

# Appendix C: Equations of the model

This appendix provides all the equations of the model. Note that there are two versions of the household block: (1) the standard version where a LES utility function is assumed for all commodities; (2) the hybrid version where transport, car, housing and energy consumption are modeled separately.

In this appendix, lower-case variables are in logarithm  $x_t = \ln(X_t)$ .  $t$  as an index is the time operator. Variable in first difference and growth rate are respectively referred as :  $\Delta X_t = X_t - X_{t-1}$  and  $\dot{X}_t = \frac{X_t}{X_{t-1}} - 1 \approx \Delta x_t$ . All parameters written in Greek letter are positive.  $n$  as an exponent refers to notional value of a given variable that is the optimal value desired by the maximization agent: e.g.  $X_t^n$  is the notional value of variable  $X_t$ . Because of adjustment constraint, effective values adjust slowly to their notional value. The time index  $t$  is omitted when no confusion arises, e.g.  $X = X_t$ .

## 1 Aggregate equilibrium

Since each relation is written in value and in volume, the value equation defines the price.

### Equilibrium for domestically produced commodities (value & volume):

$$\begin{aligned} PQD_c.QD_c &= PCID_c.CID_c + PCHD_c.CD_c + PGD_c.GD_c + PID_c.ID_c + PXD_c.XD_c \\ &\quad + PDSD_c.DSD_c \end{aligned} \quad (1.1)$$

$$QD_c = CID_c + CHD_c + GD_c + ID_c + XD_c + DSD_c \quad (1.2)$$

### Equilibrium for imported commodities (value & volume):

$$\begin{aligned} PQM_c.QM_c &= PCIM_c.CIM_c + PCHM_c.CHM_c + PGM_c.GM_c + PIM_c.IM_c + PXM_c.XM_c \\ &\quad + PDSM_c.DSM_c \end{aligned} \quad (1.3)$$

$$QM_c = CIM_c + CHM_c + GM_c + IM_c + XM_c + DSM_c \quad (1.4)$$

### Aggregate equilibrium : calculation for variable “ Var” :

var = {Q (production of commodities at market price); CH (households' consumption);  
G (public spendings); I (private investment); DS (change in inventories); }

$$Pvar_c.var_c = PvarD_c.varD_c + PvarM_c.varM_c \quad (1.5)$$

$$var_c = varD_c + varM_c \quad (1.6)$$

### Equilibrium for exports c (value):

$$PX_c.X_c = PXD_c.XD_c + PXM_c.XM_c \quad (1.7)$$

The volume of export per commodities is defined by the foreign demand.

### Calculation of aggregates for variable "var":

var = {Q (Production of commodities at market price); CH (Households' consumption);  
G (Public spendings); X (Export); DS (Change in inventories); CI (Intermediate  
raw material); MT (Transport margins); MC (Commercial margins)}

### Aggregate domestically produced variable "var" (value & volume):

$$PvarD.varD = \sum_c PvarD_c.varD_c \quad (1.8)$$

$$varD = \sum_c varD_c \quad (1.9)$$

### Aggregate imported variable "var" (value & volume):

$$PvarM.varM = \sum_c PvarM_c.varM_c \quad (1.10)$$

$$varM = \sum_c varM_c \quad (1.11)$$

### Aggregate variable "var" (value & volume):

$$Pvar.var = PvarD.varD + PvarM.varM \quad (1.12)$$

$$var = varD + varM \quad (1.13)$$

### Equilibrium for intermediary raw material consumption domestically produced (value & volume):

$$PCID_c.CID_c = \sum_a PCID_{c,a}.CID_{c,a} \quad (1.14)$$

$$CID_c = \sum_a CID_{c,a} \quad (1.15)$$

**Equilibrium for imported intermediary raw material (value & volume):**

$$PCIM_c.CIM_c = \sum_a PCIM_{c,a}.CIM_{c,a} \quad (1.16)$$

$$CIM_c = \sum_a CIM_{c,a} \quad (1.17)$$

**Domestic intermediary raw material consumption c by activity a (value & volume):**

$$\begin{aligned} PCID_{c,a} &= PMATD_c \quad \text{if } c = \{1, \dots, 20\} \\ PCID_{c,a} &= PED_c \quad \text{if } c = \{21, \dots, 24\} \end{aligned} \quad (1.18)$$

$$\begin{aligned} CID_{c,a} &= MATD_{c,a} \quad \text{if } c = \{1, \dots, 20\} \\ CID_{c,a} &= ED_{c,a} \quad \text{if } c = \{21, \dots, 24\} \end{aligned} \quad (1.19)$$

**Imported intermediary raw material consumption c by activity a (value & volume):**

$$\begin{aligned} PCIM_{c,a} &= PMATD_c \quad \text{if } c = \{1, \dots, 20\} \\ PCIM_{c,a} &= PED_c \quad \text{if } c = \{21, \dots, 24\} \end{aligned} \quad (1.20)$$

$$\begin{aligned} CIM_{c,a} &= MATD_{c,a} \quad \text{if } c = \{1, \dots, 20\} \\ CIM_{c,a} &= ED_{c,a} \quad \text{if } c = \{21, \dots, 24\} \end{aligned} \quad (1.21)$$

**Aggregation of importations at base price (value & volume)**

$$PM.M = \sum_c PM_c.M_c \quad (1.22)$$

$$M = \sum_c M \quad (1.23)$$

**GDP (value & volume):**

**Product definition:**

$$PGDP.GDP = PCH.CH + PI.I + PG.G + PDS.DS + PX.X - PM.M \quad (1.24)$$

$$GDP = CH + I + IG + G + DS + X - M \quad (1.25)$$

**Product definition 2 (verification):**

$$PGDP_c.GDP_c = PCH_c.CH_c + PI_c.I_c + PG_c.G_c + PDS_c.DS_c + PX_c.X_c - PM_c.M_c \quad (1.26)$$

$$GDP_c = CH_c + I_c + GD_c + DS_c + XD_c - M_c \quad (1.27)$$

$$PGDPbis.GDPbis = \sum_c PGDP_c.GDP_c \quad (1.28)$$

$$GDPbis = \sum_c GDP_c \quad (1.29)$$

**Value-added definition:**

$$PGDPter.GDPter = PVA.VA + PTAX.TAX + PSUB.SUB \quad (1.30)$$

$$GDPter = VA + TAX + SUB \quad (1.31)$$

Subventions are negative.

**Equilibrium for production for domestically produced commodities at basic price (volume):**

$$\begin{aligned} YQ_c.PYQ_c = & PQD_c.QD_c - PVATD_c.VATD_c - POTHTD_c.OTHTD_c - PSUB_c.SUB_c \\ & - (PMCD_c.MCD_c + PMTD_c.MTD_c) - PENERTD_c.ENERTD_c \end{aligned} \quad (1.32)$$

$$YQbis_c = QD_c - VATD_c - OTHTD_c - SUB_c - (MCD_c + MTD_c) - ENERTD_c \quad (1.33)$$

**Equilibrium for imported produced commodities at basic price (volume):**

$$\begin{aligned} M_c.PM_c = & PQM_c.QM_c - PVATM_c.VATM_c - POTHTM_c.OTHTM_c \\ & - (PMCM_c.MCM_c + PMTM_c.MTM_c) - PENERTM_c.ENERTM_c \end{aligned} \quad (1.34)$$

$$Mbis_c = QM_c - VATM_c - OTHTM_c - (MCM_c + MTM_c) - ENERTM_c \quad (1.35)$$

**Aggregate transport margins paid on the domestically produced commodity  $c \neq \{14, \dots, 18\}$  (value & volume):**

$$PMTD_c.MTD_c = \sum_{m=14}^{18} PMTD_{m,c}.MTD_{m,c} \quad (1.36)$$

$$MTD_c = \sum_{m=14}^{18} MTD_{m,c} \quad (1.37)$$

**Aggregate transport margins paid on imported commodity  $c \neq \{14, \dots, 18\}$  (value & volume):**

$$PMTM_c.MTM_c = \sum_{m=14}^{18} PMTM_{m,c}.MTM_{m,c} \quad (1.38)$$

$$MTM_c = \sum_{m=14}^{18} MTM_{m,c} \quad (1.39)$$

**Aggregate transport margins for the commodities  $c$  (value & volume):**

$$PMT_c.MT_c = PMTD_c.MTD_c + PMTM_c.MTM_c \quad (1.40)$$

$$MT_c = MTD_c + MTM_c \quad (1.41)$$

**Domestically produced aggregate investment (value & volume):**

$$PID_c.ID_c = \sum_a PIAD_c.IAD_{c,a} \quad (1.42)$$

$$ID_c = \sum_a IAD_{c,a} \quad (1.43)$$

**Imported aggregate investment (value & volume):**

$$PIM_c.IM_c = \sum_a PIAM_c.IAM_{c,a} \quad (1.44)$$

$$IM_c = \sum_a IAM_{c,a} \quad (1.45)$$

**Value-added in activity a (value & volume)**

$$PVA_aVA_a = PY_aY_a - PMAT_a.MAT_a - PE_a.E_a \quad (1.46)$$

$$VA_a = Y_a - MAT_a - E_a \quad (1.47)$$

**Aggregate value-added (value & volume)**

$$PVA.VA = \sum_a PVA_aVA_a \quad (1.48)$$

$$VA = \sum_a VA_a \quad (1.49)$$

**EBE in activity a (value & volume)**

$$PEBE_aEBE_a = PVA_aVA_a - CL\_S_a.L\_S_a.PROG_a - PSY_a.SY_a - PIY_a.IY_a \quad (1.50)$$

$$EBE_a = VA_a - \frac{CL\_S_a.L\_S_a.PROG_a}{PEBE_a} - SY_a - IY_a \quad (1.51)$$

**Aggregate EBE (value & volume)**

$$PEBE.EBE = \sum_a PEBE_aEBE_a \quad (1.52)$$

$$EBE = \sum_a EBE_a \quad (1.53)$$

**Aggregate production (value & volume)**

$$PY.Y = \sum_a PY_aY_a \quad (1.54)$$

$$Y = \sum_a Y_a \quad (1.55)$$

## 2 The Producer

**Domestic production of commodity c by activity a (value and volume):**

$$PYQ_c.YQ_c = \sum_c PY_a.Y_{c,a} \quad (2.1)$$

$$Y_{c,a} = \varphi_{c,a}YQ_c \quad (2.2)$$

To facilitate the calibration this equation can be written:  $\ln(Y_{c,a}) = \ln(YQ_c) + \ln(\varphi_{c,a})$ . E-views will calculate automatically  $\ln(\varphi_{c,a})$  as an add factor. There is no need to calibrate the share of commodity c produced by activity a  $\varphi_{c,a}$ . To verify that  $\sum_a \varphi_{c,a} = 1$ , one can check that  $\sum_a \ln(\varphi_{c,a}) = 0$ .

### Aggregate (domestic) production of activity a (volume):

$$Y_a = \sum_a Y_{c,a} \quad (2.3)$$

### Level I:

#### Demand for input in activity a:

$$\begin{aligned} \Delta k_{a,t}^n &= \Delta y_{a,t} - \Delta prog_{a,t}^K + \Delta SUBST\_K_{a,t} \\ \Delta SUBST\_K_{a,t}^n &= -\eta_a^{KL} \varphi_{a,t-1}^L \Delta(c_{a,t}^K - c_{j,t}^L) - \eta_a^{KE} \varphi_{a,t-1}^E \Delta(c_{a,t}^K - p_{a,t}^E) - \eta_a^{KMat} \varphi_{a,t-1}^{Mat} \Delta(c_{a,t}^K - p_{a,t}^{Mat}) \end{aligned} \quad (2.4)$$

$$\begin{aligned} \Delta l_{a,t}^n &= \Delta y_{a,t} - \Delta prog_{a,t}^L + \Delta SUBST\_L_{a,t} \\ \Delta SUBST\_L_{a,t}^n &= -\eta_a^{KL} \varphi_{a,t-1}^K \Delta(c_{a,t}^L - c_{a,t}^K) - \eta_a^{LE} \varphi_{a,t-1}^E \Delta(c_{a,t}^L - p_{a,t}^E) - \eta_j^{LM} \varphi_{a,t-1}^{Mat} \Delta(c_{a,t}^L - p_{a,t}^{Mat}) \end{aligned} \quad (2.5)$$

Assuming that the adjustment process is defined according to Equations (8.1), (8.2) and (8.3), the full dynamic for labor is also defined by the three following additional relations:

$$\begin{aligned} \ln(L_{a,t}) &= \lambda_0^L \ln(L_{a,t}^n) + (1 - \lambda_0^L) \ln(L_{a,t-1} + \Delta \ln(L_{a,t}^e)) \\ \Delta \ln(L_{a,t}^e) &= \lambda_1^L \Delta \ln(L_{a,t-1}^e) + \lambda_2^L \Delta \ln(L_{a,t-1}) + \lambda_3^L \Delta \ln(L_{a,t}^n) + \lambda_4^L \Delta \ln(L_{a,t+1}) \\ SUBST\_L_{a,t} &= \lambda_5^L SUBST\_L_{a,t}^n + (1 - \lambda_5^L) SUBST\_L_{a,t-1} \end{aligned}$$

For the sake of concision, the representation of adjustment dynamic [Equations(8.1),(8.2) and(8.3)] is not reproduced for each variable. Only notional variables are presented in the rest of the document.

$$\begin{aligned} \Delta e_{a,t}^n &= \Delta y_{a,t} - \Delta prog_{a,t}^E + \Delta SUBST\_E_{a,t} \\ \Delta SUBST\_E_{a,t}^n &= -\eta_a^{KE} \varphi_{a,t-1}^K \Delta(p_{a,t}^E - c_{a,t}^K) - \eta_a^{LE} \varphi_{a,t-1}^L \Delta(p_{a,t}^E - c_{a,t}^L) - \eta_a^{EMat} \varphi_{a,t-1}^{Mat} \Delta(p_{a,t}^E - p_{a,t}^{Mat}) \end{aligned} \quad (2.6)$$

$$\begin{aligned} \Delta mat_{a,t}^n &= \Delta y_{a,t} - \Delta prog_{a,t}^{Mat} + \Delta SUBST\_Mat_{a,t} \\ \Delta SUBST\_Mat_{a,t}^n &= -\eta_j^{KLMat} \varphi_{a,t-1}^K \Delta(p_{a,t}^{Mat} - c_{a,t}^K) - \eta_a^{LMat} \varphi_{a,t-1}^L \Delta(p_{a,t}^{Mat} - c_{a,t}^L) \\ &\quad - \eta_a^{EMat} \varphi_{a,t-1}^E \Delta(p_{a,t}^{Mat} - p_{a,t}^{Mat}) \end{aligned} \quad (2.7)$$

$$\text{with } \varphi_a^j = \frac{P_{j,a}^{Input} I_{j,a}^{Input}}{\sum_j P_{j,a}^{Input} I_{j,a}^{Input}} \text{ and } j = \{K, L, E, Mat\}$$

**Commodity type c investment in activity a:**

$$\Delta ia_{c,a} = \Delta ia_a \quad (2.8)$$

**Aggregate capital stock in activity a (value & volume):**

$$PK_{a,t}.K_{a,t} = PK_{a,t-1}K_{a,t-1}(1 - \delta_a) + PIA_{a,t}.IA_{a,t} \quad (2.9)$$

$$K_{a,t} = K_{a,t-1}(1 - \delta_a) + IA_{a,t} \quad (2.10)$$

$$\Delta ia_{a,t} = \rho_1^{IA}.\Delta ia_{a,t-1} + \rho_2^{IA}\Delta y_{a,t}^e + \rho_3^{IA}(k_{a,t-1}^n - k_{a,t-1}) + \rho_4^{IA}.\Delta SUBST_a^K \quad (2.11)$$

$$y_{a,t}^e = \rho_1^{ye}.\Delta y_{a,t-1}^e + \rho_2^{ye}\Delta y_{a,t} \quad (2.12)$$

The equation gives the average price of the installed capital capacity. Because the capital depreciation rate is lower than 1, the average price of the installed capital is lower than the investment price. When the economy is at the steady state  $PK_a = PIA_a \frac{(\delta_a + \mu)(1 + \pi)}{\delta_a - 1 + (1 + \mu)(1 + \pi)}$ . This relation was used to calibrate the base year.

