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 ($\beta_{VA}^j$) depends on an exogenous annual growth rate ($\beta_{yields}^j$), 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 \((\beta_K)\) thus would be reduced in a drought year \((d_{K,j,t})\), 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 \((L_{Surb_t})\) and rural \((L_{Surr_t})\) 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 \((Y_{Hurb_t} and Y_{Hurr_t})\) and index prices \((P_{urb_t} and P_{urr_t})\). 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


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
- 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**

\[ J \text{ or } I = \{ \text{All activities or products} \} \]

**Institutions**

\[ AG = \{ \text{All agents} \} \]

\[ AGNG = \{ \text{All non-government agents} \} \subset AG \]

\[ AGD = \{ \text{All domestic agents} \} \subset AG \]

\[ H = \{ \text{All households} \} \subset AG \]

**Time periods**

\[ T = \{ 1, \ldots, 15 \} \]

A3. Model equations

1. Within-period (t) static equations

1.1. Production

1. \( V_{At} = v_{jt} XST_{jt}, \forall j \)

2. \( C_{At} = \omega_{jt} XST_{jt}, \forall j \)

3. \( V_{jt} = B^{a}_{jt} \left[ r^{a}_{jt} \cdot L_{jt}^{a} \cdot (1 - \beta^{a}_{jt}) \cdot K_{jt}^{a} \right] \gamma^{a}_{jt} \), \forall j

4. \( L_{jt} = \frac{K_{jt} \left[ \beta^{a}_{jt} \cdot R^{a}_{jt} \cdot \gamma^{a}_{jt} \right]}{1 - \beta^{a}_{jt} \cdot W_{jt}} \), \forall j

5. \( K_{jt} = \text{Land}_{jt}, \forall j \) or \( j = \text{crop activities} \)

6. \( K_{jt} = \text{Cap}_{jt}, \forall j \in J_{NAGR} \)

1.2. Income and savings

**Households**

7. \( YH_{ht} = \Lambda_{h} \sum_{j} W_{jt} \cdot LD_{jt} + \sum_{j} R_{jt} \cdot K_{jt} + \sum_{ag} TR_{aght}, \forall h \)

8. \( YDH_{ht} = YH_{ht} - TDH_{ht} - \sum_{ag} TR_{aght}, \forall h \)

9. \( TDH_{ht} = PIXCON_{ht} \cdot dh_{ht} + tdh_{ht} \cdot YH_{ht}, \forall h \)

10. \( CTH_{ht} = YDH_{ht} - SH_{ht}, \forall h \)

11. \( SH_{ht} = PIXCON_{ht} \cdot sh_{ht} + sh_{ht} \cdot YDH_{ht}, \forall h \)

**Firms**

12. \( YF_{t} = \frac{K_{jt} \sum_{j} R_{jt} \cdot K_{jt} + \sum_{ag} TR_{aght}}{\sum_{j} W_{jt}} \)

13. \( YDF_{t} = YF_{t} - \Delta F_{t} \)

14. \( TF_{t} = PIXCON_{t} \cdot tdf_{t} + tdf_{t} \cdot YF_{t} \)

15. \( SF_{t} = YDF_{t} - \sum_{ag} TR_{aght} \)

**Government**

16. \( YG = \sum_{j} \sum_{i} R_{jt} \cdot K_{jt} + \sum_{ag} \sum_{i} TDH_{jt} + YDF_{t} + \sum_{h} \sum_{i} TIP_{ij} + \sum_{i} TVA_{i} \)

17. \( TIM_{ij} = \sum_{j} tW_{j} \cdot PWM_{ij} + ER_{ij} \cdot IM_{ij}, \forall i \)

18. \( TVA_{ij} = tva_{i} \cdot P_{i} \cdot DD_{ij} \), \forall i

19. \( SG_{i} = YG_{i} - \sum_{ag} TR_{aght} \cdot G_{i} \)

**Transfers**

20. \( TR_{aght} = \frac{\Lambda_{h} \cdot y_{g}}{\sum_{h} YDH_{ht}} \)

21. \( TR_{aght} = \frac{\Lambda_{h} \cdot y_{g} \cdot tr_{h}}{\sum_{h} YH_{ht}} \)

22. \( TR_{aght} = \frac{\Lambda_{h} \cdot y_{g} \cdot YDF_{t}}{\sum_{h} YDF_{t}} \)

