Agricultural drought impacts on crops sector and adaptation options in Mali: a macroeconomic computable general equilibrium analysis

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ONLINE APPENDIX

A. DRCGE MODEL

A1. Main features of the Malian Model

Our DRCGE model for Mali is adapted from the standard PEP-1-t model proposed by Decaluwé *et al*. (2013). It features two groups of households (*rural* and *urban*), one government agent, one firm agent, three agricultural activities (*subsistence agriculture, cash-crop agriculture* and *livestock*), five industrial activities, and two service activities (all equations and variables are presented below).

The within-period specifications of the model rely on fairly standard general equilibrium assumptions for low income countries. On the supply side (equations (1)-(6)), each producer maximises its profit by combining labour with capital (assumed to be fixed for each given period), which for agricultural activities is specific to land stock. On the income side (equations (7)-(24)), each agent receives factor revenues on the basis of its initial endowments and secondary revenues from government or other agents. With regard to demand (equations (25)-(30)), households' consumption follows a linear expenditure system function and government's consumption is exogenous. On the markets side (equations (54)-(62)), the prices and wages are determined endogenously (the numeraire is the nominal exchange rate) and the nominal investments are saving driven in the capital market.

The between-period specifications are recursive with a main assignment pertaining to the accumulation of capital in each activity as determined in the preceding period (equations (63)-(70)). We introduced here some modifications compared to the standard PEP-1-t model. The first one involves the potential effects of drought on the crop activities. In the latter, for a given period *t*, we assume first that the total factor productivity parameter ($\beta_{j,t}^{VA}$) depends on an exogenous annual growth rate (β_{yields}), reflecting a Hicks-neutral technical change in the production process (equation (71)). The FAOSTAT database shows indeed that, in the past decades, average crop yields have increased in Mali (because of land use rationalization,

better use of organic or chemical input, improvement of farming techniques, better institutional environment, etc.). We moreover assume that it depends on a random negative annual effect ($dyields_{j,t}$) when a drought occurs. Such random drought impacts is also introduced on land stock reflecting deterioration or higher depreciation rates. Crop land expansion in a normal year (β_K) thus would be reduced in a drought year ($d_{Kj,t}$), with a two-year post-drought recovery period (equations (72), (73) and (74)).

The second modification of the standard model pertains to the labour market. We chose to capture the urban–rural dualism of Mali by including two distinct segments with two different wage rates (equations (56)-(59)). Disguised unemployment exists in the rural segment (75 per cent of the labour force), such that the wage earned by agricultural workers (mainly family workers) is lower than the urban wage at the initial equilibrium. For a given period *t*, rural and urban labour supplies are exogenously predetermined, and workers flow freely across all activities in each area but not among areas. The labour force supplies in urban ($LSurb_t$) and rural ($LSrur_t$) areas grow over time, given an exogenous population growth rate (n_t), but also depend on rural-to-urban migrations ($Migr_t$) that may occur between periods (equations (75)-(79)). An implicit assumption is that such migrations take place after a harvest failure and are a way to cope with drought (for example, Marchiori *et al*., 2012; Gautier *et al*., 2016). We thus consider a one-period lag, assuming that it takes some time for workers to decide to migrate and that the adjustments are not instantaneous, as is conventionally assumed in other CGE models. The incentives to migrate then should be determined by the ratio of the respective average purchasing powers that prevail in urban and rural areas in the previous period, which depend on the respective households' nominal income ($YHurb_t$ and $YHrur_t$) and index prices ($Purb_t$ and $Prur_t$). The latter reflect the typical basket of goods consumed by rural or urban households, respectively, at the initial equilibrium (equations (78)-(79)).

Finally, we have also included two food security indicators in the model for each area (equations (52) and (53)): a *food access index* measures the food purchasing power of households, depending on both their nominal income per capita and the food price index, and a *food availability index* measures the volume of overall food supply per capita.