**Transport margins  $m = \{14, \dots, 18\}$  paid on domestic commodities  $c \neq m$  (volume):**

$$\Delta mtd_{m,c} = \Delta yq_c + \Delta SUBST\_MTD_{m,c} \text{ for } c \neq m \quad (2.13)$$

$$\Delta SUBST\_MTD_{m,c}^n = - \sum_{m'=14}^{18} \eta^{m,m'} \varphi_{mtd',c} \Delta(p_m^E - p_{m'}^E)$$

**Transport margins  $m = \{14, \dots, 18\}$  paid on imported commodities  $c \neq m$  (volume):**

$$\Delta mtm_{m,c} = \Delta m_c + \Delta SUBST\_MTM_{m,c} \text{ for } c \neq m \quad (2.14)$$

$$\Delta SUBST\_MTM_{m,c}^n = - \sum_{m'=14}^{18} \eta^{m,m'} \varphi_{mtd',c} \Delta(p_m^E - p_{m'}^E)$$

**Commercial margins  $m = 19$  paid on domestic commodities  $c \neq 19$  (volume):**

$$\Delta mcd_c = \Delta yq_c \text{ for } c \neq 19 \quad (2.15)$$



**Commercial margins  $m = 19$  paid on imported commodities  $c \neq 19$  (volume):**

$$\Delta mcm_c = \Delta m_c \text{ for } c \neq 19 \quad (2.16)$$

**Stock/inventories for commodity  $c$  (domestic & imported):**

We assume that inventories are equal to a share of the annual production  $\alpha_c^S = (\text{Number of days of sales})/365$ .

$$DSD_c = \Delta SD_c \quad (2.17)$$

$$SD_c^n = \alpha_c^S (CID_c + CHD_c + GD_c + ID_c + XD_c) \quad (2.18)$$

$$DSM_c = \Delta SM_c \quad (2.19)$$

$$SM_c^n = \alpha_c^S (CIM_c + CHM_c + GM_c + IM_c + XM_c) \quad (2.20)$$

**Level II:**

**Notional demand in energy  $c$  by activity  $a$**

$$\begin{aligned} \Delta e_{c,a} &= \Delta e_a + \Delta SUBST\_E_{c,a} \\ \Delta SUBST\_E_{c,a,t}^n &= - \sum_{c'=21}^{24} \eta^{cc'} \varphi_{c',a,t-1} \Delta \left( \frac{P_{c,a,t-1}^{TEP}}{P_{c',a,t-1}^{TEP}} \cdot p_{c,a,t}^E - \frac{P_{c',a,t-1}^{TEP}}{P_{c,a,t-1}^{TEP}} \cdot p_{c',a,t}^E \right) \end{aligned} \quad (2.21)$$

Note that here the notional variable is not presented since we assume that the adjustment is instantaneous. However there is still a dynamic for substitution according to the adjustment process defined by Equation (8.3):

**Self employed and employed**

$$\Delta L\_S_a = \Delta L_a \quad (2.22)$$

$$L\_SE_a = L_a - L\_S_a$$

$$L\_S = \sum_a L\_S_a \quad (2.23)$$

$$L\_SE = \sum_a L\_SE_a \quad (2.24)$$

**Notional demand for material  $i$  of the sector  $a$**

$$\Delta mat_{c,a} = \Delta mat_a + \Delta SUBST\_MAT_{c,a} \quad (2.25)$$

$$\Delta SUBST\_MAT_{c,a,t}^n = - \sum_{c'=14}^{18} \eta^{cc'} \varphi_{c',a,t-1} \Delta (p_{c,a,t}^{Mat} - p_{c',a,t}^{Mat})$$

### Level III:

**Demand for imported material c of the sector a (for c=1...20)**

$$\begin{aligned}\Delta matm_{c,a}^n &= \Delta mat_{c,a} + \Delta SUBST\_MATM_{c,a} \\ \Delta SUBST\_MATM_{c,a,t}^n &= -\eta^{cd,cm} \varphi_{c,a,t-1} \Delta(p_{c,t}^{MatM} - p_{c,t}^{MatD})\end{aligned}\quad (2.26)$$

**Demand for domestic material c of the sector a (for c=1...20)**

$$\begin{aligned}\Delta matd_{c,a,t}^n &= \Delta mat_{c,a,t} + \Delta SUBST\_MATD_{a,t} \\ \Delta SUBST\_MATD_{c,a,t}^n &= -\eta^{cd,cm} \varphi_{c,a,t-1} \Delta(p_{c,t}^{MatD} - p_{c,t}^{MatM})\end{aligned}\quad (2.27)$$

**Demand for imported energy c of the sector a (for c=21...24)**

$$\begin{aligned}\Delta em_{c,a,t} &= \Delta e_{c,a,t} + \Delta SUBST\_EM_{c,a,t} \\ \Delta SUBST\_EM_{c,a,t}^n &= -\eta^{cm,cd} \varphi_{c,a,t-1}^EM \Delta(p_{c,t}^{EM} - p_{c,t}^{ED})\end{aligned}\quad (2.28)$$

**Demand for domestic energy c of the sector a (for c=21...24)**

$$\begin{aligned}\Delta ed_{c,a} &= \Delta e_{c,a} + \Delta SUBST\_ED_{c,a} \\ \Delta SUBST\_ED_{c,a,t}^n &= -\eta^{cd,cm} \varphi_{c,a,t-1}^{ED} \Delta(p_{c,t}^{ED} - p_{c,t}^{EM})\end{aligned}\quad (2.29)$$

**Allocation of Investment between Import and Domestic:**

**Import:**

$$\begin{aligned}\Delta iam_{c,a} &= \Delta ia_{c,a} + \Delta SUBST\_IAM_{c,a,t} \\ \Delta SUBST\_IAM_{c,a,t}^n &= -\eta^{cd,cm} \varphi_{c,a,t-1}^{IAM} \Delta(p_{c,t}^{IAM} - p_{c,t}^{IAD})\end{aligned}\quad (2.30)$$

**Domestic:**

$$\begin{aligned}\Delta iad_{c,a,t} &= \Delta ia_{c,a,t} + \Delta SUBST\_IAD_{c,a,t} \\ \Delta SUBST\_IAD_{c,a,t}^n &= -\eta^{cd,cm} \varphi_{c,a,t-1}^{IAM} \Delta(p_c^{IAD} - p_c^{IAM})\end{aligned}\quad (2.31)$$

**Transport margins  $m = \{14, \dots, 18\}$  domestically produced (value & volume):**

$$PMTD_m.MTD_m = -\frac{YQ_m}{YQ_m + M_m} \sum_c (PMTD_{m,c}.MTD_{m,c} + PMTM_{m,c}.MTM_{m,c}) \text{ for } c \neq m \quad (2.32)$$

$$MTD_m = -\frac{YQ_m}{YQ_m + M_m} \sum_c (MTD_{m,c} + MTM_{m,c}) \text{ for } c \neq m \quad (2.33)$$

**Imported transport margins  $m = \{14, \dots, 18\}$  (value & volume):**

$$PMTM_m.MTM_m = -\frac{M_m}{YQ_m + M_m} \sum_c (PMTD_{m,c}.MTD_{m,c} + PMTM_{m,c}.MTM_{m,c}) \text{ for } c \neq m \quad (2.34)$$

$$MTM_m = -\frac{M_m}{YQ_m + M_m} \sum_c (MTD_{m,c} + MTM_{m,c}) \text{ for } c \neq m \quad (2.35)$$

**Commercial margins domestically produced (value & volume):**

$$PMCD_{19}.MCD_{19} = -\frac{YQ_{19}}{YQ_{19} + M_{19}} \sum_c (PMCD_c.MCD_c + PMCM_c.MCM_c) \text{ for } c \neq 19 \quad (2.36)$$

$$MCD_{19} = -\frac{YQ_{19}}{YQ_{19} + M_{19}} \sum_c (MCD_c + MCM_c) \text{ for } c \neq 19 \quad (2.37)$$

**Imported commercial margins (value & volume):**

$$PMCM_{19}.MCM_{19} = -\frac{M_{19}}{YQ_{19} + M_{19}} \sum_c (PMCD_c.MCD_c + PMCM_c.MCM_c) \text{ for } c \neq 19 \quad (2.38)$$

$$MCM_{19} = -\frac{M_{19}}{YQ_{19} + M_{19}} \sum_c (MCD_c + MCM_c) \text{ for } c \neq 19 \quad (2.39)$$

**Export**

$$\begin{aligned} \Delta x_{c,t} &= \Delta wd_{c,t} + \Delta SUBST_- X_{c,t} \\ \Delta SUBST_- X_{c,t}^n &= -\eta^x \Delta(p_{c,t}^X - tc.p_{c,t}^W) \end{aligned} \quad (2.40)$$

**Exportations of domestic products:**

$$\begin{aligned} \Delta xd_{c,t} &= \Delta x_{c,t} + \Delta SUBST_- XD_{c,t} \\ \Delta SUBST_- XD_{c,t}^n &= -\eta^{xd} \varphi_{c,t-1}^{XM} \Delta(p_{c,t}^{XD} - p_{c,t}^{XM}) \end{aligned} \quad (2.41)$$

**Exportations of imported products:**

$$\begin{aligned}\Delta x_{m_{c,t}} &= \Delta x_{c,t} + \Delta SUBST\_XM_{c,t} \\ \Delta SUBST\_XM_{c,t}^n &= -\eta^{xd} \varphi_{c,t-1}^{XD} \Delta(p_{c,t}^{XM} - p_{c,t}^{XD})\end{aligned}\tag{2.42}$$

**External balance**

$$DC\_VAL_a = PX_a \cdot X_a - PM_a \cdot M_a\tag{2.43}$$

$$DC\_VAL = \sum_a DC\_VAL_a\tag{2.44}$$

### 3 The government

**Tax on energy c domestically produced (value & volume):**

$$PENERTD_{c,t} \cdot ENERTD_{c,t} = T_{c,t}^{ENERTD} \cdot YQ_{c,t}\tag{3.1}$$

$$ENERTD_{c,t} = T_{c,0}^{ENERTD} \cdot YQ_{c,t}\tag{3.2}$$

We assume that the tax is proportional to the quantity produced. Only the 4 energy sectors pay this tax: TIPP, TICE, etc.

**Tax on imported energy c (value & volume):**

$$PENERTM_{c,t} \cdot ENERTM_{c,t} = T_{c,t}^{ENERTM} \cdot M_{c,t}\tag{3.3}$$

$$ENERTM_{c,t} = T_{c,0}^{ENERTM} \cdot M_{c,t}\tag{3.4}$$

**Tax on energy c (value & volume):**

$$PENERT_c \cdot ENERT_c = PENERTM_c \cdot ENERTM_c + PENERTD_c \cdot ENERTD_c\tag{3.5}$$

$$ENERT_c = ENERTM_c + ENERTD_c\tag{3.6}$$

**Agregate tax on energy (value & volume):**

$$PENERT.ENERT = \sum_c PENERT_c.ENERT_c \quad (3.7)$$

$$ENERT = \sum_c ENERT_c \quad (3.8)$$

**VAT tax on commodity c (value & volume):**

$$PVATD_{c,t}.VATD_{c,t} = \frac{PCHD_{c,t}.CHD_{c,t}}{1 + T_{c,t}^{VATD}} + T_{c,t}^{VATD_{oth}} \frac{PID_{c,t}.ID_{c,t} + PCID_{c,t}.CID_{c,t} + PGD_{c,t}.GD_{c,t}}{1 + T_{c,t}^{VATD_{oth}}} \quad (3.9)$$

$$VATD_{c,t} = T_{c,0}^{VATD} \frac{CHD_{c,t}}{1 + T_{c,0}^{VATD}} + T_{c,0}^{VATD_{oth}} \frac{ID_{c,t} + CID_{c,t} + GD_{c,t}}{1 + T_{c,0}^{VATD_{oth}}} \quad (3.10)$$

$$PVATM_{c,t}.VATM_{c,t} = T_{c,t}^{VATM} \frac{PCHM_{c,t}.CHM_{c,t}}{1 + T_{c,t}^{VATM}} + T_{c,t}^{VATM_{oth}} \frac{PIM_{c,t}.IM_{c,t} + PCIM_{c,t}.CIM_{c,t} + PGM_{c,t}.GM_{c,t}}{1 + T_{c,t}^{VATM_{oth}}} \quad (3.11)$$

$$VATM_{c,t} = T_{c,0}^{VATM} \frac{CHM_{c,t}}{1 + T_{c,0}^{VATM}} + T_{c,0}^{VATM_{oth}} \frac{IM_{c,t} + CIM_{c,t} + GM_{c,t}}{1 + T_{c,0}^{VATM_{oth}}} \quad (3.12)$$

**VAT tax on commodity c (value & volume):**

$$PVAT_c.VAT_c = PVATD_c.VATD_c + PVATM_c.VATM_c \quad (3.13)$$

$$VAT_c = VATD_c + VATM_c \quad (3.14)$$

**Agregate VAT (value & volume):**

$$PVAT.VAT = \sum_c PVAT_c.VAT_c \quad (3.15)$$

$$VAT = \sum_c VAT_c \quad (3.16)$$

**Other tax on commodity c (value & volume):**

$$POTHTD_{c,t} \cdot OTHTD_{c,t} = T_{c,t}^{OTHTD} \cdot PYQ_{c,t} \cdot YQ_{c,t} \quad (3.17)$$

$$OTHTD_{c,t} = T_{c,0}^{OTHTD} \cdot YQ_{c,t} \quad (3.18)$$

$$POTHTM_{c,t} \cdot OTHTM_{c,t} = T_{c,t}^{OTHTM} \cdot PM_{c,t} \cdot M_{c,t} \quad (3.19)$$

$$OTHTM_{c,t} = T_{c,0}^{OTHTM} \cdot M_{c,t} \quad (3.20)$$

**Other tax on commodity c (value & volume):**

$$POTHT_c \cdot OTHT_c = POTHTD_c \cdot OTHTD_c + POTHTM_c \cdot OTHTM_c \quad (3.21)$$

$$OTHT_c = OTHTD_c + OTHTM_c \quad (3.22)$$

**Agregate other tax (value & volume):**

$$POTHT \cdot OTHT = \sum_c POTHT_c \cdot OTHT_c \quad (3.23)$$

$$OTHT = \sum_c OTHT_c \quad (3.24)$$

**Total tax on commodity (value & volume):**

$$PTAX_c \cdot TAX_c = PVAT_c \cdot VAT_c + PENERT_c \cdot ENERT_c + POTHT_c \cdot OTHT_c \quad (3.25)$$

$$TAX_c = VAT_c + ENERT_c + OTHT_c \quad (3.26)$$

**Agregate tax (value & volume):**

$$PTAX \cdot TAX = \sum_c PTAX_c \cdot TAX_c \quad (3.27)$$

$$TAX = \sum_c TAX_c \quad (3.28)$$

**Taxes on benefits (value & volume):**

$$PIS_a \cdot IS_{a,t} = T_t^{IS} \cdot PEBE_{a,t-1} \cdot EBE_{a,t-1} \quad (3.29)$$

$$IS_{a,t} = T_0^{IS} \cdot EBE_{a,t-1} \quad (3.30)$$

**Agregate tax on benefits (value & volume):**

$$PIS.IS = \sum_a PIS_a.IS_a \quad (3.31)$$

$$IS = \sum_a PIS_a \quad (3.32)$$

**Taxes on income (value):**

$$IR_{h,t} VAL = T_0^{IR}.DISPINC_{h,t}^{AI} VAL \quad (3.33)$$

**Agregate tax on income (value):**

$$IR VAL = \sum_h IR_{h,t} VAL \quad (3.34)$$

**Taxes on capital (value):**

$$AIC_{h,t} VAL = T_t^{AIC}.DISPINC_{h,t}^{AI} VAL \quad (3.35)$$

**Agregate tax on Capital (value):**

$$AIC VAL = \sum_h AIC_{h,t} VAL \quad (3.36)$$

**Subvention on commodity c (value & volume):**

$$PSUB_{c,t}.SUB_{c,t} = T_{c,t}^{SUB}.YQ_{c,t} \quad (3.37)$$

$$SUB_{c,t} = T_{c,0}^{SUB}.YQ_{c,t} \quad (3.38)$$

We assume that the subvention is proportional to the quantity produced which is true in most cases (in particular for agriculture). Consequently the price of the subvention grows at the same rate as the subvention. For simplicity, we assume that in equilibrium, the subvention rate grows at the rate of inflation.

**Subvention on commodity c (value & volume):**

$$PSUB.SUB = \sum_c PSUB_c.SUB_c \quad (3.39)$$

$$SUB = \sum_c SUB_c \quad (3.40)$$

**Tax on activities (value & volume)**

$$PIY_a.IY_a = TIYN_{a,t}.PY_a.Y_a \quad (3.41)$$

$$IY_a = TIYN_{a,0}.Y_a \quad (3.42)$$

**Aggregate Tax on activities (value & volume)**

$$PIY.IY = \sum_a PIY_a.IY_a \quad (3.43)$$

$$IY = \sum_a IY_a \quad (3.44)$$

**Subventions on activities (value & volume)**

$$PSY_a.SY_a = TSYN_a.PY_a.Y_a \quad (3.45)$$

$$SY_a = TSYN_{a,0}.Y_a \quad (3.46)$$

**Aggregate subventions on activities (value & volume)**

$$PSY.SY = \sum_a PSY_a.SY_a \quad (3.47)$$

$$SY = \sum_a SY_a \quad (3.48)$$

**Social Security Accounting:Employer Social Contribution**

$$CSE_a.PCSE_a = T_{a,t}^{CSE}.L\_S_a.W\_S_a \quad (3.49)$$

$$PCSE_a = PCH_{19} \quad (3.50)$$

**Aggregate Employer Social Contribution (value & volume)**

$$PCSE.CSE = \sum_a PCSE_a.CSE_a \quad (3.51)$$

$$CSE = \sum_a CSE_a \quad (3.52)$$

**Employer Social Contribution from the rest of the world**

$$CSE^{ROW}.PCSE^{ROW} = T_{a,t}^{CSE^{ROW}}SB^{ROW} \quad (3.53)$$

$$PCSE^{ROW} = PCH_{19} \quad (3.54)$$



**Total employer Social Contribution (in value & volume)**

$$PCSE^{TOT}.CSE^{TOT} = PCSE.CSE + PCSE^{ROW}.CSE^{ROW} \quad (3.55)$$

$$CSE^{TOT} = CSE + CSE^{ROW} \quad (3.56)$$

**Social Security Accounting:Salary Social Contribution**

$$CSS_a.PCSS_a = T_t^{CSS}.L_a.W_{-}S_a \quad (3.57)$$

$$PCSS_a = PCH_{19} \quad (3.58)$$

**Social Security Accounting:Salary Social Contribution of self-employed labor**

$$CSS_{-}SE.PCSS^{SE} = T_t^{CSS_{-}SE}.L_{-}SE.W_{-}SE_{19} \quad (3.59)$$

$$PCSS^{SE} = PCH_{19} \quad (3.60)$$

**Aggregate Employer Social Contribution (value & volume)**

$$PCSS.CSS = \sum_a PCSS_a.CSS_a \quad (3.61)$$

$$CSS = \sum_a CSS_a \quad (3.62)$$

$$PCSS_{-}SE.CSS_{-}SE = \sum_a PCSS_a^{SE}.CSS_a^{SE} \quad (3.63)$$

$$CSS_{-}SE = \sum_a CSS_a^{SE} \quad (3.64)$$

**Total Employer Social Contribution (value & volume)**

$$PCSS^{TOT}.CSS^{TOT} = PCSS.(CSS + CSS^{ROW}) + PCSS_{-}SE.CSS_{-}SE \quad (3.65)$$

$$CSS^{TOT} = CSS + CSS_{-}SE + CSS^{ROW} \quad (3.66)$$

**Receipts from the private activity (in value and volume)**

$$DIV^{GOV}_{-}VAL = \sum_a DIV_a^{GOV}_{-}VAL \quad (3.67)$$

### Public receipts (in value & volume)

$$\begin{aligned}
 REC\_VAL = & PY_{20}.Y_{20} + PTAX.TAX + PIY.IY + PSY.SY + PIS.IS \\
 & + IR\_VAL + AIC\_VAL + PCSE^{TOT}.CSE^{TOT} + PCSS^{TOT}.CSS^{TOT} \\
 & + DIV^{GOV}\_VAL + TCO^{VAL}
 \end{aligned} \tag{3.68}$$