23. \( TR_{aght} = \frac{\Lambda_{h} \cdot y_{g} \cdot P_{aght} \cdot p_{h}}{\sum_{h} YH_{ht}} \)

24. \( TR_{aght} = \frac{\Lambda_{h} \cdot y_{g} \cdot P_{aght} \cdot p_{h}}{\sum_{h} YH_{ht}} \)
1.3. Demand

Intermediate consumption
25. \( Dl_{ij} = \sum a_{ij}C_{li} \quad \forall i \)

Final Consumption
26. \( PC_{ij}C_{kh} = PC_{ij}C_{kh}^{\min} + p_{n,k}C_{kh} \left[ CTH_{kh} - \sum C_{kh}^{\min} \cdot PC_{ij} \right] \quad \forall h \text{ and } \forall i \)

Investment
28. \( PC_{ij}INV_{ij}^{\nu} = \gamma_{ij}^{\nu} \cdot IT_{ij}^{\nu} \quad \forall i \)
29. \( PC_{ij}INV_{ij}^{\tau} = \gamma_{ij}^{\tau} \cdot IT_{ij}^{\tau} \quad \forall i \)
30. \( INV_{ij} = INV_{ij}^{\nu} + INV_{ij}^{\tau} \quad \forall i \)

1.4. International Trade

Exports and domestic sales
31. \( XST_{ij} = XS_{ij} \quad \forall i \in I \text{ and } j \in J \)
32. \( XS_{ij} = B_i^X \left[ \beta_i^X \cdot EX_{ij}^{\nu} + \left( 1 - \beta_i^X \right) \cdot DS_{ij}^{\nu} \right] \quad \forall i \)
33. \( EX_{ij} = DS_{ij}^{\nu} \cdot \left[ \frac{1 - \beta_i^X}{\beta_i^X} \cdot PE_{i} \cdot \frac{1 - \beta_i^X}{\beta_i^X} \cdot PL \right] \quad \forall i \)
34. \( EXD_{ij} = EXD^{\nu} \cdot \text{pop}(i) \left[ \frac{ER_{i} \cdot PWM_{ij}}{PE_{i}} \right] \quad \forall i \)

Imports and domestic sales
35. \( Q_{ij} = B_i^I \left[ \beta_i^I \cdot IM_{ij}^{\nu} + \left( 1 - \beta_i^I \right) \cdot DD_{ij}^{\nu} \right] \quad \forall i \)
36. \( IM_{ij} = DD_{ij}^{\nu} \left[ \frac{\beta_i^I \cdot PD_{ij}^{\nu}}{1 - \beta_i^I \cdot FM_{ij}^{\nu}} \right] \quad \forall i \)

1.5 Prices
37. \( PP_{ij} = \frac{PVA_{ij} \cdot VA_{ij} + \sum PC_{ij} \cdot Dl_{ij}}{XST_{ij}} \quad \forall j \)
38. \( PVA_{ij} \cdot VA_{ij} = W_{ij} \cdot LD_{ij} + RC_{ij} \cdot KDC_{ij} \quad \forall j \)
39. \( P_{ij} = PP_{ij} \quad \forall i \in I \text{ and } j \in J \)
40. \( P_{ij} \cdot XS_{ij} = PE_{i} \cdot EX_{ij} + PL_{ij} \cdot DS_{ij} \quad \forall i \)
41. \( P_{ij} = PL_{ij} \quad \forall i \)
42. \( PD_{ij} = \left( 1 + \tau_{ij} C_{ij} \right) \cdot PL_{ij} \quad \forall i \)
43. \( PM_{ij} = \left( 1 + \tau_{ij} C_{ij} \right) \left( 1 + \tau_{ij} M_{ij} \right) \cdot ERI \cdot PWM_{ij} \quad \forall i \)
44. \( PC_{ij} \cdot Q_{ij} = PM_{ij} \cdot IM_{ij} + PD_{ij} \cdot DD_{ij} \quad \forall i \)
45. \( PIXGDP = \frac{\sum [PVA_{ij} \cdot VA_{ij}]}{\sum [PVA_{ij} \cdot VA_{ij}]} \sum [PVA_{ij} \cdot VA_{ij}] \)

