[i] <- XGS[i]*XPI[i] - MGS[i]*MPI[i]

# Net factor service income
NETFSY[i] <- OTHFSY[i] - INFG[i]

# Other factor service income
OTHFSY[i] <- OTHFSY[i-1]*(NGDP[i]/NGDP[i-1])/(AER[i]/AER[i-1])

# Net current transfers
NETCTR[i] <- NTRG[i] + OTHNTR[i]

# Government net current transfers from abroad
NTRG[i] <- NTRG_Y[i]*NGDP[i]/AER[i]

# Other current transfers from abroad
OTHNTR[i] <- OTHNTR[i-1]*(NGDP[i]/NGDP[i-1])/(AER[i]/AER[i-1])

# Current account balance
CURBAL[i] <- RESBAL[i] + NETFSY[i] + NETCTR[i]

# Government net capital transfers from abroad
KTRG[i] <- KTRG[i-1]*(NGDP[i]/NGDP[i-1])/(AER[i]/AER[i-1])

# Other capital transfers from abroad
OTHKTR[i] <- OTHKTR[i-1]*(NGDP[i]/NGDP[i-1])/(AER[i]/AER[i-1])

# Foreign Direct Investment
FDI[i] <- FDI[i-1]*(IVP[i]/IVP[i-1])/(AER[i]/AER[i-1])
```

```
      # Change in private net foreign debt
      D_NFDP[i] <- (RES[i] - RES[i-1]) - (CURBAL[i] + (NFDG[i] - NFDG[i-1]) +
                                          FDI[i] + KTRG[i] + OTHKTR[i])
    }
  }
}
```

Selected output are shown in Table 2.

TABLE 2. Madagascar: selected macroeconomic indicators.

	2019	2020	2021	2022	2023	2024	2025
Real sector[1]							
Real aggregate GDP	4.4	4.5	4.7	4.8	4.9	4.9	5.0
Absorption deflator	10.1	6.2	6.2	6.2	6.2	6.1	6.1
Government sector[2]							
Domestic revenue	11.3	12.0	12.7	13.4	14.1	14.8	15.5
Net transfers from abroad	0.7	0.6	0.5	0.4	0.2	0.1	0.0
Consumption	9.5	9.8	10.0	10.3	10.7	11.2	11.6
Investment	5.6	6.8	7.1	7.3	7.6	7.9	8.2
of which: domestic financed	1.5	1.8	2.1	2.4	2.7	3.0	3.3
Borrowing requirement	3.8	4.6	4.5	4.5	4.6	4.7	4.8
Savings and investment[2]							
Total savings	16.4	16.6	16.9	17.1	17.2	17.3	17.3
Government	1.8	2.2	2.5	2.8	3.1	3.2	3.4
Private	14.6	14.5	14.4	14.2	14.1	14.0	13.9
Total investment	19.8	20.2	20.5	20.8	21.1	21.3	21.5
of which: private investment	14.2	13.4	13.5	13.5	13.5	13.4	13.4
External sector[2]							
Resource balance	-5.8	-5.8	-5.8	-5.8	-5.9	-5.9	-6.0
Exports*	28.4	28.1	27.9	27.6	27.3	27.0	26.7
Imports*	34.2	33.9	33.7	33.5	33.2	33.0	32.7
Current account balance	-3.3	-3.5	-3.6	-3.8	-3.9	-4.1	-4.3
Private foreign financing	-4.0	-2.4	-2.1	-1.9	-1.6	-1.3	-0.9
Stock of debt[2]							
Foreign debt	22.9	22.7	22.5	22.3	22.0	21.8	21.5
Domestic debt	7.3	6.8	6.3	5.9	5.5	5.4	5.4
Monetary sector[1]							
Money	7.1	11.3	11.5	11.6	11.7	11.8	11.8
Reserve	-6.3	9.8	9.5	9.6	9.6	9.7	9.8
Government domestic credit	-1.2	4.1	2.4	2.6	5.2	10.2	17.0
Private domestic credit	24.5	14.1	14.9	14.7	13.9	12.7	11.2
Memorandum item[3]							
Nominal GDP (Billions of Ariary)	51035.2	56820.8	63333.2	70662.7	78911.2	88193.4	98638.1

[1] Percentage change; [2] Percent of GDP [3] Unit as indicated

* of goods and non-factor services

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[3] Mohsin S. Khan, Peter Montiel and Nadeem U. Haque, (1992), Adjustment with growth: Relating the analytical approaches of the IMF and the World Bank, *Journal of Development Economics* **32**, 155–179.

[4] Nicolas Ponty, (2018), *Présentation et utilisation du modèle MA2P*, Ministère de l'Économie et du Plan.

