CHAPTER 9. A DYNAMIC GENERAL EQUILIBRIUM MODEL OF THE FRENCH ECONOMY

The model was developed by Maylis Coupet et Jean-Paul Renne at the DGTPE. I gave you the text of their paper and their simulation program under DYNARE (well commented). The text and the comments are written in French. I will present the model in English. I will simplify it a little bit and skip technical details. Then, I will comment the program.

The model represents the behaviour of four agents: households, domestic firms, the government and the central bank.

1. Households

The intertemporal expected utility of French households at time zero is

$$E_t \Sigma_{k=0}^{\infty} \beta^k U(C_{t+k}, C_{t+k-1}, L_{t+k}, N_{t+k}, N_{t+k-1}).$$

It depends on their consumption C_t and on the number of hours they work L_t. N_t is an index of the size of the population. The specification of function *U* is

$$U(C_t, C_{t-1}, L_t, N_t, N_{t-1}) = \log\left(\frac{C_t}{N_t} - h\frac{C_{t-1}}{N_{t-1}}\right) + \varphi \log\left(\bar{l} - \frac{L_t}{N_t}\right)$$

C_t / N_t and L_t / N_t represent consumption per capita and the average work duration. $\bar{l}$ is the maximum work duration, which is physically possible. $0 \le h < 1$ is a parameter, which introduces *real* inertia in consumption choice.

The household budget constraint is

$$P_{c,t}\frac{C_t}{N_t}+P_{d,t}(1+\tau_{rem,t})\frac{I_t}{N_t}+\frac{B_t^d}{N_t}+\varepsilon_t\frac{B_t^{*d}}{N_t}+\frac{\Psi_W}{2}\left(\frac{W_t^{(i)}}{W_{t-1}^{(i)}}-\Gamma_W\right)^2 P_{c,t}\frac{C_t}{N_t}$$
$$\leq (1+i_{t-1})\frac{B_{t-1}^d}{N_{t-1}\Gamma_{N_t}}+\left(1+i_{t-1}^*\right)(1+rp_t)\varepsilon_t\frac{B_{t-1}^{*d}}{N_{t-1}\Gamma_{N_t}}+W_t^{(i)}\frac{L_t^{(i)}}{N_t}+\frac{div_t}{N_t}+impots_t+CA_t+R_{K,t}\frac{K_{t-1}}{N_{t-1}\Gamma_{N_t}}$$

The left-hand side of this equation describes household spending: consumption C_t, investment I_t, purchase of domestic bonds B_t^d and of foreign bonds B_t^{d*}. $P_{c,t}$ is the consumption price index (VAT included) and $P_{d,t}$ is the investment price (equal to the price of the added value and VAT excluded). The right-had side of the equation is equal to household income. $W_t^{(i)}$ is the net wage rate (after the payment of social compensations), B_{t-1}^d and B_{t-1}^{d*} are the stocks of domestic and foreign bonds owned at the beginning of period *t* (i.e. at the end of period *t-i*). i_{t-1} and i_{t-1}^* are the domestic and foreign interest rates of these bonds. $R_{K,t}$ is the rental rate of physical capital. There are a few traps in this equation.

- The price of foreign bonds is given in foreign currencies. ε_t is the exchange rate.
- Domestic firms are owned by domestic households. These households own the capital and rent it to firms at rate $R_{K,t}$. Firms are in monopolistic competition and earn a monopolistic rent. This rent is paid to households as dividends div_t.
- Each household supplies a specific kind of labour on the labour market. This market works in a regime of monopolistic competition between workers. Worker *i* has a market power and sets his wage $W_t^{(i)}$. As, workers are otherwise identical, these wages will be the same at equilibrium and we will drop superscript *i* in the DYNARE code of the model . However, nominal wages are rigid in the short-run. This *nominal* rigidity is specified by a cost of changing the nominal wage, which is the term $\frac{\Psi_W}{2}\left(\frac{W_t^{(i)}}{W_{t-1}^{(i)}}-\Gamma_W\right)^2 P_{c,t}\frac{C_t}{N_t}$ in the left-hand side of the equation. Γ_W is the balanced growth rate of wages.