46. \( \text{PIXCON}_{ij} = \frac{\sum PC_{ij} \sum C_{kh}^{\nu}}{\sum PC_{ij} \sum C_{kh}^{\tau}} \quad \forall h \text{ and } \forall i \)
47. \( \text{PIXINV}_{ij}^{\nu} = \prod \frac{PC_{ij} \cdot PWM_{ij}}{PC_{ij} \cdot PWM_{ij}} \quad \forall h \text{ and } \forall i \)
48. \( \text{PIXINV}_{ij}^{\tau} = \prod \frac{PC_{ij} \cdot PWM_{ij}}{PC_{ij} \cdot PWM_{ij}} \quad \forall h \text{ and } \forall i \)
49. \( \text{PIXGVT}_{ij} = \prod \left( \frac{PC_{ij} \cdot PWM_{ij}}{PC_{ij} \cdot PWM_{ij}} \right) \quad \forall h \text{ and } \forall i \)

1.6. Food security indicators
50. \( \text{FoodAvail}_{i,j} = \sum \frac{XS_{ij}}{\text{LSur}_{i}} \quad \forall j \)
51. \( \text{FoodAvail}_{i,j} = \sum \frac{XS_{ij}}{\text{LSur}_{i}} \quad \forall j \)
52. \( \text{Foodacc}_{i,j} = \sum \frac{CF_{i,j}}{\text{LSur}_{i}} \quad \forall j \)
53. \( \text{Foodacc}_{i,j} = \sum \frac{CF_{i,j}}{\text{LSur}_{i}} \quad \forall j \)

1.7. Closure rules

Commodities
54. \( Q_{ij} = \sum C_{ij} + C_{ij} + INV_{ij} + DJ_{ij} \quad \forall i \)
55. \( DS_{ij} = DD_{ij} \quad \forall i \)

Labor market
56. \( LSur_{i} = \sum LD_{ij} \quad \forall i \)
57. \( LSur_{i} = \sum LD_{ij} \quad \forall i \)
58. \( W_{ij} = WAg_{ij} \quad \forall j \in JAGR \)
59. \( W_{ij} = WAg_{ij} \quad \forall j \in JAGR \)

Investment saving balance
60. \( IT_{i} = \sum SH_{ij} + SF_{i} + SG_{i} - CAB_{i} \quad \forall i \)
61. \( IT_{i}^M = IT_{i} - IT_{i}^{\nu,\tau} \quad \forall i \)

Current account balance
62. \( CAB_{i} = \sum PE_{i} \cdot EX_{ij} + \sum \frac{\left( TR_{Agd} - TR_{Agd} \right)}{\text{LSur}_{i}} + \sum \frac{\left( B_{ij} \cdot KD_{ij} - ER \right)}{\text{LSur}_{i}} \sum \frac{PWM_{ij} \cdot IM_{ij}}{\text{LSur}_{i}} \)
2. **Between-period dynamic equations**

### 2.1. Capital accumulation and investment demand function

63. \[ KD_{j,+1} = KD_j \left(1 - \delta_{j,+1}\right) + IND_j \] \( \forall j \)

64. \[ IND_{bus,j} = \phi_{bus} \left[ \frac{\beta_{bus,j}}{U_{bus,j}} \right] K_{bus,j} \]

65. \[ U_{bus,j} = PK_j^{RE}(\delta_{bus} + IR) \]

66. \[ U_{I,pob,j} = PK_j^{RE}(\delta_{I,pob} + IR) \]

67. \[ PK_j^{RE} = \frac{1}{A^{EXP}} \prod_j \left[ \frac{PC_{j,t}^{T}}{Y_{j,t}} \right]^{\gamma_{FIR}} \]

68. \[ PK_j^{REB} = \frac{1}{A^{EXP}} \prod_j \left[ \frac{PC_{j,t}^{T}}{Y_{j,t}} \right]^{\gamma_{FIRB}} \]

69. \[ IR_{t}^{RE} = PK_{t}^{REB} \sum_{s=pob} \text{IND}_{s,pob,j} \]

70. \[ IR_{t}^{REB} = PK_{t}^{RE} \sum_{s=bus} \text{IND}_{s,bus,j} \]

### 2.2. Drought impacts

**Impact on agricultural yields**

71. \[ B^{VA}_{j,t} = B^{VA}_{j,t-1} \left(1 + \beta_{yields,j} + \delta_{yields,j}\right) \] \( \forall j \in \{\text{crop activities}\} \)

With \( \delta_{yields,j} < 0 \) for a year \( t \) of drought occurrence and \( = 0 \) for other years

**Impact on Land**

72. \[ Land_j = Land_j \left(1 + \beta_{waleur} + \delta_{dland,j}\right) \] \( \forall j \in \{\text{crop activities}\} \)