### Social Prestations

$$PRESOC\_DOM^U\_VAL = 0.3.W\_S.Un\_TOT \tag{3.69}$$

$$PRESOC\_DOM^{Oth}\_VAL = PRESOC\_DOM_{t-1}^{Oth} \cdot (1 + \dot{P} + \Delta pop) - \eta^{prest} \cdot \Delta un \tag{3.70}$$

$$PRESOC\_DOM\_VAL = PRESOC\_DOM^U\_VAL + PRESOC\_DOM^{Oth}\_VAL \tag{3.71}$$

### Decomposition of Social Prestation between domestic and foreign destinations

$$PRESOC\_VAL = PRESOC\_DOM\_VAL + PRESOC\_ROW\_VAL \tag{3.72}$$

### Total expenditure by product c:

PEXP\_{\{13,h\}}

$$PEXPG.EXPG = \sum_c PEXPG_c.EXPG_c \tag{3.73}$$

$$EXPG = \sum_c EXPG_c \tag{3.74}$$

$$PEXPG_c = PG_c \tag{3.75}$$

$$\Delta expg_{c,t} = \Delta expg_t \tag{3.76}$$

**Domestic and imported government consumptions in commodity c:**

$$\begin{aligned}\Delta gd_{c,t} &= \Delta exp_{c,t} + \Delta SUBST\_GD_{c,t} \\ \Delta SUBST\_GD_{c,t}^n &= \eta^{cd,cm} \varphi_{chm,c} \Delta(p^{GD} - p^{GM})\end{aligned}\quad (3.77)$$

$$\begin{aligned}\Delta gm_{c,t} &= \Delta exp_{c,t} + \Delta SUBST\_GM_{c,t} \\ \Delta SUBST\_GM_{c,t}^n &= \eta^{cd,cm} \varphi_{chd,c} \Delta(p_c^{GM} - p_c^{GD})\end{aligned}\quad (3.78)$$

**Public spendings (in value & volume)**

$$\begin{aligned}DEP\_VAL &= (NCU_{20,Y_{20}}) + PRESOC\_VAL \\ &\quad + PRESOC\_VAL + PG.G + R\_G_{t-1}.DEBT\_G\_VAL_{t-1} \\ &\quad - PSUB.SUB + DEP^{TCO}\_VAL + CIDD + (BONUS - MALUS)\end{aligned}\quad (3.79)$$

**Public Deficit (in value & volume)**

$$BF\_G\_VAL = DEP\_VAL - REC\_VAL + BF\_G\_VAL_{ajust} \quad (3.80)$$

$$DP\_G\_VAL = BF\_G\_VAL / PGDP * GDP \quad (3.81)$$

**Dynamic of the public debt (in value & volume):**

$$DEBT\_G\_VAL = DEBT_{T-1}\_G\_VAL + BF\_G\_VAL \quad (3.82)$$

**The Carbon Tax**

$$TCOD\_VAL_e = T^{TCO}.IC_e.YQ_e \quad (3.83)$$

$$TCOM\_VAL_e = T^{TCO}.IC_e.M_e \quad (3.84)$$

$$TCO\_VAL_e = TCOM\_VAL_e + TCOD\_VAL_e \quad (3.85)$$

$$TCO\_VAL = \sum TCO\_VAL_e \quad (3.86)$$

$$REC\_TCO\_VAL = TCO\_VAL \quad (3.87)$$

$$R^{TCO}\_H = \alpha^{TCO}.REC\_TCO\_VAL \quad (3.88)$$

$$R^{TCO}_h = \varphi^{TCO_h} R^{TCO}\_H \quad (3.89)$$

$$R^{TCO}_E = \varphi^{TCO_h} REC\_TCO\_VAL \quad (3.90)$$

## 4 The consumer: households and households hybrid

**Average wage:**

$$W\_S.L\_S = \sum_a W\_S a.L\_S a \quad (4.1)$$

$$W\_SE.L\_SE = \sum_a W\_SE a.L\_SE a \quad (4.2)$$

$$CL\_S.L\_S = \sum_a CL\_S a.L\_S a \quad (4.3)$$

$$CL\_SE.L\_SE = \sum_a CL\_SE a.L\_SE a \quad (4.4)$$

$$W.L = W\_S.L\_S + W\_SE.L\_SE \quad (4.5)$$

$$CL.L = CL\_S.L\_S + CL\_SE.L\_SE \quad (4.6)$$

$$L = L\_S + L\_SE \quad (4.7)$$

**Decomposition of Financial Wealth:**

$$DIV^{HH}\_VAL = \sum_a DIV_a^{HH} \quad (4.8)$$

$$FW\_VAL = DIV^{HH}\_VAL + INT^{HH}\_VAL \quad (4.9)$$

**Total disposable income before taxes:**

$$DISPINC^{AI}\_VAL = (W\_S.L\_S + SB^{ROW}).(1 - TCSS) + W\_SE.L\_SE.(1 - TCSS\_SE) \quad (4.10)$$

$$+ PRESOC^{DOM}\_VAL + FW\_VAL + TR^{ROW}\_VAL$$

**Disposable income before taxes for household h:**

$$DISPINC_h^{AI}\_VAL = \varphi_h^{DISPINC}.DISPINC^{AI}\_VAL \quad (4.11)$$

In a future version, we may assume that  $\varphi$  varies according the the components of the disposable income.

**Net Disposable income for household h:**

$$DISPINC_h\_VAL = DISPINC_h^{AI}\_VAL - IR_h\_VAL - AIC_h\_VAL + RTCO_h \quad (4.12)$$

$$DISPINC\_VAL = \sum DISPIN_h\_VAL \quad (4.13)$$

**Household h's total expenditures (value & volume):**

$$PEXP_h.EXP_h = \sum_c PEXP_{c,h}.EXP_{c,h} \quad (4.14)$$

$$EXP_h = \sum_c .EXP_{c,h} \quad (4.15)$$

$$EXPH = \sum_h .EXP_h \quad (4.16)$$

$$PEXPH.EXPH = \sum PEXP_h.EXP_h \quad (4.17)$$

**Marginal propension to save:**

$$\Delta MPS_h = \beta_1 \Delta (UNR\_TOT) + \beta_2 \Delta (R - infl\_FR) + \beta_3 \Delta \left( \frac{DEBT\_G^{VAL}}{PGDP.GDP} \right) \quad (4.18)$$

**Savings equation:**

$$S_h = DISPINC_h\_VAL - PEXP_h.EXP_h \quad (4.19)$$

$$TS_h = \frac{DISPINC_h\_VAL - PEXP_h.EXP_h}{DISPINC_h\_VAL} \quad (4.20)$$

$$S_h = DISPINC_h\_VAL - PEXP_h.EXP_h \quad (4.21)$$

$$TS = \frac{S}{DISPINC\_VAL} \quad (4.22)$$

#### 4.1 The households (LES)

c={01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24}

**Notional household h's expenditures in commodity c:**

$$EXP_{c,h}^n.PEXP_{c,h} = PEXP_{c,h}.NEXP_{c,h} + \beta_{c,h}^{EXP} (DISPINC\_VAL_h \cdot (1 - MPS_h) - PNEXP_h.NEXP_h) \quad (4.23)$$

$\beta_{c,h,0}^{EXP} = (PEXP_{c,h,0}.EXP_{c,h,0} - PEXP_{c,h,0}.NEXP_{c,h,0}) / (PEXP_{h,0}.EXP_{h,0} - PNEXP_{h,0}.NEXP_{h,0})$  is calibrated by inverting the above equation at the base year.

**Household h's marginal propension to spend in commodity c:**

$$\Delta\beta_{c,h}^{EXP} = (1 - \eta^{LES-CES}) \cdot \Delta \frac{PEXP_{c,h}}{PEXP_h^{CES}} \quad (4.24)$$

$$PEXP_h^{CES} = \left[ \sum_c \beta_{c,h,0}^{EXP} \cdot PEXP_{c,h}^{(1-\eta^{LES-CES})} \right]^{\frac{1}{1-\eta^{LES-CES}}} \quad (4.25)$$

**Household h's total necessary expenditures (value & volume):**

$$PNEXP_h \cdot NEXP_h = \sum_c PEXP_{c,h} \cdot NEXP_{c,h} \quad (4.26)$$

$$NEXP_h = \sum_c NEXP_{c,h} \quad (4.27)$$

**Total expenditure by product c:**

$$PEXP_c \cdot EXP_c = \sum_h PEXP_{c,h} \cdot EXP_{c,h} \quad (4.28)$$

$$EXP_c = \sum_h EXP_{c,h} \quad (4.29)$$

$$\phi_{c,h}^{EXP} = EXP_{c,h} / EXP_c \quad (4.30)$$

**Household h's expenditures price c:**

$$PEXP_{c,h} = PCH_c \quad (4.31)$$

**Domestic and imported households' consumption in commodity c:**

$$\Delta CHD_{c,t} = \Delta EXP_{c,t} + \Delta SUBST\_CHD_{c,t} \quad (4.32)$$

$$\Delta SUBST\_CHD_{c,t}^n = \eta^{LVLA-HH} \Delta(pchd_c - pchm_c) \cdot \frac{PCHD_{c,t-1} \cdot CHD_{c,t-1}}{PCH_{c,t-1} \cdot CH_{c,t-1}}$$

$$\Delta CHM_{c,t} = EXP_{c,t} - CHD_c \quad (4.33)$$

$$\Delta SUBST\_CHM_{c,t}^n = \eta^{LVLA-HH} \Delta(pchm_c - pchd_c) \cdot \frac{PCHM_{c,t-1} \cdot CHM_{c,t-1}}{PCH_{c,t-1} \cdot CH_{c,t-1}}$$

**Ajustment LES:**

$$exp_{c,h,t} = \mu_1 exp_{c,h,t}^n + (1 - \mu_1) \cdot (exp_{c,h,t-1} + \Delta exp_{c,h}^e) \quad (4.34)$$

$$\Delta exp_{c,h,t}^e = \mu_2 \Delta exp_{c,h,t-1}^e + \mu_3 \Delta exp_{c,h,t-1} + \mu_4 \Delta exp_{c,h,t}^n \quad (4.35)$$

## 4.2 Household Hybrid

### Building stock dynamic

$$\Delta BUIL_{h,k,t} = \varphi_{h,k}^{NewBUIL} (\Delta BUIL_{h,t} + BUIL_{h,0,t}) \quad (4.36)$$

$$\begin{aligned} & + \sum_{k'=0}^{k-1} REHAB_{h,k',k} - \sum_{k'=k+1}^K REHAB_{h,k,k'} \\ & - \sum_{k'=0}^{k-1} \delta_{h,k,k'}^{BUIL} BUIL_{h,k,t-1} + \sum_{k'=k+1}^K \delta_{h,k',k}^{BUIL} BUIL_{h,k',t-1} \end{aligned}$$

$$BUIL_{h,0,t} = \sum_k \delta_{h,k,0}^{BUIL} BUIL_{h,k,t-1} \quad (4.37)$$

$$\Delta BUIL = \Delta pop + \Delta M2percapita \quad (4.38)$$

### Aggregation of building stock

$$BUIL_k = \sum_h BUIL_{h,k}$$

$$BUIL = \sum_h BUIL_h$$

### Proportion of the the category K's rehabilitated building

$$\Delta \tau_{h,k}^{REHAB-n} = \Delta \tau_{h,k}^{REHAB-trend} + \eta_{h,k} \frac{UC_{h,k}^{REHAB}}{UC_{h,k}} \quad (4.39)$$

$$\begin{aligned} \tau_{h,k}^{REHAB} &= \tau_{h,k}^{REHAB-*} \quad (* = L, H, n) \\ 0 \leq \tau_{h,k}^{REHAB-L} &\leq \tau_{h,k}^{REHAB} \leq \tau_{h,k}^{REHAB-H} \leq 1 \end{aligned} \quad (4.40)$$

## Rehabilitation of building

$$REHAB_{h,k,k'} = \varphi_{h,k,k'}^{REHAB} \cdot \tau_{h,k}^{REHAB} BUIL_{h,k,t-1} \quad (4.41)$$

$$\sum_{k'} \varphi_{h,k,k'}^{REHAB} = 1 \quad (4.42)$$

## The user cost of building rehabilitation

$$UC_{h,k}^{REHAB} = UC_{h,k}^{K-REHAB} + UC_{h,k}^{E-REHAB} \quad (4.43)$$

$$UC_{h,k}^{E-REHAB} = \sum_{k'=k+1}^K \varphi_{h,k,k'}^{REHAB} \cdot UC_{h,k'}^E \quad (4.44)$$

$$UC_{h,k} = UC_{h,k}^K + UC_{h,k}^E \quad (4.45)$$

$$UC_{h,k}^{K-REHAB} = P_{h,k}^{REHAB} \cdot \delta^{BUIL} (R_{h,k}^{CASH-REHAB} + \frac{R_{h,k}^{LOAN-REHAB} R_{h,k,t-1}^I \cdot LD_{h,k}^{REHAB}}{1 - (1 + R_{h,k,t-1}^{BUIL-REHAB})^{-LD_{h,k}^{REHAB}}}) \quad (4.46)$$

$$R_{h,k}^{LOAN-REHAB} = 1 - R_{h,k}^{CASH-REHAB} \quad (4.47)$$

$$LD_{h,k}^{REHAB} \leq \theta_{h,k}^{LD-REHAB} / \delta_{h,k}^{REHAB} \quad (4.48)$$

$$UC_{h,k}^K = P_{h,k}^{REHAB} \delta_{h,k}^{BUIL} (R_{h,k}^{CASH} + \frac{R_{h,k}^{LOAN} R_{h,k,t-1}^I \cdot LD_{h,k}}{1 - (1 + R_{h,k,t-1}^I)^{-LD_{h,k}}}) \quad (4.49)$$

$$R_{h,k}^{LOAN} = 1 - R_{h,k}^{CASH} \quad (4.50)$$

$$LD_{h,k} \leq \theta_{h,k}^{LD} / \delta_{h,k}^{REHAB} \quad (4.51)$$

$$\delta_{h,k}^{REHAB} = \sum_{k'=k+1}^K \varphi_{h,k,k'}^{REHAB} \delta_{h,k'}^{BUIL} \quad (4.52)$$

$$\delta_{h,k}^{BUIL} = \sum_{k'=0}^{k-1} \delta_{h,k,k'}^{BUIL} \quad (4.53)$$

$$PEN_{h,k,e}^{REHAB} \cdot EN_{h,k,e}^{REHAB} = PEX_{e,h} \cdot EXP_{h,k,e}^{REHAB}$$



$$UC_{h,k}^E = P_{h,k}^{Ener-m^2} \cdot \frac{\left(1 + \dot{P}_{h,k}^{Ener-m^2-e}\right)^{1/\delta_{h,k}^{BUIL}} - 1}{\dot{P}_{h,k}^{Ener-m^2-e}/\delta_{h,k}^{BUIL}} \quad (4.54)$$

$$P_{h,k}^{Ener-m^2} \cdot BUIL_{h,k} = PENER_{h,k}^{BUIL} \cdot ENER_{h,k}^{BUIL} \quad (4.55)$$

$$\begin{aligned} \dot{P}_{h,k,t}^{Ener-m^2-e} &= \lambda_0^{Ener-BUIL} \dot{P}_{h,k,t-1}^{Ener-m^2-e} \\ &+ (1 - \lambda_0^{Ener-BUIL}) \dot{P}_{h,k,t-1}^{Ener-m^2} \end{aligned} \quad (4.56)$$

### The average price of the investment in renovation

$$\begin{aligned} P_{h,k}^{REHAB-\delta^{BUIL}} \cdot REHAB_{h,k} &= \sum_{k'=k+1}^K \\ &\quad (1 - R_{h,k,k'}^{SUB}) P_{h,k,k'}^{REHAB} \cdot REHAB_{h,k,k'} \cdot \delta_{h,k'}^{BUIL} \end{aligned} \quad (4.57)$$

$$P_{h,k}^{REHAB-\delta^{BUIL}-bis} = \sum_{k'=k+1}^K (1 - R_{h,k,k'}^{SUB}) \varphi_{h,k,k'}^{REHAB} P_{h,k,k'}^{REHAB} \delta_{h,k'}^{BUIL}$$

$$\begin{aligned} VER_{-} P_{h,k}^{REHAB-\delta} \cdot REHAB_{h,k} &= -P_{h,k}^{REHAB-\delta} + \\ &\quad \sum_{k'=k+1}^K (1 - R_{h,k,k'}^{SUB}) P_{h,k,k'}^{REHAB} \cdot \varphi_{h,k,k'}^{REHAB} \delta_{h,k'}^{BUIL} \end{aligned} \quad (4.58)$$

## The expenditure related to housing for building K

$$\begin{aligned}
EXP\_HOUSING_{h,k}^{VAL} = & DEBT_{h,k,t-1}^{REHAB\_VAL} (R_{h,k,t-1}^{I\_REHAB} + R_{h,k,t-1}^{RMBS\_REHAB}) \quad (4.59) \\
& + R_{h,k,t}^{CASH\_REHAB} P_{h,k}^{REHAB} REHAB_{h,k} \\
& + DEBT_{h,k,t-1}^{NewBUIL\_VAL} (R_{h,k,t-1}^{I\_NewBUIL} + R_{h,k,t-1}^{RMBS\_NewBUIL}) \\
& + R_{h,k,t}^{CASH\_NewBUIL} P_{h,k}^{NewBUIL} NewBUIL_{h,k} \\
& + PENER_{h,k}^{BUIL} ENER_{h,k}^{BUIL}
\end{aligned}$$

$$\begin{aligned}
DEBT_{h,k,t}^{REHAB\_VAL} = & DEBT_{h,k,t-1}^{REHAB\_VAL} (1 - R_{h,k,t-1}^{RMBS\_REHAB}) \quad (4.60) \\
& + R_{h,k,t}^{LOAN\_REHAB} P_{h,k}^{REHAB} REHAB_{h,k}
\end{aligned}$$

$$\begin{aligned}
DEBT_{h,k,t}^{NewBUIL\_VAL} = & DEBT_{h,k,t-1}^{NewBUIL\_VAL} (1 - R_{h,k,t-1}^{RMBS\_NewBUIL}) \quad (4.61) \\
& + R_{h,k,t}^{LOAN\_REHAB} P_{h,k}^{NewBUIL} NewBUIL_{h,k}
\end{aligned}$$

$$R_{h,k}^{RMBS\_X} = \frac{1}{LD_{h,k}^X}$$

$$\Delta p_{h,k,k'}^{REHAB} = \Delta pch_{13} \quad (4.62)$$

$$\Delta p_{h,k}^{NewBUIL} = \Delta pch_{13} \quad (4.63)$$

$$R_{h,k}^{REHAB\_DEBT} = \frac{P_{h,k}^{REHAB} REHAB_{h,k}}{DEBT_{h,k}^{REHAB\_VAL}} \quad (4.64)$$