- $\tau_{rem,t}$ is a tax on investment. In theory, consumption is taxed by the VAT, but investment is exempted from this tax. However, in practice household investment in housing pays the VAT.
- $impots_t$ represent lump sum taxes net of transfers.
- rp_t is a risk premium on foreign assets (debts) We have

$$rp_t = \alpha_1 \frac{1 - e^{\alpha_2 \varepsilon_t b^{*d}_{t-1}}}{1 + e^{\alpha_2 \varepsilon_t b^{*d}_{t-1}}}$$

If domestic households have a net foreign debt ($b^{*d}_{t-1} < 0$), $1 + rp_t > 1$, and the interest rate paid to foreign lenders is higher than i^*_{t-1}.

The efficiency of labour E_t will be explained in the next section. We define $c_t = C_t / (N_t E_t)$ and $w_t = W_t / E_t$. In the theory of growth these variables are called reduced variables and have no trend. Lower cases will be used for reduced variables, and the model will be simulated after having been written in reduced variables.

Households consume an aggregate of domestic good and imported good:

$$c_t = \left(\kappa c_t^{d\,\frac{\eta-1}{\eta}} + (1-\kappa)\, m_t^{\frac{\eta-1}{\eta}} \right)^{\frac{\eta}{\eta-1}} \quad (1)$$

The (VAT excluded) prices of the two consumption goods respectively are $P_{d,t}$ and $\varepsilon_t P^*_t$. For a given level of c_t, households set the levels of c^d_t and m_t, which minimizes the cost of their consumption: $P_{c,t} c_t \equiv \tau_{TVA,t} (P_{d,t} c^d_t + \varepsilon_t P^*_t m_t)$, where $\tau_{TVA,t}$ is the VAT rate. The computation of the solution of this minimization program and of the expression of the two domestic and foreign component of consumption, is horrible (but usual for people working with the two kinds of CGE models that we have seen in this course). The authors of the paper introduce new price variables, which they substitute to the price variables we have used until now. They are $q_t^* = \varepsilon_t P_t^* / P_{d,t}$ and $q_{c,t} = P_{c,t} / P_{d,t}$. Then they establish

$$m_t = \left(\frac{(1+\tau_{TVA,t}) q_t^*}{q_{c,t}(1-\kappa)} \right)^{-\eta} c_t$$
$$c_t^d = \left(\frac{1+\tau_{TVA,t}}{\kappa q_{c,t}} \right)^{-\eta} c_t$$

(2), (3)

The investment equation is less complicated than it looks

$$(1-\delta)\frac{K_{t-1}}{N_{t-1}\Gamma_{N_t}} + \frac{I_t}{N_t}\exp\left(-\frac{\chi}{2}\left(\frac{I_t}{I_{t-1}} - \Gamma_I\right)^2\right) = \frac{K_t}{N_t}$$

(4)

$\Gamma_{N_t} = N_t / N_{t-1}$ is the growth rate of population in time *t*. Thus, we can simplify the two sides of the equation by eliminating N_t. Without the factor in the second term of the left-hand side the equation becomes

$(1-\delta)K_{t-1} + I_t = K_t$,

where δ is the depreciation rate of capital, K_t the capital at the end of period *t*, and I_t the investment in period *t*.

The factor in the second term of the left-hand side shows that if the change in investment differs from Γ_I, which is the balanced growth of capital, firms will have to pay for an adjustment cost. This specification introduces a real rigidity in investment behaviour.

Firms use a quantity of labour L_t, which aggregates the labour supplied by each household (don't' forget that each household has a unique ability and has a market power on the labour market). The demand of the labour supplied by household *(i)* is

$$L_t^{(i)} = \left(\frac{W_t^{(i)}}{W_t}\right)^{-\rho} L_t$$

Households have to solve a maximization program under constraints. They set their consumption C_t, their wages W_t, the quantities of domestic and foreign bonds they will own at the end of the period B_t^d and B_t^*, the investment of firms I_t and the capital of firms at the end of the period K_t. We get six first-order conditions, which are a horrible, and written in the appendix of the paper (equations 12 to 17). These equations must be written in the simulation program.