Within this framework, for a given period *t*, a general equilibrium of the model is defined by the vector of prices and wages for which demand equals supply in all markets simultaneously. The initial equilibrium has been defined on the basis of the last social accounting matrix (SAM) built for Mali, which depicts the observed structure of the economic system and the monetary flows associated with all transactions that have taken place between agents in the economy in 2013. This SAM is also used to calibrate different parameters in the within-period specifications of the model. If such calibrations are not possible, we obtain parameters from extant CGE literature. As is common for dynamic CGE modelling, we also define a business as usual (BAU) scenario (without drought) by updating, from one period to the next, the constants and exogenous variables of the model. Most updates refer to the annual medium population growth rate, which the United Nations projects to be close to 3.1 per cent for Mali. For crop yields and land stock expansion, we use historical data from FAO over the period 1980–2013, which indicate rates of 0.8 per cent and 3.5 per cent, respectively. For the migration function parameter, in the absence of better information, we use the last Population Census, conducted in 1998. It shows that migrations within Mali are mainly from rural towards urban areas, with a migration rate close to 1 per cent.

References

Decaluwé B, Lemelin A, Robichaud V and Maisonnave H (2013) PEP-1-t Standard Model (Single-country, Recursive Dynamic Version). Poverty and Economic Policy Network, Université Laval, Québec. Available at www.pep-net.org .

Gautier D, Denis D and Locatelli B (2016) Impacts of drought and responses of rural populations in West Africa: a systematic review. *WIREs Climate Change* **7**(5), 666–681.

Marchiori L, Maystadt J and Schumacher I (2012) The impact of weather anomalies on migration in sub-Saharan Africa. *Journal of Environmental Economics and Management* **63**, 355–374.

A2. Institutional desegregation and model sets

1. Institutions' desegregation

Agricultural sector
- *Subsistence-crop activities*
- *Cash-crop activities*
- *Livestock*

Non-agricultural sector
- *Mining*
- *Food industries*
- *Other industries*
- *Electricity and water*
- *Construction*
- *Services*
- *Public administration*

Agents
- *Rural households (Hrur)*
- *Urban households (Hurb)*
- *Firm (Firm)*
- *Government (Gvt)*
- *Rest of the World (Row)*

2. Sets and indexing

Activities or products

J or I = {All activities or products}
(indexed j or i)

JAGR or IAGR = {Agricultural activities or products} ⊂ J or I
(indexed jagr or iagr)

JNAGR or INAGR= {Non Agricultural activities or products} ⊂ J or I
(indexed jnagr or inagr)

JBUS or IBUS = {Private activities or products} ⊂ J or I
(indexed jbus or ibus)

JPUB or IPUB= {Public administration or products} ⊂ J or I
(indexed jpub or ipub)

Institutions

AG = {All agents}
(indexed ag)

AGNG = {All non-government agents} ⊂ AG
(indexed agng)

AGD = {All domestic agents} ⊂ AG
(indexed agd)

H = {All households} ⊂ AG
(indexed h)

Time periods

T = {1, ..., 15}
(indexed t)

A3. Model equations

1. Within-period (t) static equations

1.1. Production

1. $VA_{j,t} = v_j.XST_{j,t} \quad \forall j$
2. $CI_{j,t} = io_j.XST_{j,t} \quad \forall j$
3. $VA_{j,t} = B_{j,t}^{VA}\left[\beta_j^{VA}.LD_{j,t}^{-\rho_j^{VA}} + \left(1-\beta_j^{VA}\right)K_{j,t}^{-\rho_j^{VA}}\right]^{-\frac{1}{\rho_j^{VA}}} \quad \forall j$
4. $LD_{j,t} = K_{j,t}.\left[\frac{\beta_j^{VA}}{1-\beta_j^{VA}}.\frac{R_{j,t}}{W_{j,t}}\right]^{\sigma_j^{VA}} \quad \forall j$
5. $K_{j,t} = Land_{j,t} \quad \forall\ j = crop\ activities$
6. $K_{j,t} = Cap_{j,t} \quad \forall\ j \in JNAGR$