## Aggregation of equations

$$REHAB_{h,k} = \sum_{k'=k+1}^K REHAB_{h,k,k'}$$

$$REHAB_h = \sum_k REHAB_{h,k}$$

$$REHAB = \sum_h REHAB_h$$

$$P_{h,k}^{REHAB}.REHAB_{h,k} = \sum_{k'} P_{h,k,k'}^{REHAB}.REHAB_{h,k,k'}$$

$$EXP\_HOUSING_h^{VAL} = \sum_k EXP\_HOUSING_{h,k}^{VAL}$$

$$EXP\_HOUSING^{VAL} = \sum_k EXP\_HOUSING_h^{VAL}$$

$$EXP_h^{REHAB\_VAL} = P_h^{REHAB}.REHAB_h$$

$$EXP^{REHAB\_VAL} = \sum_h EXP_h^{REHAB\_VAL}$$

$$EXP_h^{NEWBUIL\_VAL} = P_h^{NEWBUIL}.NEWBUIL_h$$

$$EXP^{NEWBUIL\_VAL} = \sum_h EXP_h^{NEWBUIL\_VAL}$$

$$\phi_{13bis,h}^{EXP} = \frac{EXP_h^{NEWBUIL\_VAL} + EXP_h^{REHAB\_VAL}}{EXP^{NEWBUIL\_VAL} + EXP^{REHAB\_VAL}} \quad (4.65)$$

$$EXP_{13}^{OTH\_VAL} = \sum_h EXP_{13,h}^{OTH\_VAL} \quad (4.66)$$

$$\Delta exp_{13,h}^{OTH\_VAL} = \Delta dispinc_h^{VAL} \cdot (1 - MPS\_HH_h) \quad (4.67)$$

$$EXP_{13,h}^{OTH\_VAL} = \phi_{13bis,h}^{EXP} \cdot EXP_{13}^{OTH\_VAL} \quad \text{at} \quad \text{base year}$$

$$EXP_{13,h} = P_{h,0}^{NEWBUIL}.NEWBUIL_h + P_{h,0}^{REHAB}.REHAB_h + \frac{EXP_{13,h}^{OTH\_VAL}}{PEXP_{13,h}} \quad (4.68)$$

$$EXP_{13} = \sum EXP_{13,h} \quad (4.69)$$

$$NEWBUIL_{h,k} = \varphi_{h,k}^{NewBUIL}(\Delta BUIL_h + BUIL_{h,0}) \quad (4.70)$$

$$NEWBUIL_h = \sum_k NEWBUIL_{h,k}$$

$$P_h^{NEWBUIL}.NEWBUIL_h = \sum_k P_{h,k}^{NEWBUIL} NEWBUIL_{h,k}$$

$$NEWBUIL = \sum_h NEWBUIL_h$$

$$P^{NEWBUIL}.NEWBUIL = \sum_h P_h^{NEWBUIL} NEWBUIL_h$$

$$P_h^{EXPH}.EXPH_h = \sum_k P_{h,k}^{EXPH}.EXPH_{h,k}$$

### Verification for the initial period

$$BUIL\_VERIF_h = \sum_k BUIL_{h,k} \quad (4.71)$$

$$BUIL\_VERIF = \sum_h BUIL\_VERIF_h \quad (4.72)$$

$$VERIF\_BUIL = \sum_h (BUIL\_VERIF_h - BUIL_h) = 0 \quad (4.73)$$

$$VERIF\_ \varphi_{h,k}^{REHAB} = \sum \varphi_{h,k}^{REHAB} - 1 \quad (4.74)$$

$$EXP\_HOUSING_h^{bisVAL} = PEXP_{13,h}.EXP_{13,h} + PENER_h^{BUIL}.ENER_h^{BUIL} \quad (4.75)$$

$$EXP\_HOUSING_h^{verVAL} = EXP\_HOUSING_h^{bisVAL} - (EXP\_HOUSING_h^{VAL} + EXP_{13,h}^{OTH-VAL}) = 0 \quad (4.76)$$

### Automobile stock dynamic

$$\Delta AUTO_{h,k,t} = \varphi_{h,k}^{NewAuto}(\Delta AUTO_{h,t} + AUTO_{h,t}^{DES}) \quad (4.77)$$

$$-\delta_{h,k}^{AUTO} AUTO_{h,k,t-1}$$

$$AUTO_{h,t}^{DES} = \sum_k \delta_{h,k}^{AUTO} AUTO_{h,k,t-1} \quad (4.78)$$

$$NewAUTO_{h,k} = \varphi_{h,k}^{NewAUTO}(\Delta AUTO_h + AUTO_h^{DES}) \quad (4.79)$$

$$\Delta p_{h,k}^{NewAUTO} = \Delta pch_{03} \quad (4.80)$$

### The expenditure related to automobile

$$\begin{aligned} EXP\_MOB_{h,k}^{AUTO-VAL} &= DEBT_{h,k,t}^{AUTO-VAL}(R_{h,k,t-1}^I + R_{h,k,t-1}^{RMBS-AUTO}) \quad (4.81) \\ &+ R_{h,k,t}^{CASH-AUTO} P^{NewAUTO}.NewAUTO_{h,k}(1 - R_{h,k}^{SUB-AUTO}) \\ &+ PEXP_h^{22}.EXP_{h,k}^{AUTO} \end{aligned}$$

$$\begin{aligned} UC_{h,k}^{auto} &= P_{h,k}^{REHAB} \delta_{h,k}^{BUIL} \left( R_{h,k}^{CASH-AUTO} + \frac{R_{h,k}^{LOAN} R_{h,k,t-1}^I LD_{h,k}}{1 - (1 + R_{h,k,t-1}^I)^{-LD_{h,k}}} \right) \quad (4.82) \\ &+ \frac{\left(1 + \dot{P}_k^{Ener-auto-e}\right)^{1/\delta_k^{auto}} - 1}{\dot{P}_k^{Ener-auto-e}/\delta_k^{auto}} \cdot \dot{P}_k^{Ener-auto} \end{aligned}$$

$$\begin{aligned} DEBT_{h,k,t}^{AUTO-VAL} &= DEBT_{h,k,t-1}^{AUTO-VAL}(1 - R_{h,k,t-1}^{RMBS-AUTO}) \\ &+ R_{h,k,t}^{LOAN-AUTO} P_{h,k}^{NewAUTO}.NewAUTO_{h,k}(1 - R_{h,k}^{SUB-AUTO}) \quad (4.83) \end{aligned}$$

$$EXP_{h,k}^{NewAUTO-VAL} = P_{h,k}^{NewAuto}.NewAUTO_{h,k}(1 - R_{h,k}^{SUB}) \quad (4.84)$$

$$\Delta km_h^{traveler} = \Delta pop^{TOT} \quad (4.85)$$

$$\Delta km_h^{traveler\_auto} = \Delta km_h^{traveler} \quad (4.86)$$

$$\Delta km_h^{AUTO} = \Delta km_h^{traveler\_auto} \quad (4.87)$$

$$\Delta AUTO_h = \Delta km_h^{AUTO} \quad (4.88)$$

$$Km_{h,k}^{AUTO} = Km_h^{AUTO} \cdot \frac{AUTO_{h,k}}{auto_h} \quad (4.89)$$

$$\begin{aligned} \Delta exp_{h,k,e}^{AUTO} = & \alpha^{AUTO} \left( \Delta km_{h,k}^{auto} - \eta^{MOB\_TRSP\_COL} \cdot (1 - \varphi^{AUTO}) \cdot (pch_{03} - pch_{14}) \right) \\ & + (1 - \alpha^{AUTO}) \Delta exp_{h,k} \end{aligned} \quad (4.90)$$

$$EXP_{h,t}^{AUTO\_elec} = EXP_{h,t-1}^{AUTO\_elec} \cdot (1 + \Delta exp_h) \cdot T^{gth\_elec}$$

$$\begin{aligned} EXP_{h,t}^{AUTO\_elec} = & + \eta^{AUTO\_elec} \cdot \varphi_{t-1}^{EXP\_AUTO22} \cdot \Delta (pexp_{22} - pexp_{23}) \\ & + \eta^{BONUS\_elec} \cdot \varphi_{t-1}^{EXP_{03}} \cdot \Delta p_{03}^{eff} \cdot T^{BONUS\_elec} \\ & + \eta^{BONUS\_elec} \cdot \varphi_{t-1}^{EXP_{03}} \cdot \Delta p_{03}^{eff} \cdot T^{BONUS\_elec} \\ & if \left( EXP_{03}^{eff} - EXP_{03}^{elec} \right) > 0 \end{aligned}$$

$$EXP_{h,t}^{AUTO\_elec} = EXP_{h,t-1}^{AUTO\_elec} \quad if \left( EXP_{03}^{eff} - EXP_{03}^{elec} \right) \leq 0$$

### Aggregation of automobile expenditure

$$EXP_{h,k}^{AUTO} = \sum_e EXP_{h,k,e}^{AUTO} \quad (4.91)$$

$$EXP_h^{AUTO} = \sum_k EXP_{h,k}^{AUTO} \quad (4.92)$$

$$EXP_{h,e}^{AUTO} = \sum_k EXP_{h,k,e}^{AUTO} \quad (4.93)$$

$$EXP_{k,e}^{AUTO} = \sum_h EXP_{h,k,e}^{AUTO} \quad (4.94)$$

$$EXP^{AUTO} = \sum_h EXP_h^{AUTO} \quad (4.95)$$

### Aggregation of automobile

$$AUTO_k = \sum_h AUTO_{h,k} \quad (4.96)$$

$$AUTO = \sum_k AUTO_k \quad (4.97)$$

$$NewAUTO_h = \sum_k NewAUTO_{h,k} \quad (4.98)$$

$$P_h^{NewAUTO}.NewAUTO_h = \sum_k P_{h,k}^{NewAUTO}.NewAUTO_{h,k} \quad (4.99)$$

$$EXP_h^{NewAUTO\_VAL} = \sum_k EXP_{h,k}^{NewAUTO\_VAL} \quad (4.100)$$

$$EXP^{NewAUTO\_VAL} = \sum_h EXP_h^{NewAUTO\_VAL} \quad (4.101)$$

$$\phi_{03bis,h}^{EXP} = \frac{EXP_h^{NewAUTO\_VAL}}{EXP^{NewAUTO\_VAL}} \quad (4.102)$$

$$EXP\_MOB_h^{AUTO\_VAL} = \sum EXP\_MOB_{h,k}^{AUTO\_VAL} \quad (4.103)$$

$$EXP\_MOB^{AUTO\_VAL} = \sum EXP\_MOB_h^{AUTO\_VAL} \quad (4.104)$$

$$EXP_{03}^{OTH\_VAL} = \sum_h EXP_{03,h}^{OTH\_VAL} \quad (4.105)$$

$$EXP_{03}^{OTH\_VAL} = PEXP_{03}.EXP_{03} - EXP^{NewAUTO\_VAL} \text{ for base year}$$

$$EXP_{03} = \sum_h EXP_{03,h} \quad (4.106)$$

$$\Delta exp_{03,h}^{OTH\_VAL} = \Delta dispinc_h^{VAL} \cdot (1 - MPS_h^{HH}) \quad (4.107)$$

$$EXP_{03,h}^{OTH\_VAL} = \phi_{03bis,h}^{EXP} \cdot EXP_{03}^{OTH\_VAL} \text{ for base year}$$

$$EXP_{03,h} = P_{h,k,0}^{NewAuto} \cdot NewAUTO_{h,k} + \frac{EXP_{03}^{OTH\_VAL}}{PEXP_{03,h}} \quad (4.108)$$

## Verification of automobile

$$EXP\_MOB_h^{AUTObis\_VAL} = PEXP_{03,h} \cdot EXP_{03,h} + \frac{PEXP_{03,h} \cdot EXP_h^{AUTO}}{PEXP_{03,h} \cdot EXP_h^{AUTO}} \quad (4.109)$$

$$EXP\_MOB^{AUTObis\_VAL} = \sum EXP\_MOB_h^{AUTObis\_VAL} \quad (4.110)$$

$$EXP\_MOB_h^{AUTOver\_VAL} = EXP\_MOB_h^{AUTObis\_VAL} - \frac{EXP\_MOB_h^{AUTO\_VAL} + EXP_{03,h}^{OTH\_VAL}}{EXP\_MOB_h^{AUTO\_VAL} + EXP_{03,h}^{OTH\_VAL}} \quad (4.111)$$

$$EXP\_MOB^{AUTOver\_VAL} = EXP\_MOB^{AUTObis\_VAL} - \frac{EXP\_MOB^{AUTO\_VAL} + EXP_{03,h}^{OTH\_VAL}}{EXP\_MOB^{AUTO\_VAL} + EXP_{03,h}^{OTH\_VAL}} \quad (4.112)$$



**Other transports:**

$c=\{14\ 15\ 16\ 17\ 18\}$

$$EXP\_MOB_h^{OTH\_VAL} = \sum_c PEXP_{c,h} \cdot EXP_{c,h} \quad (4.113)$$

$c = 14, 15, 16, 17, 18$

$$\Delta km_{c,h}^{traveler} = \Delta km_h^{traveler} \quad (4.114)$$

$$\Delta exp_{c,h} = \Delta km_{c,h}^{traveler} \quad (4.115)$$

$$EXP_c = \sum_h EXP_{c,h} \quad (4.116)$$

**Total Mobility**

$$EXP\_MOB_h^{VAL} = EXP\_MOB_h^{AUTO\_VAL} + EXP\_MOB_h^{OTH\_VAL} + EXP_{03,h}^{OTH\_VAL} \quad (4.117)$$

#### 4.2.1 Energy Consumption

**Energy of building**

$$ENER_{h,k,e}^{BUIL} = ENER_{h,k,e}^{perM2} \cdot BUIL_{h,k} \quad (4.118)$$

$$\Delta ener_{h,k,e}^{perM2} = 0 \quad (4.119)$$

$$\Delta exp_{h,k,e}^{BUIL} = \Delta ener_{h,k,e}^{BUIL} \quad (4.120)$$

$$\begin{aligned} \Delta exp\_buil_{h,k,22} = & \Delta ener\_buil_{h,k,22} + \Delta standard\_BUIL \\ & + \eta^{EXP_{h,k,22}} \cdot (\Delta pexp_{22} - \Delta pexp) \\ & + \eta^{Buil_{h,k,24-22}} \cdot \left( \frac{PEXP_{24,t-1}^{TEP}}{PEXP_{22,t-1}^{TEP}} \cdot \Delta pexp_{24} - \frac{PEXP_{22,t-1}^{TEP}}{PEXP_{24,t-1}^{TEP}} \cdot \Delta pexp_{22} \right) \\ & \cdot \frac{EXP_{24\_BUIL\_eff,t-1}}{EXP_{22\_BUIL\_eff,t-1} + EXP_{24\_BUIL\_eff,t-1}} \quad \text{if } ener\_buil_{h,k,22} > 0 \\ \Delta exp\_buil_{h,k,22} = & \Delta ener\_buil_{h,k,22} \\ & + \Delta standard\_BUIL \quad \text{if } ener\_buil_{h,k,22} \leq 0 \end{aligned}$$

$$\begin{aligned}
\Delta exp\_buil_{h,k,23} = & \Delta ener\_buil_{h,k,23} + \Delta standard\_BUIL \\
& + \eta^{\overline{EXP}_{h,k,23}} \cdot (\Delta pexp_{23} - \Delta pexp) \\
& + \eta^{Buil_{h,k,24}_{-23}} \cdot \left( \frac{PEXP_{24,t-1}^{TEP}}{PEXP_{22,t-1}^{TEP}} \cdot \Delta pexp_{24} - \frac{PEXP_{23,t-1}^{TEP}}{PEXP_{23,t-1}^{TEP}} \cdot \Delta pexp_{23} \right) \\
& \cdot \frac{EXP_{24\_BUIL\_eff,t-1}}{EXP_{23\_BUIL\_eff,t-1} + EXP_{24\_BUIL\_eff,t-1}} \quad \text{if } ener\_buil_{h,k,23} > 0
\end{aligned}$$

$$\begin{aligned}
\Delta exp\_buil_{h,k,23} = & \Delta ener\_buil_{h,k,23} \\
& + \Delta standard\_BUIL \text{ if } ener\_buil_{h,k,23} \leq 0
\end{aligned}$$

$$\begin{aligned}
\Delta exp\_buil_{h,k,24} = & \Delta ener\_buil_{h,k,24} + \Delta standard\_BUIL \\
& + \eta^{\overline{EXP}_{h,k,24}} \cdot (\Delta pexp_{24} - \Delta pexp) \\
& + \eta^{Buil_{h,k,22}_{-24}} \cdot \left( \frac{PEXP_{22,t-1}^{TEP}}{PEXP_{24,t-1}^{TEP}} \cdot \Delta pexp_{22} - \frac{PEXP_{24,t-1}^{TEP}}{PEXP_{22,t-1}^{TEP}} \cdot \Delta pexp_{24} \right) \\
& \cdot \frac{EXP_{22\_BUIL\_eff,t-1}}{EXP_{22\_BUIL\_eff,t-1} + EXP_{24\_BUIL\_eff,t-1}} \\
& + \eta^{Buil_{h,k,23}_{-24}} \cdot \left( \frac{PEXP_{23,t-1}^{TEP}}{PEXP_{24,t-1}^{TEP}} \cdot \Delta pexp_{23} - \frac{PEXP_{24,t-1}^{TEP}}{PEXP_{23,t-1}^{TEP}} \cdot \Delta pexp_{24} \right) \\
& \cdot \frac{EXP_{23\_BUIL\_eff,t-1}}{EXP_{22\_BUIL\_eff,t-1} + EXP_{24\_BUIL\_eff,t-1}} \quad \text{if } ener\_buil_{h,k,23} > 0
\end{aligned}$$

$$\begin{aligned}
\Delta exp\_buil_{h,k,24} = & \Delta ener\_buil_{h,k,24} \\
& + \Delta standard\_BUIL \text{ if } ener\_buil_{h,k,24} \leq 0
\end{aligned}$$

$$PEN ER_{h,k,e}^{BUIL} \cdot EN ER_{h,k,e}^{BUIL} = PEX P_{e,h} \cdot EXP_{h,k,e}^{BUIL} \quad (4.121)$$