2. Firms

You may find the specification of the production sector a bit strange. However it is quite usual in macroeconomics. There is a large number of firms, indexed by *i* (beware, it is not the same *i*, which was used to index households). Each firm produces a specific intermediary good according to the production function

(5) $$Y_t^{(i)} = A_t \left(\gamma K_t^{(i)\frac{\sigma-1}{\sigma}} + (1-\gamma)\left(E_t L_t^{(i)}\right)^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}$$

Firm *i* produces the quantity $Y_t^{(i)}$ of output *i*, with the quantity of labour $L_t^{(i)}$ and the stock of capital $K_t^{(i)}$. As, firms are otherwise identical, they produce the same output and make the same decisions at equilibrium and we will drop superscript *i* in the DYNARE code of the model . We remind that E_t is the efficiency of labour, which grows over time. These firms are in monopolistic competition on the market of the intermediary goods.

The intermediary goods are aggregated and transformed into a final good by other firms, which have the production function

$$Y_t^d = \left[\int_{i=0}^{1} \left(Y_t^{d(i)} \right)^{\frac{\theta}{1+\theta}} di \right]^{\frac{1+\theta}{\theta}}$$

The final good can be used for domestic consumption and investment. The price of the intermediary good *i* is $P_{d,t}^{(i)}$. The price of the final good is $P_{d,t}$. To produce the quantity of final good Y_t, these firms will use the quantities of intermediary goods *i*, which minimise theirs production cost. As these firms are in perfect competition and as they use a constant return technology, their profit is zero, which establishes a relationship between $P_{d,t}$ and the prices of intermediary goods $P_{d,t}^{(i)}$. A cumbersome computation gives the demand of intermediary good *i*

$$Y_t^{d(i)} = \left(\frac{P_{d,t}^{(i)}}{P_t^d} \right)^{-\theta_t} Y_t^d,$$

The exported good is also an aggregate of intermediary goods, but with different values of the parameters and different prices, P_t and $P_t^{(i)}$. These prices are expressed in foreign currency..

$$Y_t^f = \left[\int_{i=0}^{1} \left(Y_t^{f(i)} \right)^{\frac{\theta^*}{1+\theta^*}} di \right]^{\frac{1+\theta^*}{\theta^*}}$$

We get

$$Y_t^{f(i)} = \left(\frac{\bar{P}_t^{(i)}}{P_t} \right)^{-\theta^*} Y_t^f.$$

We introduce three new quadratic rigidities. It is costly to change the domestic price and the export price of the final good at a rate different from the long run inflation rate, Γ_{Pd}. Changing employment has also a cost. $\tau_{cse,t}$ is the social compensation rate. Thus, W_t is the wage income of the workers and $(1+\tau_{cse,t})W_t$ is the cost of labour for firms. Finally firms set the levels of employment and capital and the prices of the final good when it is domestically used, and when it is exported, to maximise their profit

$$\Pi_t^{(i)} = P_{d,t}^{(i)} Y_t^{d(i)} + \varepsilon_t \bar{P}_t^{(i)} Y_t^{f(i)} - (1+\tau_{cse,t}) W_t L_t^{(i)} - R_{K,t} K_t^{(i)} - \frac{\Psi_P}{2} \left(\frac{P_{d,t}^{(i)}}{P_{d,t-1}^{(i)}} - \Gamma_{Pd} \right)^2 P_{d,t}^{(i)} Y_t^{d(i)}$$
$$- \frac{\Psi_{P*}}{2} \left(\frac{\varepsilon_t^{\nu-1} \bar{P}_t^{(i)}}{\varepsilon_{t-1}^{\nu-1} \bar{P}_{t-1}^{(i)}} - \Gamma_\varepsilon^{\nu-1} \Gamma_{\bar{\pi}} \right)^2 \varepsilon_t \bar{P}_t^{(i)} Y_t^{f(i)} - \frac{\Psi_L}{2} \left(\frac{L_t^{(i)}}{L_{t-1}^{(i)}} - \Gamma_L \right)^2 W_t L_t^{(i)}$$

We get four first-order conditions, which are a horrible, and written in the appendix of the paper (equations 18 to 21). These equations must be written in the simulation program.