1.2. Income and savings

Households

7. $YH_{h,t} = \lambda_h^L \sum_j W_{j,t}.LD_{j,t} + \lambda_h^K \sum_j R_{j,t}.K_{j,t} + \sum_{ag} TR_{h,ag,t} \quad \forall h$
8. $YDH_{h,t} = YH_{h,t} - TDH_{h,t} - \sum_{ag} TR_{ag,h,t} \quad \forall h$
9. $TDH_{h,t} = PIXCON_t.tdh^o{}_{h,t} + tdh^1{}_{h,t}.YH_{h,t} \quad \forall h$
10. $CTH_{h,t} = YDH_{h,t} - SH_{h,t} \quad \forall h$
11. $SH_{h,t} = PIXCON_t.sh^o{}_{h,t} + sh^1{}_{h,t}.YDH_{h,t} \quad \forall h$

Firms

12. $YF_t = \lambda_{Firm}^K \sum_j R_{j,t}.K_{j,t} + \sum_{ag} TR_{Firm,ag,t}$
13. $YDF_t = YF_t - TDF_t$
14. $TDF_t = PIXCON_t.tdf^0{}_t + tdf^1{}_t.YFK_{h,t}$
15. $SF_t = YDF_t - \sum_{ag} TR_{ag,Firm,t}$

Government

16. $YG_t = \lambda_{Gvt}^K \sum_j R_{j,t}.K_{j,t} + \sum_{agng} TR_{Gvt,agng,t} + \sum_h TDH_{h,t} + TDF_t + \sum_i TIM_{i,t} + \sum_i TVA_{i,t}$
17. $TIM_{i,t} = tim_i.PWM_{i,t}.ER_t.IM_{i,t} \quad \forall i$
18. $TVA_{i,t} = tva_i.PL_{i,t}.DD_{i,t} \quad \forall i$
19. $SG_t = YG_t - \sum_{agng} TR_{agng,Gvt,t} - G_t$

Transfers

20. $TR_{agng,h,t} = \lambda_{agng,h}^{TR}.YDH_{h,t} \quad \forall h$
21. $TR_{gvt,h,t} = PIXCON_t.tr^0{}_{h,t} + tr^1{}_{h,t}.YH_{h,t} \quad \forall h$
22. $TR_{ag,Firm,t} = \lambda_{ag,Firm}^{TR}.YDF_t$
23. $TR_{agng,Gvt,t} = PIXCON_t.tr^0{}_{agng,Gvt}.pop_t$
24. $TR_{agd,Row,t} = PIXCON_t.tr^0{}_{agd,Row}.pop_t$

1.3. Demand

Intermediate consumption

25. $DI_{i,t} = \sum_j aij_{i,j}.CI_{j,t} \quad \forall i$

Final Consumption

26.

$$PC_{i,t}.C_{i,h,t} = PC_{i,t}.C^{MIN}_{i,h,t} + p_{mc_{i,h}}.\left[CTH_{h,t} - \sum_{i' \neq i} C^{MIN}_{i',h,t}.PC_{i'}\right] \quad \forall h \; and \; \forall i$$

27. $PC_{i,t}.CG_{i,t} = \gamma^{GVT}_i.G_t \quad \forall i$

Investment

28. $PC_{i,t}.INV^{PRI}_{i,t} = \gamma^{PRI}_i.IT^{PRI}_t \quad \forall i$

29. $PC_{i,t}.INV^{PUB}_{i,t} = \gamma^{PUB}_i.IT^{PUB}_t \quad \forall i$

30. $INV_{i,t} = INV^{PUB}_{i,t} + INV^{PUB}_{i,t} \quad \forall i$

1.4. International Trade

Exports and domestic sales

31. $XST_{j,t} = XS_{i,t} \quad \forall i \in I \approx j \in J$

32. $XS_{i,t} = B^X_i.\left[\beta^X_i.EX^{\rho^X_i}_{i,t} + \left(1-\beta^X_i\right)DS^{\rho^X_i}_{i,t}\right]^{\frac{1}{\rho^X_i}} \quad \forall i$