### Aggregation Energy consumption in building

$$PEN ER_{h,k}^{BUIL} \cdot EN ER_{h,k}^{BUIL} = \sum_e (PEN ER_{h,k,e}^{BUIL} \cdot EN ER_{h,k,e}^{BUIL}) \quad (4.122)$$

$$EN ER_{h,k}^{BUIL} = \sum_e EN ER_{h,k,e}^{BUIL} \quad (4.123)$$

$$PEN ER_h^{BUIL} \cdot EN ER_h^{BUIL} = \sum_k PEN ER_{h,k}^{BUIL} \cdot EN ER_{h,k}^{BUIL} \quad (4.124)$$

$$EN ER_h^{BUIL} = \sum_k EN ER_{h,k}^{BUIL} \quad (4.125)$$

$$PENER^{BUIL}.ENER^{BUIL} = \sum_h PENER_h^{BUIL}.ENER_h^{BUIL} \quad (4.126)$$

$$ENER^{BUIL} = \sum_h ENER_h^{BUIL} \quad (4.127)$$

$$PENER_{h,e}^{BUIL}.ENER_{h,e}^{BUIL} = \sum_k PENER_{h,k,e}^{BUIL}.ENER_{h,k,e}^{BUIL} \quad (4.128)$$

$$ENER_{h,e}^{BUIL} = \sum_k ENER_{h,k,e}^{BUIL} \quad (4.129)$$

$$PENER_e^{BUIL}.ENER_e^{BUIL} = \sum_h PENER_{h,e}^{BUIL}.ENER_{h,e}^{BUIL} \quad (4.130)$$

$$ENER_e^{BUIL} = \sum_h ENER_{h,e}^{BUIL} \quad (4.131)$$

**Agregation of total energy expenditure (automobile + building)**

$$ENER_{h,k} = PENER_{h,k,0}^{BUIL}.ENER_{h,k}^{BUIL} + EXP_{h,k}^{AUTO} \quad (4.132)$$

$$PENER_{h,k}.ENER_{h,k} = PENER_{h,k}^{BUIL}.ENER_{h,k}^{BUIL} + PEXP_{03,h}.EXP_{h,k}^{AUTO} \quad (4.133)$$

$$ENER_h = PENER_{h,0}^{BUIL}.ENER_h^{BUIL} + EXP_h^{AUTO} \quad (4.134)$$

$$PENER_h.ENER_h = PENER_h^{BUIL}.ENER_h^{BUIL} + PEXP_{03,h}.EXP_h^{AUTO} \quad (4.135)$$

$$PENER.ENER = PENER^{BUIL}.ENER^{BUIL} + PEXP_{03}.EXP^{AUTO} \quad (4.136)$$

$$EXP_{h,e} = PENER_{h,e}^{BUIL}.ENER_{h,e}^{BUIL} + EXP_{h,e}^{AUTO} \quad (4.137)$$

$$EXP_e = \sum_h EXP_{h,e} \quad (4.138)$$

**Notional household h's expenditures in commodity c:**

$c=\{01\ 02\ 04\ 05\ 06\ 07\ 08\ 09\ 10\ 11\ 12\ 19\ 20\}$

$$\begin{aligned} EXP_{c,h}^n.PEXP_{c,h} &= PEXP_{c,h}.NEXP_{c,h} \\ &+ \beta_{c,h}^{EXP}(DISPINC_h\_VAL.(1 - MPS_h) - PNEXP_h.NEXP_h) \end{aligned} \quad (4.139)$$

$$\begin{aligned} \beta_{c,h,0}^{EXP} &= (PEXP_{c,h,0}.EXP_{c,h,0} - PEXP_{c,h,0}.NEXP_{c,h,0}) / \\ & (DISPINC_h\_VAL.(1 - MPS_h^{HH}P_{h,0}) - PNEXP_{h,0}.NEXP_{h,0} - EXP_{h,0}^{HOUSING\_VAL} \\ & - EXP_{13,h,0}^{OTH\_VAL} - EXP_{h,0}^{MOB\_VAL}) \end{aligned}$$

is calibrated by inverting the above equation at the base year.

**Household h's marginal propension to spend in commodity c:**

$$\Delta \ln(\beta_{c,h}^{EXP}) = (1 - \eta^{LES-CES}).\Delta \ln\left(\frac{PEXP_{c,h}}{PEXP_h^{CES}}\right) \quad (4.140)$$

The marginal propension to spend in commodity c is assumed constant. In a future version, it may depend on the relative price to account for substitution effects.

$$PEXP_h^{CES} = \left[ \sum_c \beta_{c,h,0}^{EXP}.PEXP_{c,h}^{(1-\eta^{LES-CES})} \right]^{\frac{1}{1-\eta^{LES-CES}}} \quad (4.141)$$

**Household h's total necessary expenditures (value & volume):**

$$PNEXP_h.NEXP_h = \sum_c PEXP_{c,h}.NEXP_{c,h} \quad (4.142)$$

$$NEXP_h = \sum_c NEXP_{c,h} \quad (4.143)$$

**Total expenditure by product c:**

$$PEXP_c \cdot EXP_c = \sum_h PEXP_{c,h} \cdot EXP_{c,h} \quad (4.144)$$

$$EXP_c = \sum_h EXP_{c,h} \quad (4.145)$$

$$\phi_{c,h}^{EXP} = \frac{EXP_{c,h}}{EXP_c} \quad (4.146)$$

**Household h's expenditures price c:**

c={01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24}

$$PEXP_{c,h} = PCH_c \quad (4.147)$$

**Domestic et imported households' consumption in commodity c:**

$$\Delta CHD_{c,t} = \Delta EXP_{c,t} + \Delta SUBST\_CHD_{c,t} \quad (4.148)$$

$$\Delta SUBST\_CHD_{c,t}^n = \eta^{LVLA-HH} \Delta(pchd_c - pchm_c) \cdot \frac{PCHD_{c,t-1} \cdot CHD_{c,t-1}}{PCH_{c,t-1} \cdot CH_{c,t-1}}$$

$$\Delta CHM_{c,t} = EXP_{c,t} - CHD_c \quad (4.149)$$

$$\Delta SUBST\_CHM_{c,t}^n = \eta^{LVLA-HH} \Delta(pchm_c - pchd_c) \cdot \frac{PCHM_{c,t-1} \cdot CHM_{c,t-1}}{PCH_{c,t-1} \cdot CH_{c,t-1}}$$

**Ajustment :**

c={01 02 04 05 06 07 08 09 10 11 12 19 20}

$$exp_{c,h,t} = \mu_1 exp_{c,h,t}^n + (1 - \mu_1) \cdot exp_{c,h,t-1} + \Delta exp_{c,h}^e \quad (4.150)$$

$$\Delta exp_{c,h,t}^e = \mu_2 \Delta exp_{c,h,t-1}^e + \mu_3 \Delta exp_{c,h,t-1} + \mu_4 \Delta exp_{c,h,t}^n \quad (4.151)$$

## 5 Prices

**Production price in activity a**

$$PY_a^n = NCU_a \cdot (1 + TMD_a) \quad (5.1)$$

### Net cost per unit of production in activity a

$$\begin{aligned}
 NCU_a.Y_a = CU_a.Y_a + PIY_a.IY_a + PIS_a.IS_a - PSY_a.SY_a + DIV_a^{HH} \_ VAL \\
 + DIV_a^{GOV} \_ VAL + DIV_a^{ROW} \_ VAL + DIV_a^{BK} \_ VAL - \frac{L_a}{L}.RTOE
 \end{aligned} \tag{5.2}$$

### Cost per unit of production in activity a

$$CU_a.Y_a = CK_a.K_a + CL_a.L_a.PROG_a + PE_a.E_a + PMAT_a.MAT_a \tag{5.3}$$

$$CL_a.L_a = CL\_SE_a.L\_SE_a + CL\_S_a.L\_S_a \tag{5.4}$$

### Mark-up in activity a

$$TMD_a = \alpha_a^{TMD} \frac{Y_a}{YOPT_a} \tag{5.5}$$

### Potential production in activity a

$$\begin{aligned}
 \Delta y_{opt_{a,t}} = \frac{CK_{a,t-1}K_{a,t-1}}{CU_{a,t-1}.Y_{a,t-1}} \Delta k_{a,t} + \frac{CL_{a,t-1}L_{a,t-1}PROG_{a,t-1}}{CU_{a,t-1}.Y_{a,t-1}} \Delta(l_{a,t} + prog_{a,t}) \\
 + \frac{PE_{a,t-1}E_{a,t-1}}{CU_{a,t-1}.Y_{a,t-1}} \Delta e_{a,t} + \frac{PMAT_{a,t-1}MAT_{a,t-1}}{CU_{a,t-1}.Y_{a,t-1}} \Delta mat_{a,t}
 \end{aligned} \tag{5.6}$$

### Labor cost in activity a

$$CL\_S_a = \frac{W\_S_a(1 + TCE_a)}{PROG_a} \tag{5.7}$$

$$CL\_SE_a = \frac{W\_SE_a}{PROG_a} \tag{5.8}$$

### Capital cost in activity a

$$CK_{a,t}K_{a,t} = PI_{a,t}K_{a,t-1}(\delta_a + \varphi_a^{autof} \dot{K}_{a,t}) + PDEBT_{a,t-1}DEBT_{a,t-1}r_{a,t} \tag{5.9}$$

$$PDEBT_{a,t} = PIA_a \tag{5.10}$$

### Composite intermediary consumption price in activity a

$$PMAT_a.MAT_a = \sum_{c=1}^{20} PMAT_{c,a}.MAT_{c,a} \quad (5.11)$$

$$PE_a.E_a = \sum_{c=21}^{24} PE_{c,a}.E_{c,a} \quad (5.12)$$

$$DEBT_a = K_a \quad (5.13)$$

In a future version, we may assume that capital is not integrally financed by the debt.

### Material price for commodity c paid by activity a (c=1,...,20)

$$PMAT_{c,a}.MAT_{c,a} = PMATD_c.MATD_{c,a} + PMATM_c.MATM_{c,a} \quad for\ c = \{1, ..., 20\} \quad (5.14)$$

### Energy price for commodity c paid by activity a (c=21,...,24)

$$PE_{c,a}.E_{c,a} = PED_c.ED_{c,a} + PEM_c.EM_{c,a} \quad for\ c = \{21, ..., 24\} \quad (5.15)$$

### Aggregate investment price for activity a:

$$PIA_a.IA_a = \sum_c PIA_{c,a}.IA_{c,a} \quad (5.16)$$

### Selling price (including margins, exclusive of VAT) for domestic commodity c

$$PYQS_c.YQS_c = PYQ_c.YQ_c.(1 + T_c^{ENERTD}) + YQ_c.(T_c^{OTHD} + T_c^{SUB}) \quad (5.17)$$

$$+ PMTD_c.MTD_c + PMCD_c.MCD_c \quad if\ c \neq \{14, ..., 19\}$$

$$PYQS_c.YQS_c = PYQ_c.YQ_c.(1 + T_c^{ENERTD}) + YQ_c.(T_c^{OTHD} + T_c^{SUB}) \quad if\ c = \{14, ..., 19\}$$

$$\Delta yqs_c = \Delta yq_c \quad (5.18)$$

$YQS_c$  is the volume of the production expressed at market price before VAT. It should not be seen as a composite of several "goods": production at base price and margins. Indeed, it does not increase when the volume of the commercial and transport margins increase. The price does instead. Its specification is  $YQS_{c,t} = YQ_{c,t} \left( 1 + T_{c,0}^{ENERT} + T_{c,0}^{OTHD} + T_{c,0}^{SUB} + \frac{MTD_{c,0}}{YQ_{c,0}} + \frac{MCD_{c,0}}{YQ_{c,0}} \right)$  which is equivalent to 5.18, that is to assuming that  $YQS_c$  is always proportional to  $YQ_c$ . Writing it following the specification composite of several goods,

$YQS_{c,t} = YQ_{c,t} \left( 1 + T_{c,0}^{ENERT} + T_{c,0}^{OTHD} + T_{c,0}^{SUB} + \frac{MTD_{c,t}}{YQ_{c,t}} + \frac{MCD_{c,t}}{YQ_{c,t}} \right)$ , would lead to inaccurate results since a decrease in the quantity of transport used per unit of production would not lead to a decrease of the selling price. Notice that the similarity with the specification of the volume of a tax or a subvention. As specified earlier, we assume that an increase in the tax rate does not increase the volume of the tax but increases its price. The volume of the tax increases only when the volume of the tax bases (e.g. consumption, production) increases.

### **Selling price (including margins, exclusive of VAT) for imported commodity c**

$$PMS_c.MS_c = PM_c.M_c.(1 + T_c^{OTHM}) + M_c.T_c^{ENERTM} + PMTM_c.MTM_c + PMCM_c.MCM_c \quad \text{if } c \neq \{14, \dots, 19\} \quad (5.19)$$

$$PMS_c.MS_c = PM_c.M_c.(1 + T_c^{OTHM}) + M_c.T_c^{ENERTM} \quad \text{if } c = \{14, \dots, 19\}$$

$$\Delta ms_c = \Delta m_c \quad (5.20)$$

### **Price of the domestically produced intermediary consumption c**

$$PMATD_{c,t} = PYQS_{c,t} \frac{(1 + T_{c,t}^{VATD_{oth}})}{(1 + T_{c,0}^{VATD_{oth}})} \quad \text{if } c = \{1, \dots, 20\} \quad (5.21)$$

$$PED_{c,t} = PYQS_{c,t} \frac{(1 + T_{c,t}^{VATD_{oth}})}{(1 + T_{c,0}^{VATD_{oth}})} \quad \text{if } c = \{21, \dots, 24\} \quad (5.22)$$

### **Price of the imported intermediary consumption c**

$$PMATM_{c,t} = PMS_{c,t} \frac{(1 + T_{c,t}^{VATM_{oth}})}{(1 + T_{c,0}^{VATM_{oth}})} \quad \text{if } c = \{1, \dots, 20\} \quad (5.23)$$

$$PEM_{c,t} = PMS_{c,t} \frac{(1 + T_{c,t}^{VATM_{oth}})}{(1 + T_{c,0}^{VATM_{oth}})} \quad \text{if } c = \{21, \dots, 24\} \quad (5.24)$$

### **Domestically produced households' consumption price for commodity c**

$$PCHD_{c,t} = PYQS_{c,t} \frac{(1 + T_{c,t}^{VATD})}{(1 + T_{c,0}^{VATD})} \quad (5.25)$$



**Imported households' consumption price for commodity c**

$$PCHM_{c,t} = PMS_{c,t} \frac{(1 + T_{c,t}^{VATD})}{(1 + T_{c,0}^{VATD})} \quad (5.26)$$

**Domesticly produced public spending price for commodity c**

$$PGD_{c,t} = PYQS_{c,t} \frac{(1 + T_{c,t}^{VATD_{oth}})}{(1 + T_{c,0}^{VATD_{oth}})} \quad (5.27)$$

**Imported public spending price for commodity c**

$$PGM_{c,t} = PMS_{c,t} \frac{(1 + T_{c,t}^{VATM_{oth}})}{(1 + T_{c,0}^{VATM_{oth}})} \quad (5.28)$$

**Domesticly produced investment price for commodity c bought by activity a**

$$PIAD_{c,t} = PYQS_{c,t} \frac{(1 + T_{c,t}^{VATD_{oth}})}{(1 + T_{c,0}^{VATD_{oth}})} \quad (5.29)$$

**Imported investment price for commodity c**

$$PIAM_{c,t} = PMS_{c,t} \frac{(1 + T_{c,t}^{VATM_{oth}})}{(1 + T_{c,0}^{VATM_{oth}})} \quad (5.30)$$

**Domesticly produced export price for commodity c**

$$PXD_c = PYQS_c \quad (5.31)$$

**Imported export price for commodity c**

$$PXM_c = PMS_c \quad (5.32)$$

**Domesticly produced changes in inventories price for commodity c**

$$PDSD_c = PYQS_c \quad (5.33)$$

**Imported changes in inventories price for commodity c**

$$PDSM_c = PMS_c \quad (5.34)$$

**Price of transport margins m paid on domesticly produced commodity c**

$$PMTD_{m,c} = \frac{YQ_m}{YQ_m + M_m} PYQS_m + \frac{M_m}{YQ_m + M_m} PMS_m \quad \text{if } m = \{14, \dots, 18\} \text{ and } c \neq \{14, \dots, 18\} \quad (5.35)$$

**Price of transport margins m paid on imported commodity c**

$$PMTM_{m,c} = PMTD_{m,c} \quad \text{if } m = \{14, \dots, 18\} \text{ and } c \neq \{14, \dots, 18\} \quad (5.36)$$

**Price of commercial margins paid on domesticly produced commodity c**

$$PMCD_c = \frac{YQ_{19}}{YQ_{19} + M_{19}} PYQS_{19} + \frac{M_{19}}{YQ_{19} + M_{19}} PMS_{19} \quad \text{if } c \neq 19 \quad (5.37)$$

**Price of the imported transport margins m paid on commodity c**

$$PMCM_{m,c} = PMCD_c \quad \text{if } c \neq 19 \quad (5.38)$$

**Import price at base cost for commodity c**

$$PM_c = PWD_c.TC \quad (5.39)$$

**Notional wage by activity:**

$$\Delta w_{a,t}^n = \rho_{1,a} + \rho_{2,a} \Delta p_t + \rho_3 \Delta p_{a,t}^{rog} - \rho_{4,a} \Delta (p_{a,t}^m - p_{a,t}^y) - \rho_5 U_t - \rho_6 \Delta U_t + \rho_7 \Delta (l_{a,t} - l_t) \quad (5.40)$$

$$\Delta w_{se_{a,t}} = \Delta w_{s_{a,t}} \quad (5.41)$$

**Taylor Rule**

$$R_{Dir} = \theta_1 \Delta \dot{P}_t - \theta_2 \Delta U_t \quad (5.42)$$

## 6 Green House Gases Emissions and Energy

Carbon intensity of the energy commodities e:

$$IC_e = \frac{EMS_e}{QD_e + M_e - X_e} \quad for \quad e = 21, 22, 23 \quad (6.1)$$