Table 3. The real social accounting matrix (RSAM) for the Merged model.

	COM	STAT	PRV	GCAP	PCAP	ACAP	DFIN	FFIN	ROW	Total
COM		P_tCG_t	P_tCP_t	P_tIG_t	P_tIP_t				$e_tX_tXPI_t$	(1)
STAT			TG_t						e_tNTRG_t	(3)
PRV	P_tGDP_t						$INDG_t$		$e_t(OTHFSY_t + OTHCTR_t)$	(2)
GCAP		SG_t				BRG_t				(4)
PCAP			SP_t			BRP_t				(5)
ACAP									$-e_tCURBAL_t$	(6)
DFIN		e_tINFG_t								(7)
FFIN		$INDG_t$								(8)
ROW	$e_tM_tMPI_t$							e_tINFG_t		(9)
Total	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	

Table 4. The financial social accounting matrix (FSAM) for the Merged model.

	DFIN	FFIN	FFDI	GFIN	PFIN	CAPGAIN	ACAP	Total
DFIN					ΔMD_t			(1)
FFIN	$E_t\Delta R_t$					$(e_t - E_t)\Delta R_t$	$-e_tCURBAL_t$	(2)
FFDI		e_tFDI_t						(3)
GFIN	ΔDCG_t	$e_t\Delta NFDG_t$			ΔBG_t	e_tKTRG_t		(4)
PFIN	ΔDCP_t	$e_t\Delta NFDP_t$	e_tFDI_t			$e_tOTHKTR_t + R_{t-1}\Delta E_t + (E_t - e_t)\Delta R_t$		(5)
CAPGAIN	$R_{t-1}\Delta E_t$	$e_t(KTRG_t + OTHKTR_t)$						(6)
ACAP				BRG_t	BRP_t			(7)
Total	(1)	(2)	(3)	(4)	(5)	(6)	(7)	

COM : Commodities account
STAT : Government current account
PRV : Private current account
GCAP : Government capital account
PCAP : Private capital account
ACAP : Aggregate capital account
DFIN : Domestic financial account
FFIN : Foreign financial account
ROW : Rest of the world account
FFDI : Foreign direct investment account
GFIN : Government financial account
PFIN : Private financial account
CAPGAIN: Capital gains account

TABLE 5. Madagascar: 2019 Real SAM.

	COM	STAT	PRV	GCAP	PCAP	ACAP	DFIN	FFIN	ROW	Total
COM		4845.2	39046.5	2854.6	7224.7				14506.5	68477.5
STAT			5772.2						365.1	6137.3
PRV	51035.2						249.2		984.7	52269.1
GCAP		936.1				1918.5				2854.6
PCAP			7450.4			-225.7				7224.7
ACAP									1692.8	1692.8
DFIN		249.2								249.2
FFIN		106.8								106.8
ROW	17442.3							106.8		17549.1
Total	68477.5	6137.3	52269.1	2854.6	7224.7	1692.8	249.2	106.8	17549.1	

TABLE 6. Madagascar: 2019 Financial SAM.

	DFIN	FFIN	FFDI	GFIN	PFIN	CAPGAIN	ACAP	Total
DFIN					835.6			835.6
FFIN	-511.7					0.7	1692.8	1181.9
FFDI		1350.4						1350.4
GFIN	-25.0	655.1			66.7	1221.7		1918.5
PFIN	1173.5	-2045.3	1350.4			198.1		676.6
CAPGAIN	198.8	1221.7						1420.6
ACAP				1918.5	-225.7			1692.8
Total	835.6	1181.9	1350.4	1918.5	676.6	1420.6	1692.8	

TABLE 7. Madagascar: 2018–2019 Auxiliary data.

	2018	**2019**	Unit
GDP_t	20956.5	21880.9	Billions of Ariary
$AGRGDP_t$	4809.0	5094.3	Billions of Ariary
$INDGDP_t$	3218.3	3436.3	Billions of Ariary
$SVCGDP_t$	11145.3	11699.8	Billions of Ariary
$ITAX_t$	1783.8	1650.4	Billions of Ariary
X_t	1929.1	2020.0	Millions of SDRs
$E_t \times 1000$	4812.0	5006.2	Ariary/SDR, end-of-period
$P_t \times 100$	202.6	223.0	
$NDDG_t$	3671.4		Billions of Ariary
$NFDG_t$	2210.3		millions of SDRs
MD_t	11823.7		Billions of Ariary
DCP_t	4797.5		Billions of Ariary
DCG_t	2099.2		Billions of Ariary
R_t	1023.9		Millions of SDRs
$e_t \times 1000$		4998.9	Ariary/SDR, period average
$XPI_t \times 100$		143.7	
$MPI_t \times 100$		140.4	
$P_t \times 100$		233.2	
$OTHFSY_t$		-307.8	millions of SDRs
$FIVG_t$		2105.9	Billions of Ariary
$DIVG_t$		748.7	Billions of Ariary