33. $EX_{i,t} = DS_{i,t}.\left[\frac{1-\beta^X_{i,t}}{\beta^X_{i,t}}.\frac{PE_{i,t}}{PL_i}\right]^{\sigma^X_i} \quad \forall i$

34. $EXD_{i,t} = EXD^O_i.pop(t).\left[\frac{ER_t.PWX_{i,t}}{PE_{i,t}}\right]^{\sigma^{XD}_i} \quad \forall i$

Imports and domestic sales

35. $Q_{i,t} = B^M_i.\left[\beta^M_i IM^{-\rho^M_i}_{i,t} + \left(1-\beta^M_i\right)DD^{-\rho^M_i}_{i,t}\right]^{-\frac{1}{\rho^M_i}} \quad \forall i$

36. $IM_{i,t} = DD_{i,t}.\left[\frac{\beta^M_i}{1-\beta^M_i}\frac{PD_{i,t}}{PM_{i,t}}\right]^{\sigma^M_i} \quad \forall i$

1.5 Prices

37. $PP_{j,t} = \frac{PVA_{j,t}.VA_{j,t} + \sum_i PC_{i,t}.DI_{i,j,t}}{XST_{j,t}} \quad \forall j$

38. $PVA_{j,t}.VA_{j,t} = W_{j,t}.LD_{j,t} + RC_{j,t}.KDC_{j,t} \quad \forall j$

39. $P_{i,t} = PP_{j,t} \quad \forall i \in I \approx j \in J$

40. $P_{i,t}.XS_{i,t} = PE_{i,t}.EX_{i,t} + PL_{i,t}.DS_{i,t} \quad \forall i$

41. $P_{i,t} = PL_{i,t} \quad \forall i$

42. $PD_{i,t} = \left(1+tic_{i,t}\right)PL_{i,t} \quad \forall i$

43. $PM_{i,t} = \left(1+tic_{i,t}\right)\left(1+tim_{i,t}\right)ER_t.PWM_{i,t} \quad \forall i$

44. $PC_{i,t}.Q_{i,t} = PM_{i,t}.IM_{i,t} + PD_{i,t}.DD_{i,t} \quad \forall i$

45. $PIXGDP_t = \sqrt{\frac{\sum_j \left(PVA_{j,t}.VA^O_j\right)}{\sum_j \left(PVA^O_j.VA^O_j\right)}\frac{\sum_j \left(PVA_{j,t}.VA_{j,t}\right)}{\sum_j \left(PVA^O_j\right)VA_{j,t}}}$

46. $PIXCON_t = \frac{\sum_i PC_{i,t}.\sum_h C^O_{i,h}}{\sum_{ii'} PC^O_{i',t}.\sum_h C^O_{i',h}}$

47. $PIXINV^{PRI}_t = \prod_i \left(\frac{PC_{i,t}}{PC^O_i}\right)^{\gamma^{INVPRI}_i}$

48. $PIXINV^{PUB}_t = \prod_i \left(\frac{PC_{i,t}}{PC^O_i}\right)^{\gamma^{INVPUB}_i}$

49. $PIXGVT_t = \prod_i \left(\frac{PC_{i,t}}{PC^O_i}\right)^{\gamma^{GVT}_i}$

1.6. Food security indicators

50. $FoodAvail_{Hrur,t} = \frac{\sum_{i \in IAGR} XS_{i,t}}{LSrur_t}$

51. $FoodAvail_{Hurb,t} = \frac{\sum_{i \in IAGR} XS_{i,t}}{LSurb_t}$

52. $Foodacc_{Hrur,t} = \frac{\sum_{i \in IAGR} CF_{Hrur,i,t}}{LSrur_t}$

53. $Foodacc_{Hurb,t} = \frac{\sum_{i \in AGR} CF_{Hurb,i,t}}{LSurb_t}$

1.7. Closure rules

Commodities

54. $Q_{i,t} = \sum_h C_{i,h} + CG_{i,t} + INV_{i,t} + DIT_{i,t} \quad \forall i$