Emissions by activity and by type :

$$\Delta ems_{e,a} = \Delta e_a \quad (6.2)$$

Aggregate emissions by activity :

$$EMS_a = \sum_e EMS_{e,a} \quad (6.3)$$

Decarbonation :

$$\Delta ems_{dc_a} = \Delta mat_a \quad (6.4)$$

GHG emissions of Households :

$$\Delta ems_{e,h} = \Delta exp_{e,h} \quad (6.5)$$

GHG emissions from building of Households

$$\Delta ems_{hh_{e,h,k}^{BUIL}} = \Delta \varphi_e^{EXP} + \Delta ener_{buil_{e,h,k}} \quad (6.6)$$

$$EMS_{HH\_BUIL_{h,k}} = \sum_e EMS_{HH\_BUIL_{e,h,k}} \quad (6.7)$$

$$EMS_{HH\_BUIL_h} = \sum_k EMS_{HH\_BUIL_{h,k}} \quad (6.8)$$

$$EMS_{HH\_BUIL_k} = \sum_h EMS_{HH\_BUIL_{h,k}} \quad (6.9)$$

$$EMS_{HH\_BUIL} = \sum_h EMS_{HH\_BUIL_h} \quad (6.10)$$

### GHG emissions from building of Households

$$\Delta ems\_hh_{e,h,k}^{AUTO} = \Delta \varphi_e^{EXP} + \Delta ener\_auto_{e,h,k} \quad (6.11)$$

$$EMS\_HH\_AUTO_{h,k} = \sum_e EMS\_HH\_AUTO_{e,h,k} \quad (6.12)$$

$$EMS\_HH\_AUTO_h = \sum_k EMS\_HH\_AUTO_{h,k} \quad (6.13)$$

$$EMS\_HH\_AUTO_k = \sum_h EMS\_HH\_AUTO_{h,k} \quad (6.14)$$

$$EMS\_HH\_AUTO = \sum_h EMS\_HH\_AUTO_h \quad (6.15)$$

### Aggregation of automobile and housing emissions

$$EMS\_HH_{h,k,e} = EMS\_HH\_AUTO_{e,h,k} + EMS\_HH\_BUIL_{e,h,k} \quad (6.16)$$

$$EMS\_HH_{h,k} = \sum_e EMS\_HH_{e,h,k} \quad (6.17)$$

$$EMS\_HH_h = \sum_k EMS\_HH_{h,k} \quad (6.18)$$

$$EMS\_HH_k = \sum_h EMS\_HH_{h,k} \quad (6.19)$$

$$EMS\_HH = \sum_h EMS\_HH_h \quad (6.20)$$

### Total of GHG emissions :

$$EMS = EMS\_S + EMS\_HH \quad (6.21)$$

### Aggregate emissions by source e:

$$EMS_e = \sum_a EMS_{e,a} + \sum_h EMS_{e,h} \quad (6.22)$$

**Energetic Consumption in Mtep of Households :**

$$\Delta q\_Mtep\_H_{e,h} = \Delta ener\_buil_{e,h} \quad (6.23)$$

$$Q\_Mtep\_H_e = \sum_h Q\_Mtep\_H_{e,h} \quad (6.24)$$

$$Q\_Mtep\_H = \sum_e Q\_Mtep\_H_{e,h} \quad (6.25)$$

$$\Delta q\_Mtep\_TRSP_{e,h} = \Delta ener\_auto_{e,h} \quad (6.26)$$

$$Q\_Mtep\_TRSP_e = \sum_h Q\_Mtep\_TRSP_{e,h} \quad (6.27)$$

$$Q\_Mtep\_TRSP = \sum_e Q\_Mtep\_TRSP_{e,h} \quad (6.28)$$

**Energetic Production in Mtep :**

$$\Delta q\_Mtep_{e,a} = \Delta e_{e,a} \quad (6.29)$$

$$Q\_Mtep_e = \sum_a Q\_Mtep_{e,a} + Q\_Mtep\_TRSP_e + Q\_Mtep\_H_e \quad (6.30)$$

**Energetic consumption of automobile of households :**

$$\Delta q\_Mtep\_autoparc_{e,h} = \Delta ener\_auto_{e,h} \quad (6.31)$$

$$Q\_Mtep\_AUTOPARC_e = \sum_h Q\_Mtep\_AUTOPARC_{e,h} \quad (6.32)$$

$$Q\_Mtep\_AUTOPARC = \sum_e Q\_Mtep\_AUTOPARC_e \quad (6.33)$$

**Energetic Production in Mtep by subsectors:**

$$\begin{aligned} ED_{ena} &= \sum_e ED_{ena,e} & for \quad ena \in a = 21, 2201, \dots, 2406 \\ EM_{ena} &= \sum_e EM_{ena,e} \end{aligned} \quad (6.34)$$

$$E_{ena} = EM_{ena} + ED_{ena} \quad (6.35)$$

$$Q\_Mtep_{ena,e} = \varphi_{ena,e}^Y \cdot (Q\_Mtep\_H_e + Q\_Mtep\_TRSP_e + Q\_Mtep_{e,a}) \quad for \quad e = 22, 23, 24 \quad (6.36)$$

**Conversion between primary energy and final energy:**

$$Q\_Mtep_{ena}^{EP} = \zeta_{ena}^{ENE} \cdot Q\_Mtep_{ena} \quad (6.37)$$

$$Q\_Mtep^{EP} = \sum_{ena} Q\_Mtep_{ena}^{EP} \quad (6.38)$$

**Aggregation of energy consumption**

$$Q\_Mtep_e = Q\_Mtep\_H_e + \sum_a Q\_Mtep_{e,a} + Q\_Mtep\_H\_TRSP_e \quad (6.39)$$

$$Q\_Mtep = Q\_Mtep_e \quad (6.40)$$

**Unitary energy prices in euro per Mtep :**

$$PE_e^{TEP} \cdot Q\_Mtep_{a,e} = PE_e \cdot E_{e,a} \quad (6.41)$$

$$PEXP_e^{TEP} \cdot Q\_Mtep\_H_{e,e} = PENER\_BUIL_e \cdot ENER\_BUIL_e \quad (6.42)$$

$$PEXP_e^{TEP} \cdot Q\_Mtep\_H_{e,e} = PEXP_e \cdot EXP_e \quad (6.43)$$

$$PEXP\_TRSP_e^{TEP} \cdot Q\_Mtep\_TRSP_{h,e} = PEXP_{03} \sum_k EXP\_AUTO_{h,k,e} \quad (6.44)$$

$$PEXP_e^{TEP} \cdot Q\_Mtep\_H_e = \sum_k PENER\_BUIL_{k,e} \cdot PE_e \cdot E_{e,a} \quad (6.45)$$

**Special Contribution to the Electricity's Public services:**

$$CSPE = CSPE\_elec + CSPE\_heat + CSPE\_biocarb \quad (6.46)$$

$$CSPE\_elec_{ena} = (CU_a - CU_{23\_foss}) \cdot Y_{ena} \text{ for } a = 2305, 2306, 2307, 2308 > 0 \quad (6.47)$$

$$\begin{aligned} CSPE\_elec = & CSPE\_elec_{2305} + CSPE\_elec_{2306} + \\ & CSPE\_elec_{2307} \cdot \frac{Q\_Mtep_{2307,t} - Q\_Mtep_{2307,0}}{Q\_Mtep_{2307,t}} + CSPE\_elec_{2308} \end{aligned} \quad (6.48)$$

$$CSPE\_heat_{ena} = (CU_a - CU_{2401}) \cdot Y_{ena} \text{ for } a = 2402, 2403, 2404, 2405, 2406 > 0 \quad (6.49)$$

$$CSPE\_heat = CSPE\_heat_{2402} \cdot \left( \frac{Q\_Mtep_{2302,t} - Q\_Mtep_{2302,0}}{Q\_Mtep_{2302,t}} \right) + CSPE\_heat_{2403} + CSPE\_heat_{2404} + CSPE\_heat_{2405} + CSPE\_heat_{2406} \quad (6.50)$$

$$CU_{23}^{foss} = \frac{\sum_{ena} CU_{ena} \cdot Y_{ena}}{\sum_{ena} Y_{ena}} \text{ for } ena = 2301, 2302, 2303, 2304 > 0 \quad (6.51)$$

$$CSPE\_biocarb = (CU_{2202} - CU_{2201}) \cdot Y_{2202} \quad (6.52)$$

## 7 Demography

**Total employment (Full Time Employment equivalent):**

$$L = \sum_a (L\_S_a + L\_SE_a) \quad (7.1)$$

**Employment level by sex and age (International Labor Organisation definition):**

$$\Delta empl_{sex,age} = \Delta l \quad (7.2)$$

Where sex = {Men, Women} and age = {15-19, 20-24, 25-54, 60-64, 65+}

**Labor force by sex and age:**

$$LF_{sex,age} = PARTR_{sex,age} \cdot POP_{sex,age} \quad (7.3)$$

**Labor force participation ratio by sex and age:**

$$\Delta PARTR_{sex,age}^n = \Delta PARTR_{sex,age}^{Trend} + \beta_{sex,age} \Delta U \quad (7.4)$$

**Unemployment level by sex and age:**

$$UN_{sex,age} = LF_{sex,age} - EMPL_{sex,age} \quad (7.5)$$

### Unemployment rate by sex and age:

$$U_{sex,age} = UN_{sex,age} / LF_{sex,age} \quad (7.6)$$

$$U_{sex} = UN_{sex} / LF_{sex} \quad (7.7)$$

$$U_{age} = UN_{age} / LF_{age} \quad (7.8)$$

$$UNR\_TOT = UN\_TOT / LF\_TOT \quad (7.9)$$

### Aggregation for unemployment:

$$UN_{age} = \sum_{sex} (UN\_M_{age} + UN\_W_{age}) \quad (7.10)$$

$$UN_{sex} = \sum_{age} UN_{sex,age} \quad (7.11)$$

$$UN\_TOT = \sum_{sex} UN_{sex} \quad (7.12)$$

### Aggregation for labor force:

$$LF_{age} = \sum_{sex} (LF\_M_{age} + LF\_W_{age}) \quad (7.13)$$

$$LF_{sex} = \sum_{age} LF_{sex,age} \quad (7.14)$$

$$LF\_TOT = \sum_{sex} LF_{sex} \quad (7.15)$$

## 8 Other equations

### Adjustment process and expectations:

For quantity and prices, the adjustment process and expectations are specified according to the following equations.

$$\ln(X_t) = \lambda_0^X \ln(X_t^n) + (1 - \lambda_0^X)(\ln(X_{t-1}) + \Delta \ln(X_t^e)) \quad (8.1)$$

$$\Delta \ln(X_t^e) = \lambda_1^X \Delta \ln(X_{t-1}^e) + \lambda_2^X \Delta \ln(X_{t-1}) + \lambda_3^X \Delta \ln(X_t^n) + \lambda_4^X \Delta \ln(X_{t+1}) \quad (8.2)$$

Where  $X_t$  is the effective value of a given variable (e.g. the production price, labor, capital, etc),  $X_t^n$  its notional (or desired) level,  $X_t^e$  its expected (anticipated) value at period  $t$ . The first equation assumes a geometric adjustment process. The taking into account of the anticipation warrants that in the long run the effective variable converge to their desired levels. The second equation



assumes a general specification for expectation that combines backward-looking and forward-looking expectation. We assume further that in the long run expectation are accurate:  $\sum_{i=1}^4 \lambda_i^X = 1$ . We also assume that substitution effect adjust slowly:

$$SUBST\_X_t = \lambda_5^X . SUBST\_X_t^n + (1 - \lambda_5^X) . SUBST\_X_{t-1} \quad (8.3)$$

# Appendix D      Glossary of terms used

## Sets

$a \in A$	Activities
$c \in C$	Commodities
$ena \in ENA$	Energetic activities $ENA \subset A$
$m \in M$	Margins $M \subset A$
$h, h' \in H$	Households
$k, k' \in K$	Energetic Class
$e, e' \in E$	Energetic commodities $E \subset C$

## Endogenous variables

$AIC\_VAL$	Taxes on capital (in value)
$AIC\_VAL_h$	Taxes on capital per quintile (in value)
$AUTO_{h,k}$	Automobile stock of household $h$ per energy class $k$
$AUTO_k$	Automobile stock per energy class $k$
$AUTO_h$	Automobile stock of household $h$
$AUTO_t$	Total automobile stock
$AUTO_t^{DES}$	Stock of automobile destroyed
$AUTO_{h,t}^{DES}$	Stock of automobile destroyed of household $h$
$\beta_{c,h}^{EXP}$	Variable of household $h$ 's marginal propension to spend in commodity $c$
$BONUS\_ELEC_h$	Bonus received by the household $h$ for buying an electric car
$BUIL_{h,k}$	Building stock of household $h$ per energy class $k$ (in m2)
$BUIL_k$	Building stock per energy class $k$ (in m2)
$BUIL_h$	Building stock of household $h$ (in m2)
$BUIL_t$	Total building stock (in m2)
$BUIL_t^{DES}$	Stock of building destroyed (in m2)

$BUIL_{h,t}^{DES}$	Stock of building destroyed of household $h$ (in m2)
$BUIL\_VERIF_h$	Stock building verification of household $h$ for the initial period
$BUIL\_VERIF$	Total stock building verification for the initial period
$BF\_G\_VAL$	Public deficit (in value)
$C_{e,k}^{PerM2}$	Energy $e$ consumption per m <sup>2</sup> in buildings class $k$
$C_{e,k}^{PerKM}$	Energy $e$ consumption per Km in automobile class $k$
$CH_c$	Households' consumption of commodity $c$
$CHD_c$	Households' consumption of domestic commodity $c$
$CHM_c$	Households' consumption of imported commodity $c$
$CI_c$	Intermediary raw material $c$
$CID_c$	Domestically produced intermediary raw material $c$
$CID_{c,a}$	Domestically produced intermediary raw material $c$ by the activity $a$
$CIM_c$	Imported intermediary raw material $c$ by the activity $a$
$CIM_{c,a}$	Imported intermediary raw material $c$
$CK_a$	Capital cost in activity $a$
$CL$	Labor cost
$CL_a$	Labor cost in activity $a$
$CL\_S$	Labor cost of salary workers
$CL\_S_a$	Labor cost of salary workers in activity $a$
$CL\_SE$	Labor cost of self-employed workers
$CL\_SE_a$	Labor cost of self-employed workers in activity $a$
$CSE_a$	Employeur Social cotisations in activity $a$
$CSE$	Aggregated Employeur Social cotisations
$CSE\_ROW$	Total Employeur Social cotisations from the Rest Of the World
$CSE\_TOT$	Total Employeur Social cotisations
$CSS$	Aggregated Salary Social cotisations

$CSS_a$	Salary social cotisations in activity $a$
$CSS\_SE_a$	Self-Employed Social cotisations in the activity $a$
$CSS\_TOT$	Total Social cotisations
$CU_a$	Unitary Cost in the activity $a$
$DEBT_{h,k,t}^{AUTO\_VAL}$	Debt related to housing $h$ for automobile class $k$
$DEBT_{h,k,t}^{NEWBUIL\_VAL}$	Debt related to housing $h$ for new building $k$
$DEBT_{h,k,t}^{REHAB\_VAL}$	Debt related to housing $h$ for building rehabilitation $k$
$DC\_VAL_a$	Commercial balance in the activity $a$
$DC\_VAL$	Aggregated Commercial balance
$DEBT_a$	Debt in the activity $a$
$DEBT\_G\_VAL$	Public debt
$DEP\_TCO\_VAL$	Total amount of carbon tax receipts (in value)
$DEP\_VAL$	Public spendings
$DISPINC\_VAL$	Total net disposable income (in value)
$DISPINC^{AI}\_VAL$	Total disposable income before taxation (in value)
$DISPINC_h\_VAL$	Net Disposable income for household $h$ (in value)
$DISPINC_h^{AI}\_VAL$	Disposable income before taxation for the household $h$ (in value)
$DIV^{GOV}\_VAL$	Government receipts from the private activity ( in value)
$DIV^{HH}\_VAL$	Households dividend (in value)
$DP\_G\_VAL$	Public deficit ratio
$DS_c$	Stock variation in the commodity $c$
$DSD_c$	Stock variation in the domestically produced commodity $c$
$DSM_c$	Stock variation of the imported commodity $c$
$E_c$	Aggregate domestic energy $c$
$E_{c,a}$	Aggregate domestic energy $c$ produced by the activity $a$
$E^e_c$	Expected aggregate domestic energy $c$

$EN_c$	Notional aggregate domestic energy $c$
$EBE_a$	Gross Operating Profit of the activity $a$
$EBE$	Aggregate Gross Operating Profit
$ED_c$	Domestic energy $c$
$ED_{ena,e}$	Energy $e$ domestically produced and consumed by the energetic sector $ena$
$ED_{ena}$	Total of Energy domestically produced and consumed by the energetic sector $ena$
$EM_c$	Imported energy $c$
$EM_{ena,e}$	Energy $e$ imported and consumed by the energetic sector $ena$
$EM_{ena}$	Total of energy imported and consumed by the energetic sector $ena$
$EMPL_{sex,age}$	Number of worker per sex and age
$EMS_a$	Amount of emissions of the activity $a$
$EMS_e$	Amount of emissions from source $e$
$EMS_{e,a}$	Amount of emissions from source $e$ of the activity $a$
$ENER^{BUIL}$	Total energy consumption in Kwh
$ENER_e^{BUIL}$	Energy consumption in Kwh by type of energy $e$
$ENER_h^{BUIL}$	Energy consumption in Kwh related to housing $h$
$ENER_{h,e}^{BUIL}$	Energy consumption in Kwh related to housing $h$ by type of energy $e$
$ENER_{h,k}^{BUIL}$	Energy consumption in Kwh related to housing $h$ per energy class $k$
$ENER_k^{BUIL}$	Energy consumption in Kwh per class $k$ building
$ENER_{k,e}^{BUIL}$	Energy consumption in Kwh per building class $k$ by type of energy $e$
$ENER_{h,k,e}^{BUIL}$	Energy $e$ consumption in Kwh in building class $k$ related to housing $h$
$ENER_h$	Total energy expenditure of household $h$ (automobile + building)