73. \[ Land_{j,+1} = Land_j \left(1 + \beta_{waleur} - \delta_{dland,j}\right) \]

### 74. Land_{j,+1} = Land_j \left(1 + \beta_{waleur} - \delta_{dland,j}\right) / 2 \]

With \( \delta_{dland,j} < 0 \) for a year \( t \) of drought occurrence and \( = 0 \) for other years

### 2.3. Rural-Urban migrations process

75. \[ LSur_{t+1} = LSur_t (1 + \eta) - Mig_t \]

76. \[ LSurb_{t+1} = LSurb_t (1 + \eta) + Mig_t \]

77. \[ Mig_{t+1} = \max \left[ \frac{YH_{bus,j}/Purb}{YH_{bus,j}/Purb} \right] \]

78. \[ PRut = \frac{\sum \left[ p\left(A_{i},X_{a}\right) \right]}{\sum \left[ p\left(A_{i},X_{a}\right) \right]} \]

79. \[ Purb = \frac{\sum \left[ p\left(A_{i},X_{a}\right) \right]}{\sum \left[ p\left(A_{i},X_{a}\right) \right]} \]

### 2.4. Updating rules for variables and parameters

80. \[ pop_{t+1} = pop_t (1 + \eta) \] \( \text{with } pop_{2015} = 1 \)

81. \[ LS_{t+1} = LS_t (1 + \eta) \]

82. \[ CAB_{t+1} = CAB_t (1 + \eta) \]

83. \[ c^{MIN}_{t+1} = c^{MIN}_t (1 + \eta) \]

84. \[ G_{t+1} = G_t (1 + \eta) \]

85. \[ IND_{I,pob,t+1} = IND_{I,pob,t} (1 + \eta) \]

86. \[ sh'_{t+1} = sh'_t (1 + \eta) \]

87. \[ sh''_{t+1} = sh''_t (1 + \eta) \]

88. \[ sh'^{\prime\prime\prime}_{t+1} = sh'^{\prime\prime\prime}_t (1 + \eta) \]

89. \[ tr'_{h,t+1} = tr'_{h,t} (1 + \eta) \]

### A4. List of variables and parameters

#### Variables

- \( B^{VA}_{j,t} \) Total factor productivity parameter for CES – value added production function
- \( C_{i,h,t} \) Consumption of commodity \( i \) by type \( h \) households
- \( C^{MIN}_{i,h,t} \) Minimum consumption of commodity \( i \) by type \( h \) households
- \( CAB_{t} \) Current account balance
- \( CG_{i,t} \) Public consumption of commodity \( i \) (volume)
- \( CI_{i,t} \) 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 \( i \)
- \( FoodAvailability_{h,t} \) Food availability indicator for households \( h \)
- \( FoodAccess_{h,t} \) Food access indicator for households \( h \)
<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$G_t$</td>
<td>Current government expenditures on goods and services</td>
</tr>
<tr>
<td>$IM_{i,t}$</td>
<td>Quantity of product $i$ imported</td>
</tr>
<tr>
<td>$IND_{k,j,t}$</td>
<td>New type $k$ capital investment to sector $j$</td>
</tr>
<tr>
<td>$INV_{i,t}$</td>
<td>Demand of commodity $i$ for investment purposes</td>
</tr>
<tr>
<td>$INV_{i,t}^{PRI}$</td>
<td>Demand of commodity $i$ for private investment purposes</td>
</tr>
<tr>
<td>$INV_{i,t}^{PUB}$</td>
<td>Demand of commodity $i$ for public investment purposes</td>
</tr>
<tr>
<td>$K_{j,t}$</td>
<td>Capital stock by industry $j$</td>
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<tr>
<td>$Land_{j,t}$</td>
<td>Land area for crop activity $j$</td>
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<tr>
<td>$Herds_{j,t}$</td>
<td>Herds for livestock activity $j$</td>
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<tr>
<td>$IR_{t}$</td>
<td>Interest rate</td>
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<tr>
<td>$IT_{t}$</td>
<td>Total investment expenditures</td>
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<td>$IT_{t}^{PRI}$</td>
<td>Total private investment expenditures</td>
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<tr>
<td>$IT_{t}^{PUB}$</td>
<td>Total public investment expenditures</td>
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<tr>
<td>$LD_{j,t}$</td>
<td>Industry demand for labor</td>
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<td>$LSR_{ur_t}$</td>
<td>Supply of labor in rural areas</td>
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<tr>
<td>$LSU_{rb_t}$</td>
<td>Supply of labor in urban areas</td>
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<tr>
<td>$PC_{i,t}$</td>
<td>Purchaser price of composite commodity $i$ (including taxes)</td>
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<tr>
<td>$PD_{i,t}$</td>
<td>Price of product $i$ sold locally (including taxes)</td>
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<td>$PE_{i,t}$</td>
<td>Price of exported product $i$ (in national currency)</td>
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<td>$PIXCON_{t}$</td>
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<td>$PIXGD_{t}$</td>
<td>GDP deflator</td>
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<td>Public expenditures price index</td>
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<td>Price of new private capital</td>
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<tr>
<td>$PK_{t}$</td>
<td>Price of new public capital</td>
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<td>$PL_{i,t}$</td>
<td>Price of product $i$ sold locally (excluding taxes)</td>
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<td>Price of imported product $i$ (in national currency)</td>
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<td>$Purb_{t}$</td>
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<td>$PVA_{i,t}$</td>
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<td>$PWX_{i,t}$</td>
<td>World price of exported product $i$ (in foreign currency)</td>
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<td>$Q_{i,t}$</td>
<td>Demand of composite commodity $I$ (volume)</td>
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<td>Rental rate of capital in industry $j$</td>
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<td>Firms’ savings</td>
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<td>$WNag_{t}$</td>
<td>Wage rate in urban areas</td>
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<td>$YDH_{h,t}$</td>
<td>Disposable income of type $h$ households</td>
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<tr>
<td>$YF_{t}$</td>
<td>Firms’ total income</td>
</tr>
<tr>
<td>$YG_{t}$</td>
<td>Government total income</td>
</tr>
<tr>
<td>$YH_{h,t}$</td>
<td>Total income of type $h$ households</td>
</tr>
<tr>
<td>$YROW_{t}$</td>
<td>Rest of the world total income</td>
</tr>
<tr>
<td>$\delta_{k,j,t}$</td>
<td>Depreciation rate for capital for industry</td>
</tr>
</tbody>
</table>
Parameters