55. $DS_{i,t} = DD_{i,t} \quad \forall i$

Labor market

56. $LSrur_t = \sum_{j \in JAGR} LD_{j,t}$

57. $LSurb_t = \sum_{j \in JNAGR} LD_{j,t}$

58. $W_{j,t} = WAgr_t \quad \forall j \in JAGR$

59. $W_{j,t} = WNagr_t \quad \forall j \in JNAGR$

Investment saving balance

60. $IT_t = \sum_h SH_{h,t} + SF_t + SG_t - CAB_t$

61. $IT^{PRI}_t = IT_t - IT^{PUB}_t$

Current account balance

62.

$$CAB_t = \sum_i PE_{i,t}.EX_{i,t} + \sum_{agd}\left(TR_{agd,Row,t} - TR_{Row,agd,t}\right) - \lambda^K_{Row}.\sum_j R_{j,t}.KD_{j,t} - ER_t.\sum_i PWM_{i,t}.IM_{i,t}$$

2. Between-period dynamic equations

2.1. Capital accumulation and investment demand function

63. $KD_{j,t+1} = KD_{j,t}.\left(1-\delta_{j,t}\right)+IND_{j,t} \quad \forall j$

64. $IND_{bus,t} = \phi_{bus,t}.\left[\frac{R_{bus,t}}{U_{bus,t}}\right]^{\sigma^{INV}_{k,bus}}.K_{bus,t}$

65. $U_{bus,t} = PK_t^{PRI}\left(\delta_{bus}+IR_t\right)$

66. $U_{k,pub,t} = PK_t^{PUB}\left(\delta_{k,pub}+IR_t\right)$

67. $PK_t^{PRI} = \frac{1}{A^{KPRI}}.\prod_i\left[\frac{PC_{i,t}}{\gamma_i^{PRI}}\right]^{\gamma_i^{PRI}}$

68. $PK_t^{PUB} = \frac{1}{A^{KPUB}}.\prod_i\left[\frac{PC_{i,t}}{\gamma_i^{PUB}}\right]^{\gamma_i^{PUB}}$

69. $IT_t^{PUB} = PK_t^{PUB}.\sum_{k,pub} IND_{k,pub,t}$

70. $IT_t^{PRI} = PK_t^{PRI}.\sum_{k,bus} IND_{k,bus,t}$

2.2. Drought impacts

Impact on agricultural yields

71.

$B_{j,t}^{VA} = B_{j,t-1}^{VA}.\left(1+\beta_{yields\,j}+dyields_{j,t}\right) \ \forall j \in \{crop\ activities\}$

With $dyields_{j,t} \prec 0$ *for a year t of drought occurrence and* $=0$ *for other years*

Impact on Land

72.

$Land_{j,t} = Land_{j,t-1}.\left(1+\beta_{land}+dland_{j,t}\right) \quad \forall j \in \{crop\ activities\}$

73. $Land_{j,t+1} = Land_{j,t}.\left(1+\beta_{land}-dland_{j,t}/2\right)$

74. $Land_{j,t+2} = Land_{j,t+1}.\left(1+\beta_{land}-dland_{j,t}/2\right)$

With $dland_{j,t} \prec 0$ *for a year t of drought occurrence and* $=0$ *for other years*

2.3. Rural-Urban migrations process

75. $LSrur_{t+1} = LSRur_t.\left(1+n_t\right)-Migr_t$

76. $LSurb_{t+1} = LSUrb_t.\left(1+n_t\right)+Migr_t$

77. $Migr_{t+1} = \Psi^{MIGR}.\ln\left[YH_{Hurb,t}/Purb_t \Big/ YH_{Hrur,t}/Prur_t\right]$

78. $PRur_t = \sqrt{\frac{\sum_j\left(PVA_{j,t}.VA_j^O\right)}{\sum_j\left(PVA_j^O.VA_j^O\right)}\frac{\sum_j\left(PVA_{j,t}.VA_{j,t}\right)}{\sum_j\left(PVA_j^O\right)VA_{j,t}}}$