$ENER_{h,k}$	Total energy expenditure of household $h$ per energy class $k$ (automobile + building)
$ENER_{h,k,e}^{perM2}$	Energy consumption per M2 in Kwh of household $h$ per energy class $k$ by type of energy $e$
$ENERT_c$	Taxes on the energetic products $c$ (TICE, TICGN, TIPP, TICC)
$ENERTD_c$	Taxes on the domestic energetic products $c$ (TICE, TICGN, TIPP, TICC)
$ENERTM_c$	Taxes on the imported energetic products $c$ (TICE, TICGN, TIPP, TICE)
$EXP_c$	Total household's expenditure in commodity $c$
$EXP_{h,c}$	Household's $h$ expenditure in commodity $c$
$EXP_{03,h}^{OTH\_VAL}$	Household's $h$ other expenditure in commodity 03 (in Value)
$EXP_{13,h}^{OTH\_VAL}$	Household's $h$ other expenditure in commodity 13 (in Value)
$EXP^{AUTO}$	Household's $h$ total automobile energy expenditure
$EXP_{k,e}^{AUTO}$	Automobile energy expenditure per energy class $k$ by type of energy $e$
$EXP_h^{AUTO}$	Household's $h$ automobile energy expenditure
$EXP_{h,k}^{AUTO}$	Household's $h$ automobile energy expenditure per energy class $k$
$EXP_{h,k,e}^{AUTO}$	Household's $h$ automobile energy expenditure per energy class $k$ by type of energy $e$
$EXP_{h,k,e}^{BUIL}$	Household's $h$ building energy expenditure per energy class $k$ by type of energy $e$
$EXP_{h,c}^n$	Notional Household's $h$ expenditure in commodity $c$
$EXP_{h,c}^e$	Expected Household's $h$ expenditure in commodity $c$
$EXP_h$	Household's $h$ expenditure
$EXP^{HOUSING\_VAL}$	Total building expenditure (New building + rehabilitation + energy expenditure)
$EXP_h^{HOUSING\_VAL}$	Household's $h$ total building expenditure (New building + rehabilitation + energy expenditure)

$EXP_{h,k}^{HOUSING\_VAL}$	Household's $h$ total building expenditure per energy class $k$ (New building + rehabilitation + energy expenditure)
$EXP^{HOUSINGbis\_VAL}$	Total building expenditure bis
$EXP_h^{HOUSINGbis\_VAL}$	Household's $h$ total building expenditure bis
$EXP^{HOUSINGver\_VAL}$	Verification of total building expenditure
$EXP_h^{HOUSINGver\_VAL}$	Household's $h$ verification of total building expenditure
$EXP\_MOB_h^{OTH\_VAL}$	Household's $h$ other mobility expenditure
$EXP\_MOB_h^{VAL}$	Household's $h$ mobility expenditure
$EXP\_MOB^{AUTO\_VAL}$	Total automobile mobility expenditure
$EXP\_MOB_h^{AUTO\_VAL}$	Household's $h$ automobile mobility expenditure
$EXP\_MOB_{h,k}^{AUTO\_VAL}$	Household's $h$ automobile mobility expenditure in energy class $k$
$EXP\_MOB^{AUTObis\_VAL}$	Total automobile mobility expenditure bis
$EXP\_MOB_h^{AUTObis\_VAL}$	Household's $h$ automobile mobility expenditure bis
$EXP\_MOB^{AUTOver\_VAL}$	Verification of total automobile mobility expenditure
$EXP\_MOB_h^{AUTOver\_VAL}$	Verification of Household's $h$ automobile mobility expenditure
$EXP_{h,c}^n$	Notional Household's $h$ expenditure in commodity $c$
$EXP^{NEWAUTO\_VAL}$	Total new automobile expenditure
$EXP_h^{NEWAUTO\_VAL}$	Household's $h$ new automobile expenditure
$EXP_{h,k}^{NEWAUTO\_VAL}$	Household's $h$ new automobile expenditure in energy class $k$
$EXP^{NEWBUIL\_VAL}$	Total new building expenditure
$EXP_h^{NEWBUIL\_VAL}$	Household's $h$ new building expenditure
$EXP_{h,k}^{NEWBUIL\_VAL}$	Household's $h$ new building expenditure in energy class $k$
$EXP^{REHAB\_VAL}$	Total rehabilitation expenditure in energy class $k$
$EXP_h^{REHAB\_VAL}$	Household's $h$ rehabilitation expenditure

$EXP_{h,k}^{REHAB\_VAL}$	Household's $h$ rehabilitation expenditure
$EXP_{h,03}^{elec}$	Household's $h$ expenditures in an electric car
$EXP_{G_c}$	Public expenditure in commodity $c$
$EXPH$	Total household's expenditure
$EXPH_c$	Household's expenditure in commodity $c$
$FW\_VAL$	Households financial wealth (in value)
$G_c$	Public expenditures of the public good $c$
$GD_c$	Public expenditures in the domestic public good $c$
$GDP$	Gross domestic product (product definition)
$GDP_c$	Gross domestic product for commodity $c$
$GDPbis$	Gross domestic product (product definition check)
$GDPter$	Gross domestic product (value-added definition)
$GM_c$	Public expenditures of the imported public good $c$
$I_c$	Private investment with the commodity $c$
$IA_a$	Aggregate Investment in the activity $a$
$ia_{c,a}$	Commodity $c$ investement in activity $a$
$IAD_{c,a}$	Aggregate Investment in the activity $a$ in domestic commodity $c$
$IAM_{c,a}$	Aggregate Investment in the activity $a$ in imported commodity $c$
$IC_c$	commodity $c$
$ID_c$	Private investment with the domestically produced commodity $c$
$IM_c$	Private investment in imported commodity $c$
$IR\_VAL$	Aggregate tax on income
$IR_h\_VAL$	Tax on income for the household $h$
$IS$	Aggregate tax on benefits
$IS_a$	Tax on benefits in activity $a$
$IY$	Aggregate tax on activities



$IY_a$	Tax on activity $a$
$K_a$	Capital stock in the activity $a$
$Km_h^{AUTO}$	Household's $h$ automobile kilometers traveled
$Km_{h,k}^{AUTO}$	Household's $h$ automobile kilometers by energy class $k$
$Km_{c,h}^{Traveler}$	Household's $h$ kilometers traveled by type of transport $c$
$Km_h^{Traveler\_AUTO}$	Household's $h$ automobile kilometers traveled
$Km_h^{Traveler}$	Household's $h$ total kilometers traveled
$K_a^e$	Expected capital stock in activity $a$
$K_a^n$	Notional capital stock in activity $a$
$L$	Total employment
$L_a$	Employment in the activity $a$
$LD_{h,k}$	Household's $h$ duration loan in class energy $k$
$LD_{h,k}^{REHAB}$	Household's $h$ duration loan for building rehabilitation in class energy $k$
$L_a^e$	Expected employment in activity $a$
$L_a^n$	Notional employment in activity $a$
$L\_S$	Total employment of salary workers
$L\_S_a$	Employment of salary workers in activity $a$
$L\_SE$	Total employment of self-employed workers
$L\_SE_a$	Employment of self-employed workers in activity $a$
$LF_{age}$	Labor force by age
$LF_{sexe,age}$	Labor force by sexe and age
$LF\_TOT$	Total labor force
$LF_{sexe}$	Labor force by sexe
$M$	Aggregate importation
$M_c$	Importation of commodity $c$
$MAT_a$	Total raw material in activity $a$
$MAT_{c,a}$	Raw material of commodity $c$ in the activity $a$

$MAT_a^e$	Expected total raw material in activity $a$
$MAT_a^n$	Notional total raw material in activity $a$
$MATD_{c,a}$	Domestic raw material of commodity $c$ in activity $a$
$MATM_{c,a}$	Imported raw material of commodity $c$ in activity $a$
$MBIS_c$	Importation of commodity $c$ (verification)
$MC$	Aggregate commercial margins on the commodity $c$
$MCD$	Agregate ommercial margins on the domestic commodity $c$
$MCD_c$	Commercial margins on the domestic commodity $c$
$MCM$	Aggregate commercial margins on the imported commodity $c$
$MCM_c$	The commercial margins on the imported commodity $c$
$MPS_h$	The marginal propension to save of household $h$
$MT$	Aggregate transport margins on the domestic commodity
$MT_c$	Transport margins on the commodity $c$
$MTD$	Aggregate transport margins on the domestic commodity
$MTD_c$	Transport margins on the domestic commodity $c$
$MTD_{a,c}$	Transport margins of the sector $a$ on the domestic commodity $c$
$MTM$	Aggregate transport margins on the imported commodity
$MTM_c$	Transport margins on the imported commodity $c$
$MTM_{a,c}$	Transport margins of the sector $a$ on the imported commodity $c$
$NCU_a$	Net Unitary Cost in the activity $a$
$NEWAUTO_h$	Household's $h$ new auto
$NEWAUTO_{h,k}$	Household's $h$ new auto in class energy $k$
$NEWBUIL_h$	Household's $h$ new building
$NEWBUIL_{h,k}$	Household's $h$ new building in class energy $k$

$NEXP_h$	Necessary expenditures of household's $h$
$OTHT$	Aggregate others taxes
$OTHT_c$	Others taxes on the commodity $c$
$OTHTD_c$	Others taxes on the domestic commodity $c$
$OTHTM_c$	Others taxes on the imported commodity $c$
$P$	Price
$PARTR_{sex,age}^n$	Notional labor force participation by sex and age
$\dot{P}_{h,k}^{Ener\_m2\_e}$	Expected growth rate of energy price per m2 for household $h$ in class $k$
$\dot{p}_{h,k}^{Ener\_m2}$	Growth rate of energy price per m2 for household $h$ in class $k$
$P_{h,k}^{Ener\_m2}$	Energy price per m2 for household $h$ in class $k$
$P_k^I-auto$	Average price of investement in automobile class $k$
$P_k^{REHAB}$	Average price of the investement in renovation
$PAUTO_{h,k}$	Price of expenditure related to class $k$ automobile
$PCH$	Aggregate composite price for the consumed commodity
$PCH_c$	Composite price for the consumed commodity $c$
$PCHD$	Aggregate composite price of the domestic consumed commodity
$PCHD_c$	Composite price of the domestic consumed commodity $c$
$PCHM$	Aggregate composite price of the imported consumed commodity
$PCHM_c$	Composite price of the imported consumed commodity $c$
$PCI$	Aggregate composite price for the intermediary raw material
$PCID$	Aggregate composite price for the domestic intermediary raw material $c$
$PCID_c$	Composite price for the domestic intermediary raw material $c$

$PCID_{c,a}$	Composite price for the domestic intermediary raw material $c$ in activity $a$
$PCIM_c$	Aggregate composite price for the imported intermediary raw material
$PCIM_c$	Composite price for the imported intermediary raw material $c$
$PCIM_{c,a}$	Composite price for the imported intermediary raw material $c$ in activity $a$
$PCSE$	Aggregate price of employer social contribution paid by domestic producer
$PCSE_a$	Price of employer social contribution paid by domestic producer in activity $a$
$PCSE^{ROW}$	Price of employer social contribution paid by foreign domestic producer
$PCSE^{SE}$	Price of employer social contribution paid by self-employed worker
$PCSE_a^{TOT}$	Price of the total employer social contribution
$PCSS$	Aggregate price of salary social contribution paid by domestic producers
$PCSS_a$	Price of salary social contribution paid by domestic producer in activity $a$
$PCSS^{TOT}$	Price of the total salary social contribution paid by domestic producers
$PDEBT_a$	Price of the debt of activity $a$
$PDEBT$	Aggregate price of the debt of activities
$PDS$	Aggregate price of changes in inventories for commodities
$PDS_c$	Price of changes in inventories for commodity $c$
$PDSD$	Aggregate price of domestically produced changes in inventories for commodities
$PDSD_c$	Price of domestically produced changes in inventories for commodity $c$
$PDSM$	Aggregate price of imported changes in inventories for commodities

$PDSM_c$	Price of imported changes in inventories for commodity $c$
$PDIV_a$	Price of dividends paid by activity $a$
$PE$	Composite Price of the energy
$PE_c$	Aggregate Price of the energy $c$
$PE_{c,a}$	Aggregate Price of the energy $c$ in the activity $a$
$PE_e^{TEP}$	Unitary energy production in euro per Mtep by type of energy $e$ for productive use
$PEBE$	Aggregate composite price Gross Operating Profit
$PEBE_c$	Composite price of the commodity $c$ Gross Operating Profit
$PED_c$	Aggregate Price of the domestic energy $c$
$PEM_c$	Aggregated price of the imported energy $c$
$PED_{c,a}$	Price of the domestic energy $c$ in activity $a$
$PEM_{c,a}$	Aggregated price of the imported energy $c$
$PENER$	Price of energy consumption
$PENER_h$	Household's $h$ aggregate price of energy consumption
$PENER_{h,k}$	Household's $h$ aggregate price of energy consumption in energy class $k$
$PENER^{BUIL}$	Aggregate price of building energy consumption in energy class $k$
$PENER_e^{BUIL}$	Aggregate price of building energy consumption by type of energy $e$
$PENER_h^{BUIL}$	Household's $h$ aggregate price of building energy consumption
$PENER_{h,e}^{BUIL}$	Household's $h$ aggregate price of building energy consumption by type of energy $e$
$PENER_{h,k}^{BUIL}$	Average energy price paid in class $k$ building
$PENER_{h,k,e}^{BUIL}$	Household's $h$ price of building energy consumption by type of energy $e$ in energy class $k$
$PENERT$	Aggregate composite price of the taxes on the energetic products (TICE, TICGN, TIPP, TICC)

$PENERT_c$	Composite price of the taxes on the energetic products $c$ (TICE,TICGN, TIPP, TICC)
$PENERTD_c$	Composite price of the taxes on the domestic energetic products $c$ (TICE,TICGN, TIPP, TICC)
$PENERTM_c$	Composite price of the taxes on the imported energetic products $c$ (TICE,TICGN, TIPP, TICC)
$PEXP_{c,h}$	Price of household $h$ 's $h$ expenditure in commodity $c$
$PEXP_h$	Price of household $h$ 's $h$ expenditure
$PEXP_e^{TEP}$	Unitary energy production in euro per Mtep by type of energy $e$ for domestic use
$PEXP\_TRSP_e^{TEP}$	Unitary energy production in euro per Mtep by type of energy $e$ for transportation use
$PEXP_{03}^{eff}$	Expenditures Price in an efficient automobile $k = A, B, C$
$PEXPH$	Price of total household expenditure
$PEXPG_c$	Aggregate price of the public expenditures in commodity $c$
$PG$	Agregate composite public spending price
$PG_c$	Composite public spending price for commodity $c$
$PGD$	Aggregate domestically produced public spending price
$PGD_c$	Domestically produced public spending price for commodity $c$
$PGDP$	Composite price for the gross domestic product
$PGDP_c$	Composite price for the gross domestic product for each product $c$
$PGDPbis$	Composite price for the gross domestic product (aggregation of $PGDP_c$ )
$PGDPter$	Composite price for the gross domestic product (Added Value Method)
$PGM$	Aggregate import public spending price
$PGM_c$	Import public spending price for commodity $c$
$\phi_{c,h}^{EXP}$	Household's $h$ expenditure share in commodity $c$
$\phi_{03bis,h}^{EXP}$	Household's $h$ expenditure share in new automobile

$\phi_{13bis,h}^{EXP}$	Household's $h$ expenditure share in new building
$\phi_a^{NRJ}$	Energy share in activity $a$
$PI$	Agregate composite price for the domestic intermediary raw materials
$PI_c$	Composite price for the domestic intermediary raw material $c$
$PIA$	Investment composite price
$PIA_a$	Investment composite price in activity $a$
$PIA_{c,a}$	Investment composite price for commodity $c$ in activity $a$
$PIAD_c$	Domestically produced investment price for commodity $c$
$PIAM_c$	Imported investment price for commodity $c$
$PID$	Composite price of the domestic private investment
$PID_c$	Composite price of the domestic private investment for commodity $c$
$PIM$	Composite price of the private investment in imported
$PIM_c$	Composite price of the private investment in imported commodity $c$
$PIR$	Composite price of the tax on income
$PIS$	Price of tax on benefits
$PIS_c$	Price of tax on benefits on commodity $c$
$PIY$	Price of tax on activities
$PIY_a$	Price of tax on activity $a$
$PK_a$	Price of capital stock on activity $a$
$PM$	Import Price at base cost
$PM_a$	Import Price at base cost on activity $a$
$PMAT$	Aggregate price of the material raws
$PMAT_c$	Price of the material raws $c$
$PMAT_{c,a}$	Price of the material for the imported commodity $c$ in the activity $a$ in the sector $a$

$PMATD_c$	Aggregated price of the domestic material raws $c$
$PMATM_c$	Aggregated price of the imported material raws $c$
$PMC_c$	Composite price of the the commercial margins on the commodity $c$
$PMCD$	Composite price of the the commercial margins on the domestic commodities
$PMCD_c$	Composite price of the the commercial margins on the domestic commodity $c$
$PMCM$	Composite price of the the commercial margins on the imported commodities
$PMCM_c$	Composite price of the the commercial margins on the imported commodity $c$
$PMS_c$	Composite selling price of the imported production on the commodity $c$
$PMT_c$	Composite price of the transport margins of the sector $a$ on the commodity $c$
$PMTD$	Composite price of the transport margins on the domestic commodities
$PMTD_c$	Composite price of the transport margins on the domestic commodity $c$
$PMTD_{c,a}$	Composite price of the transport margins of the sector $a$ on the domestic commodity $c$
$PMTM$	Composite price of the transport margins on the imported commodities
$PMTM_c$	Composite price of the transport margins of the imported commodity $c$
$PMTM_{c,a}$	Composite price of the transport margins of the sector $a$ on the imported commodity $c$
$P_h^{NEWAUTO}$	Price of household's $h$ new auto
$P_{h,k}^{NEWAUTO}$	Price of household's $h$ new auto in class energy $k$
$P^{NEWBUIL}$	Price of new building
$P_h^{NEWBUIL}$	Price of household's $h$ new building
$P_{h,k}^{NEWBUIL}$	Price of household's $h$ new building in class energy $k$



$POTHT$	Composite price of others taxes on commodities
$POTHT_c$	Composite price of others taxes on commodity $c$
$POTHD_c$	Composite price of others taxes on the domestic commodity $c$
$POTHTM_c$	Composite price of others taxes on the imported commodity $c$
$PQ_c$	Composite price for product
$PQ_c$	Composite price for product on commodity $c$
$PQD$	Agregate composite price for the domestic commodities
$PQD_c$	Composite price for the domestic commodity $c$
$PQM$	Agragte composite price for the imported commodities
$PQM_c$	Composite price for the imported commodity $c$
$P_{h,k}^{REHAB-\delta}$	Price of household's $h$ building rehabilitation in class $k$
$P_{h,k}^{REHAB}$	Price of household's $h$ building rehabilitation in class $k$
$P_{h,k,k'}^{REHAB}$	Price of household's $h$ building rehabilitation from energy class $k'$ to energy class $k$
$PRESOC\_DOM^{Oth}\_VAL$	Others domestic social prestations
$PRESOC\_DOM^U\_VAL$	unplyment social prestations
$PRESOC\_DOM\_VAL$	Agregate domestic social prestations
$PRESOC\_VAL$	Agregate social prestations
$PSUB$	Agregate composite price of the subvention on commodities
$PSUB_c$	Composite price of the subvention on commodity $c$
$PSY$	Price of subvention on activities
$PSY_a$	Price of subvention on activity $a$
$PTAX$	Composite price of the taxes
$PTAX_c$	Composite price of the taxes on the commodity $c$
$PVA$	Composite price for the Added-Value
$PVA_c$	Composite price for the Added-Value of the commodity $c$