\(i_0\)  Leontief coefficient for intermediate consumption
\(v_j\)  Leontief coefficient for value added
\(B^v_j\)  Scale parameter for CES – value added production function
\(\beta^v_j\)  Share parameter for CES – value added production function
\(\rho^v_j\)  Elasticity parameter for CES – value added production function
\(B^f_{i,o}\)  Scale parameter for CES – composite capital function
\(\beta^f_j\)  Share parameter for CES – composite capital function
\(\rho^f_j\)  Elasticity parameter for CES – composite capital function
\(a_{ij}\)  Input-output coefficient
\(\lambda^{h}_{ag,k}\)  Share of type \(k\) capital income received by agent
\(sh_{1,h,t}\)  Savings function intercept for type \(h\) households
\(sh_{1,ag}^{h}\)  Savings function slope for type \(h\) households
\(td^f_{o,t}\)  Taxation function intercept for Firms
\(td^f_{o,h,t}\)  Taxation function intercept for type \(h\) households
\(td^f_{1,h,t}\)  Marginal income tax rate of type \(h\) households
\(tm_{i,1}\)  Rate of taxes and duties on imports of commodity \(i\)
\(\tau_{va}\)  Tax rate on commodity \(i\)
\(\lambda^{ag,ag}_{i}\)  Share parameter for transfers functions
\(tr_{1,h}\)  Transfers to government function intercept for type \(h\) households
\(\lambda^{v}_i\)  Marginal share of commodity \(i\) in type \(h\) household consumption budget
\(\lambda^{pri}_i\)  Share of commodity \(i\) in total private investment expenditure
\(\lambda^{pub}_i\)  Share of commodity \(i\) in total public investment expenditure
\(B^x_i\)  Scale parameter for CET – Export function
\(\beta^x_i\)  Share parameter for CET – Export function
\(\rho^x_i\)  Elasticity parameter for CET – Export function
\(\sigma^{x}\)  Price-elasticity of the world demand for exports of product \(i\)
\(A^{pri}_i\)  Scale parameter for private investment demand function
\(A^{pub}_i\)  Scale parameter for public investment demand function
\(\phi_{k,j}\)  Scale parameter (allocation of investment to industries)
\(\sigma^{INV}_{k,h}\)  Elasticity of private investment demand relative to Tobin’s \(q\)
\(n_t\)  Annual population rate growth