79. $Purb_t = \sqrt{\frac{\sum_j\left(PVA_{j,t}.VA_j^O\right)}{\sum_j\left(PVA_j^O.VA_j^O\right)}\frac{\sum_j\left(PVA_{j,t}.VA_{j,t}\right)}{\sum_j\left(PVA_j^O\right)VA_{j,t}}}$

2.4. Updating rules for variables and parameters

80. $pop_{t+1} = pop_t.\left(1+n_t\right) \quad with\ pop_{2015}=1$

81 $LS_{t+1} = LS_t.\left(1+n_t\right)$

82. $CAB_{t+1} = CAB_t.\left(1+n_t\right)$

83. $C_{i,h,t+1}^{MIN} = C_{i,h,t}^{MIN}.\left(1+n_t\right)$

84. $G_{t+1} = G_t.\left(1+n_t\right)$

85. $IND_{k,pub,t+1} = IND_{k,pub,t}.\left(1+n_t\right)$

86. $sh^o{}_{t+1} = sh^o{}_t.\left(1+n_t\right)$

87. $tdh^o{}_{h,t+1} = tdh^o{}_{h,t}.\left(1+n_t\right)$

88. $tdf^o{}_{t+1} = tdf^o{}_t.\left(1+n_t\right)$

89. $tr^o{}_{h,t+1} = tr^o{}_{h,t}.\left(1+n_t\right)$

A4. List of variables and parameters

Variables

B_j^{VA}	Total factor Productivity parameter for CES – value added production function
$C_{i,h,t}$	Consumption of commodity i by type h households
$C_{i,h,t}^{Min}$	Minimum consumption of commodity i by type h households
CAB_t	Current account balance
$CG_{i,t}$	Public consumption of commodity i (volume)
$CI_{j,t}$	Total intermediate consumption of industry j
$CTH_{h,t}$	Consumption budget of type h households
$DD_{i,t}$	Domestic demand for commodity i produced locally
$DI_{i,j,t}$	Intermediate consumption of commodity i by industry j
$DS_{i,t}$	Quantity of product i sold in the domestic market
ER_t	Exchange rate
$EX_{i,t}$	Quantity of product i exported
$EXD_{i,t}$	World demand for exports of product i
$FoodAvail_{H,t}$	Food availability indicator for households h
$FoodAcess_{H,t}$	Food access indicator for households h

G_t	Current government expenditures on goods and services
$IM_{i,t}$	Quantity of product *i* imported
$IND_{k,j,t}$	New type *k* capital investment to sector *j*
$INV_{i,t}$	Demand of commodity *i* for investment purposes
$INV_{i,t}^{PRI}$	Demand of commodity *i* for private investment purposes
$INV_{i,t}^{PUB}$	Demand of commodity *i* for public investment purposes
$K_{j,t}$	Capital stock by industry *j*
$Land_{j,t}$	Land area for crop activity *j*
$Herds_{j,t}$	Herds for *Livestock* activity
IR_t	Interest rate
IT_t	Total investment expenditures
IT_t^{PRI}	Total private investment expenditures
IT_t^{PUB}	Total public investment expenditures
$LD_{j,t}$	Industry *j* demand for labor
$LSRur_t$	Supply of labor in rural areas
$LSUrb_t$	Supply of labor in urban areas
$PC_{i,t}$	Purchaser price of composite commodity *i* (including taxes)
$PD_{i,t}$	Price of product *i* sold locally (including taxes)
$PE_{i,t}$	Price of exported product *i* (in national currency)
$PIXCON_t$	Consumer price index
$PIXGDP_t$	GDP deflator
$PIXINV_t^{PRI}$	Private investment price index
$PIXINV_t^{PUB}$	Public investment price index
$PIXGVT_t$	Public expenditures price index
PK_t^{PRI}	Price of new private capital
PK_t^{PUB}	Price of new public capital
$PL_{i,t}$	Price of product *i* sold locally (excluding taxes)
$PM_{i,t}$	Price of imported product *i* (in national currency)
$PP_{j,t}$	Basic price of activity *j*'s output
$Prur_t$	Consumer price index in rural areas
$Purb_t$	Consumer price index in urban areas
$PVA_{j,t}$	Price of industry *j*'s value added
$PWM_{i,t}$	World price of imported product *i* (in foreign currency)
$PWX_{i,t}$	World price of exported product *i* (in foreign currency)
$Q_{i,t}$	Demand of composite commodity *I* (volume)
$R_{j,t}$	Rental rate of capital in industry *j*
SF_t	Firms' savings
SG_t	Government savings
$SH_{h,t}$	Savings of type *h* households
TDF_t	Firms' income taxes
$TDH_{h,t}$	Income taxes of type *h* households
$TR_{ag,ag',t}$	Transfers from agent *ag'* to agent *ag*
$U_{k,j,t}$	User cost of type *k* capital in industry *j*
$VA_{j,t}$	Value added of industry *j*
$W_{j,t}$	Wage rate in industry *j*
$WAgr_t$	Wage rate in rural areas
$WNagr_t$	Wage rate in urban areas
$XST_{j,t}$	Total output of industry *j*
YDF_t	Firms' disposable income
$YDH_{h,t}$	Disposable income of type *h* households
YF_t	Firms' total income
YG_t	Government total income
$YH_{h,t}$	Total income of type *h* households
$YROW_t$	Rest of the world total income
$\delta_{k,j,t}$	Depreciation rate for capital for industry