$PVAT$	Aggregate composite price of the Value Added Tax
$PVAT_c$	Composite price of the Value Added Tax on commodity $c$
$PVATD_c$	Composite price of the Value Added Tax on domestic commodity $c$
$PVATM_c$	Composite price of the Value Added Tax on imported commodity $c$
$PX$	Aggregate composite price of export
$PX_c$	Composite price of export on commodity $c$
$PXD$	Aggregate price of the exports of the commodity $c$
$PXD_c$	Price of the exports of the commodity $c$
$PXM$	Aggregate price of the exported importations
$PXM_c$	Price of the exported importations of the commodity $c$
$PY$	Aggregate price of the domestically production
$PY_a$	Price of the domestically production in the activity $a$
$PY_a^e$	Expected Price of the domestically production in the activity $a$
$PY_a^n$	Notional price of the domestically production in the activity $a$
$PYQ$	Aggregate composite price of the domestically production
$PYQ_c$	Composite price of the domestically production on commodity $c$
$PYQS_c$	Selling price for domestic commodity $c$
$Q$	Aggregate produced commodity $c$
$Q_c$	Produced commodity $c$
$QD$	Domestically produced commodities
$QD_c$	Domestically produced commodity $c$
$QM$	Imported commodities
$QM_c$	Imported commodity $c$

$Q_a^{MTEP}$	Energy production in activity $a$ expressed in physical currency
$Q_{e,h}^{MTEP-H}$	Consumption of energy $e$ in class of household $h$ expressed in physical currency
$Q_{e,h}^{MTEP-H-TRSP}$	Consumption of energy $e$ in class of household $h$ expressed in physical currency linked to a transportation use
$Q_{e,h}^{MTEP-H-TRSP}$	Consumption of energy $e$ in class of household $h$ expressed in physical currency linked to a transportation use
$Q_{2301}^{MTEP-EP}$	Primary energy production of nuclear sector
$Q_{2301}^{MTEP-EF}$	Final energy production of nuclear sector
$R$	Interest rate
$R_a$	Interest rate in activity $a$
$R_k^{CASH-auto}$	Share of investement in automobile paid cash
$R_{h,k}^{LOAN}$	Household's $h$ share of investment in building paid with a loan in energy class $k$
$R_{h,k}^{LOAN-REHAB}$	Household's $h$ share of investment in building rehabilitation paid with a loan in energy class $k$
$R_{h,k}^{REHAB-DEBT}$	Household's $h$ share of debt in building rehabilitation
$REHAB$	Total building rehabilitation (in m2)
$REHAB_h$	Household's $h$ building rehabilitation (in m2)
$REHAB_{h,k}$	Household's $h$ building rehabilitation in energy class $k$ (in m2)
$REHAB_{h,k,k'}$	household's $h$ building rehabilitation from energy class $k'$ to energy class $k$ (in m2)
$R_k^{LOAN-auto}$	Share of investement in automobile paid with a loan
$R_k^I$	Interest rate
$R_k^I-auto$	Interest rate of automobile
$R_k^{RMBS}$	Rate of reimbursement of the debt
$R_k^{RMBS-auto}$	Rate of reimbursement of the automobile debt

$R_k^{SUB}$	Rate of subsidies on investement in energy efficiency
$R_k^{SUB\_auto}$	Rate of subsidies on investement in automobile
$R\_Dir$	Interest rate by the taylor rule
$R^e$	Expected interest rate
$R^G$	Interest rate
$R^N$	Notional interest rate
$REC\_VAL$	Public receipts
$RTCO_h$	Carbon tax redistributed to household $h$
$RTCO_E$	Carbon tax redistributed to the economic activities
$S$	Aggregate saving
$S_h$	Saving of household $h$
$SD_c$	Domestic stock/inventories for commodity $c$
$SD_c^e$	Domestic expected stock/inventories for commodity $c$
$SD_c^n$	Domestic notional stock/inventories for commodity $c$
$SM_c$	Imported stock/inventories for commodity $c$
$SM_c^e$	Imported expected stock/inventories for commodity $c$
$SM_c^n$	Imported notional stock/inventories for commodity $c$
$STANDARD\_BUIL$	buildings norms
$SUB$	Agregate subvention
$SUB_c$	Subvention on the commodity $c$
$SUBST\_CHD_c$	Factor of substitution of domestic household consumption in commodity $c$
$SUBST\_CHD_c^n$	Factor of substitution of domestic household consumption in commodity $c$ (notional)
$SUBST\_CHM_c$	Factor of substitution of imported household consumption in commodity $c$
$SUBST\_CHM_c^n$	Factor of substitution of imported household consumption in commodity $c$ (notional)
$SUBST\_E_a^n$	Factor of substitution of energy(notional)

$SUBST\_E_a$	Factor of substitution of energy
$SUBST\_E\_n_{c,a}$	Factor of substitution between energy sources (c=21...24) (notional)
$SUBST\_E_{c,a}$	Factor of substitution between energy sources (c=21...24)
$SUBST\_ED_{c,a}$	Factor of substitution for domestic energy $c$ in activity $a$ (c=21...24)
$SUBST\_ED^n_{c,a}$	Factor of substitution for domestic energy $c$ in activity $a$ (c=21...24) (notional)
$SUBST\_EM_{c,a}$	Factor of substitution for imported energy $c$ in activity $a$ (c=21...24)
$SUBST\_EM^n_{c,a}$	Factor of substitution for imported energy $c$ in activity $a$ (c=21...24) (notional)
$SUBST\_GD^n_c$	Factor of substitution for domestic government consumption in commodity $c$ (notional)
$SUBST\_GD_c$	Factor of substitution for domestic government consumption in commodity $c$
$SUBST\_GM_c$	Factor of substitution for imported government consumption in commodity $c$
$SUBST\_IAD_{c,a}$	Factor of substitution for domestic investment in commodity $c$ (c=14...18)
$SUBST\_IAD^n_{c,a}$	Factor of substitution for domestic investment in commodity $c$ (c=14...18) (notional)
$SUBST\_IAM_{c,a}$	Factor of substitution for imported investment in commodity $c$ (c=14...18)
$SUBST\_K^n_a$	Factor of substitution of capital (notional)
$SUBST\_K_a$	Factor of substitution of capital
$SUBST\_L^n_a$	Factor of substitution of labor (notional)
$SUBST\_L_a$	Factor of substitution of labor
$SUBST\_MAT_a$	Factor of substitution of material
$SUBST\_MAT^n_{c,a}$	Factor of substitution between transport of intermediary consumption (c=14...18) (notional)
$SUBST\_MAT_{c,a}$	Factor of substitution between transport of intermediary consumption (c=14...18)

$SUBST\_MAT_a^n$	Factor of substitution of material (notional)
$SUBST\_MATD_{c,a}^n$	Factor of substitution between domestic transport of material raw (c=14...18) (notional)
$SUBST\_MATD_{c,a}$	Factor of substitution between transport of intermediary consumption (c=14...18)
$SUBST\_MATM_{c,a}^n$	Factor of substitution between foreign, transport of intermediary consumption (c=14...18) (notional)
$SUBST\_MATM_{c,a}$	Factor of substitution between transport of intermediary consumption (c=14...18)
$SUBST\_MTD_{c,a}^n$	Factor of substitution between domestic transports (c=14...18) (notional)
$SUBST\_MTD_{c,a}$	Factor of substitution between domestic transports (c=14...18)
$SUBST\_MTM_{c,a}^n$	Factor of substitution between foreign transports (c=14...18) (notional)
$SUBST\_MTM_{c,a}$	Factor of substitution between foreign transports (c=14...18)
$SUBST\_X_c$	Factor of substitution for exportation in commodity $c$
$SUBST\_X_c^n$	Factor of substitution for exportation in commodity $c$ (notional)
$SUBST\_XD_c$	Factor of substitution for exportation of domestic products in commodity $c$
$SUBST\_XD_c^n$	Factor of substitution for exportation of domestic products in commodity $c$ (notional)
$SUBST\_XM_c$	Factor of substitution for exportation of imported products in commodity $c$
$\sum \varphi_{h,k}^{REHAB}$	sum of household's $h$ renovation share of class $k$ building
$SY$	Agregate subvention on activities
$SY_a$	Subvention on activity $a$
$\tau_{h,k}^{REHAB}$	Household's $h$ proportion of buildings rehabilitated in energy class $k$
$\tau_{h,k}^{REHAB-n}$	Household's $h$ notional proportion of buildings rehabilitated in energy class $k$
$TAX$	Aggregate Tax on domestic commodity $c$
$TAX_c$	Tax on domestic commodity $c$

$TCO_c\_VAL$	Carbon tax on commodity $c$
$TCOD_c\_VAL$	Carbon tax on domestic commodity $c$
$TMD_a$	Mark-up in activity $a$
$TS$	saving rate
$TS_h$	Household's $h$ saving rate
$UC_{h,k}^E$	Household's $h$ user cost of energy building in energy class $k$
$UC_{h,k}^{E-REHAB}$	Household's $h$ user cost of energy building in energy class $k$
$UC_{h,k}$	Household's $h$ user cost of building in energy class $k$
$UC_{h,k}^K$	Household's $h$ user cost of capital building in energy class $k$
$UC_{h,k}^{K-REHAB}$	Household's $h$ user cost of capital building rehabilitation in energy class $k$
$UC_{h,k}^{REHAB}$	Household's $h$ user cost building rehabilitation in energy class $k$
$UN_{age}$	Unemployment level by age
$UN_{sex,age}$	Unemployment level by sex and age
$UN_{sex}$	Unemployment level by sex
$UNR_{age}$	Unemployment rate by age
$UNR\_FR$	Unemployment rate in France
$UNR\_HFR$	Unemployment rate in France
$UNR_{sex,age}$	Unemployment rate by sex and age
$UNR_{sex}$	Unemployment rate by sex
$UNR\_TOT$	Total unemployment rate
$UNR\_ZE$	European unemployment rate
$VA$	Agregate value-added
$VA_a$	Value-added in activity $a$
$VAT$	Value Added Tax on domestic commodities
$VAT_c$	Value Added Tax on domestic commodity $c$

$VATD_c$	Value Added T)ax on domestic commodity $c$
$VATM_c$	Value Added Tax on imported commodity $c$
$VER\_P_{h,k}^{REHAB-\delta}$	Verification of price household's $h$ building rehabilitation in class $k$
$VER\_BUIL$	Verification of building stock (in m2)
$VER\_var_{h,k}^{REHAB}$	Verification of household's $h$ renovation share of class $k$ building
$W$	Agregate wage
$W\_S$	Agregate wage of salaries
$W\_S_a$	Wage of salaries in activity $a$
$W\_S_a^e$	Expected wage of salaries in activity $a$
$W\_S_a^n$	Notional wage of salaries in activity $a$
$W\_SE$	Agregate wage of self employment
$W\_SE_a$	Wage of self employment in activity $a$
$X$	Exportations of the commodities
$X_c$	Exportations of the commodity $c$
$XD$	Aggregate exportations of the domestically produced commodities
$XD_c$	Exportations of the domestically produced commodity $c$
$XM$	Aggregate re-exported importations of the commodities
$XM_c$	Re-exported importations of the commodity $c$
$Y$	Aggregate production
$Y_a$	Production in activity $a$
$Y_{c,a}$	Production of the commodity $c$ in activity $a$
$YOPT_a$	Potential production in activity $a$
$YQ$	Aggregate production
$YQ_c$	Production in commodity $c$
$YQbis_c$	Production in commodity $c$ (verification)
$YQS_c$	The volume of the production in commodity $c$ expressed at market price before VAT



## Exogenous variables

$BF\_G\_VAL\_ajust$	Public deficit adjustment (in value)
$CSS\_ROW$	Social salary cotisations paid by the Rest Of the World
$CSS\_SE$	Social salary cotisations paid by the Self-employed workers
$DEBT_{20}$	Debt in the activity 20
$DIV_a^{BK\_}VAL$	Dividends paid to the Bank by the sector $a$ (in value)
$DIV_a^{GOV\_}VAL$	Dividends paid to the government by the sector $a$ (in value)
$DIV_a^{HH\_}VAL$	Dividends paid to the household by the sector $a$ (in value)
$DIV_a^{ROW\_}VAL$	Dividends paid to the rest of the world by the sector $a$ (in value)
$DNAIRU$	Non-Accelerating Inflation Rate of Unemployment
$DP\_G^n\_VAL$	Notional public deficit expressed in percentage of GDP
$DSD_c$	Stock variation of the domestic commodity $c$
$DSM_c$	Stock variation of the imported commodity $c$
$EXPG\_TREND$	Total public spendings
$GR\_PROG_a^E$	Growth rate of technical Progress for energy in activity $a$
$GR\_PROG_a^K$	Growth rate of technical Progress for energy in activity $a$
$GR\_PROG_a^L$	Growth rate of technical Progress for energy in activity $a$
$INFL\_ZE\_TARGET$	Target inflation of europe zone
$INT\_VAL$	Total interest for household (in value)
$LD_k$	Duration of the loan
$LD_k^{auto}$	Duration of the automobile loan
$POP_{sex,age}$	Population by sex and age
$POP^{TOT}$	Total population

$PRESOC\_ROW\_VAL$	Social prestation to the benefit of the Rest Of the World (in value)
$PROG_a^j$	Index of Autonomous Technical Progress coefficient for input $j = \{K,L,E,M\}$ in activity $a$
$PWD_c$	World price for commodity $c$
$SB\_ROW$	foreign salary base
$T^{AIC}$	Rate of tax capital hold by the households
$TC$	euro currency change rate
$T^{BONUS\_elec}$	Rate of bonus granting for the buying of an electric car
$T^{TCO}$	Rate of carbon tax
$T_a^{CSS}$	Employee social contribution rate by activity $a$
$T^{CSS\_ROW}$	Employee social contribution rate paid by the rest of the world
$T^{CSS\_SE}$	Employee social contribution rate paid by self-employed
$T_c^{ENERTD}$	Energy tax rate on domestic produced commodity $c$
$T_c^{ENERTM}$	Energy tax rate on imported commodity $c$
$T^{gth\_elec}$	Penetration rate of the electric automobile
$T^{IR}$	Rate of tax on household's income
$T_a^{IS}$	Rate of tax on benefits
$T_a^{IYN}$	Rate of tax on activity $a$
$T_c^{OTHD}$	Rate of other tax on domestically produced commodity $c$
$T_c^{OTHM}$	Rate of other tax on imported commodity $c$
$TR\_ROW\_VAL$	Transferts toward the rest of the world (in value)
$T_c^{SUB}$	Subvention rate on domestically produced commodity $c$
$T_a^{SYN}$	Subvention rate for activities $a$
$T_c^{VATD}$	VAT rate on domestic produced households consumption $c$
$T_c^{VATM}$	VAT rate on imported households consumption $c$

$T_c^{VATDOTH}$	VAT rate on domestic produced commodity c (applied on intermediary consumption, investments and government consumption)
$T_c^{VATMOTH}$	VAT rate on domestic produced commodity c (applied on intermediary consumption, investments and government consumption)
$WD_c$	World demand for the product c

### Greek symbols (parameters)

$\alpha^{AUTO}$	
$\alpha_a^S$	Share of the annual production this stocked by activity a
$\alpha^{TCO}$	Share of the carbon tax receipts redistributed toward the households
$\beta_{sex,age}^{EMP}$	Participation rate to the labor market for each population of age <i>age</i> and sex <i>sex</i>
$\varphi_{h,k}^{NewBUIL}$	Share of the new building constructed with a class k label
$\delta_{h,k}^{BUIL}$	Depreciation rate from class k to k'
$\delta_a$	Depreciation rate of the capital in sector a
$\tau_{h,k}^{REHAB}$	Proportion of the building of category k is rehabilitated
$\varphi_{h,k',k}^{REHAB}$	share of the renovation of class k' building that are rehabilitated toward class k
$\varphi_{h,k}^{NewAUTO}$	Share of the new automobile constructed with a class k label
$\delta_{h,k}^{AUTO}$	Automobile depreciation rate
$\varphi_a^K$	Share (in value) of capital into the production of activity a
$\varphi_a^L$	Share (in value) of labor into the production of activity a
$\varphi_a^E$	Share (in value) of energy into the production of activity a
$\varphi_a^M$	Share (in value) of material into the production of activity a

$\varphi_h^{TCO}$	Share of the household carbon tax receipt redistributed toward the household $h$
$\varphi_{c,a}^Y$	Share of the commodity $c$ produced by the activity $a$
$\varphi^{AUTO}$	Share of the auto in the transports
$\eta_a^{j,j'}$	Elasticity of substitution in activity $a$ between the production factors $j = \{K,L,E,M\}$ and $j' = \{K,L,E,M\}$ for $j \neq j'$
$\eta_{h,k,e}^{BUIL-i,i'}$	Inter-energy Elasticity of substitution for each household $h$ and by type of energy $e$
$\eta^{BONUS\_elec}$	Elasticity between the demand in electric car and the level of the electric bonus
$\eta^{AUTO\_elec}$	Elasticity between the demand in electric car and the relative price of fuel energy
$\eta^{prest}$	Elasticity of the other social prestations to the level of unemployment
$\eta^{cd,cm}$	Armington's elasticity between the domestic good $cd$ and the imported one $cm$
$\eta^{LES\_CES}$	Elasticity of the L.E.S consumption function
$\eta^{MOB\_TRSP\_COL}$	Elasticity of substitution between the automobile and the collective transports
$\phi_{c,h}^{EXP}$	Share of the expenditure $c$ on the consumption
$\alpha_a^{TMD}$	Elasticity of mark-up with production in activity $a$
$\zeta_e^{ENE}$	conversion factor between primary and final energy production by type of energy $e$
$\lambda_i^X$	Ajustement parameter $i = \{1,...,5\}$ for variable $X$ (see Equations 8.1, 8.2, 8.3)