Parameters

io_j	Leontief coefficient for intermediate consumption
v_j	Leontief coefficient for value added
B_j^{VA}	Scale parameter for CES – value added production function
β_j^{VA}	Share parameter for CES – value added production function
ρ_j^{VA}	Elasticity parameter for CES – value added production function
B_j^{KD}	Scale parameter for CES – composite capital function
β_j^{KD}	Share parameter for CES – composite capital function
ρ_j^{KD}	Elasticity parameter for CES – composite capital function
$aij_{i,j}$	Input-output coefficient
λ_h^L	Share of labor income received by type h households
$\lambda_{ag,k}^K$	Share of type k capital income received by agent
$sho_{h,t}$	Savings function intercept for type h households
$sh1_{h,t}$	Savings function slope for type h households
$tdfo_t$	Taxation function intercept for Firms
$tdf1_t$	Marginal income tax rate of Firms
$tdfo_{h,t}$	Taxation function intercept for type h households
$tdf1_{h,t}$	Marginal income tax rate of type h households
tim_i	Rate of taxes and duties on imports of commodity i
tva_i	Tax rate on commodity i
$\lambda_{ag,ag'}^{TR}$	Share parameter for transfers functions
$tro_{h,t}$	Transfers to government function intercept for type h households
$tr1_{h,t}$	Transfers to government function slope for type h households
pop_t	Population index
$Pmc_{i,h}$	Marginal share of commodity i in type h household consumption budget
λ_i^{GVT}	Share of commodity i in total current public expenditures
λ_i^{PRI}	Share of commodity i in total private investment expenditure
λ_i^{PUB}	Share of commodity i in total public investment expenditure
B_i^X	Scale parameter for CET – Export function
β_i^X	Share parameter for CET – Export function
ρ_i^X	Elasticity parameter for CET – Export function
σ_i^X	Elasticity of transformation for CET – Export function
σ_i^{XD}	Price-elasticity of the world demand for exports of product i
B_i^M	Scale parameter for CES – Import function
β_i^M	Share parameter for CES – Import function
ρ_i^M	Elasticity parameter for CES – Import function
σ_i^M	Elasticity of substitution for CES – Import function
ψ^{MIGR}	Parameter for Migration function
A^{KPRI}	Scale parameter for private investment demand function
A^{KPUB}	Scale parameter for public investment demand function
$\phi_{k,j}$	Scale parameter (allocation of investment to industries)
$\sigma_{k,bus}^{INV}$	Elasticity of private investment demand relative to Tobin's q
n_t	Annual population rate growth