3. Closure of the model

The model includes equations (1) to (5) and the first-order conditions (12) to (21). We add

3.1. Foreign demand for French exports

This demand, x_t, depends on the ratio between the foreign price P_t^* and the price at which French goods are sold on foreign markets P_t

(6) $$x_t = \left(\frac{P_t^* (1-\kappa)}{\bar{P}_t} \right)^{-\eta} c_t^* = \left(\frac{q_t^* (1-\kappa)}{q_{b,t}} \right)^{-\eta} c_t^*$$

3.2. Exchange and monetary policies

The model represents France inside the Euro area. Thus, the exchange rate is set to 1

(7) $\varepsilon_t = 1$

The monetary policy of the European central bank is represented by the interest rule

(8)

$$i_t^* = \zeta i_{t-1}^* + (1-\zeta)(i^* + \tau((\Gamma_{Pc,t})^{0.21} (\Gamma_{P*,t})^{0.79} - \Gamma_{P*})) + \varepsilon_t^{i*}$$

i_t^* is the European interest rate, $\Gamma_{Pc,t}$ and $\Gamma_{P*,t}$ are the consumption inflation rates in France and in Europe, Γ_{P*} is the inflation rate target of the ECB.

3;3 Accounting identities

The following equations allocate the domestic production between exports, domestic consumption and investment

(9,10)

$$\begin{aligned} y_t &= y_t^d + x_t \\ y_t^d &= inv_t + c_t^d \end{aligned}$$

The next equation is the balance of payments identity

(11)

$$q_{b,t} x_t - q_t^* m_t = q_{c,t} b_t^* - \left(1 + i_{t-1}^*\right) \frac{b_{t-1}^* q_{c,t-1} q_t^*}{q_{t-1}^* \Gamma_{N,t} \Gamma_{P^*t} \Gamma_{E,t}}$$

The left-hand side represents the surplus of the trade balance. It is used to increase the stock of foreign bonds held by French households.

3.4. Last equations

Foreign inflation and demand were estimated by a VAR2

//************** Bloc estimé par VAR(2) Allgne, Pays-Bas, Italie, Espagne *****************

```
// Inflation étrangère AR(1)
gamapstar = gamapstar_ss + 0.19*(cstar(-1)-cstar_ss) - 0.25*(gamapstar(-1)-gamapstar_ss) - 0.23*(istar - istar_ss);
// Consommation étrangère
cstar = cstar_ss + 0.73*(cstar(-1)-cstar_ss) + 0.28*(gamapstar(-1)-gamapstar_ss) - 0.27*(istar - istar_ss);
```

The growth rate of the efficiency, Γ_E, and the level of global productivity, *A*, are set at exogenous levels.

```
// Productivité
gamaE = gamaE_ss;

// dynamique de A
A = A_star;
```

The two next equations give the growth rate of the prices of domestic consumption and output Γ_{Pc} and Γ_{Pd}

```
// Inflation prix conso
gamapc=qc/qc(-1)*gamapd;

// Variations du taux de change
gamaepsilon = qstar/qstar(-1)*gamapd/gamapstar;
```

Finally, there is a series of equations setting variables to exogenous levels (these variables could have been defined as exogneous).

```
// variables exogènes
thetastar = theta_ss;
gaman = gaman_ss;

tcotsoce    = tcotsoce_aux;
tcotsocs    = tcotsocs_aux;
tkm         = tkm_aux;
ttva        = ttva_aux;
tob_star    = tob_star_aux;
tob         = tob_aux;
tp          = tp_aux;
trem        = trem_aux;
tke         = tke_aux;
```

phi=phi_ss;
rho=rho_ss;

4. The code of the model under DYNARE

First, we write the names of the exogenous variables, endogenous variables and parameters. We have just seen that some endogenous variables are set to exogenous values and actually are exogenous.

var rho, phi, trem,tcotsocs,tkm,tke,tp,ttva,tob,tob_star,tcotsoce, A, balcom, gamaepsilon,gamaE,theta,y,x,m,y_d,c_d,interet,istar,invest,cstar,k,c,l,lambda,lambda1_tild,w_tild,gaman,gamapstar,gamapd,bd_star,Rk_tild,mu,qc,qstar,qb,gamapc,thetastar;

varexo tcotsoce_aux, tcotsocs_aux, tkm_aux, ttva_aux, tob_star_aux, tob_aux, tp_aux, trem_aux, tke_aux;

parameters h,tke0,trem0,tcotsoc0,psi_A, A_star,l_bar, psi_pstar, tau, eta, zeta, sigma, psiw, psip, psipbar, gw, phi_ss, rho_ss, beta, alpha1, alpha2, chi, gi, delta, psi_E, gamaE_ss, theta_ss, psi_theta, nu, gpbar, gpd, gepsilon, kappa, gama, cstar_ss, gaman_ss, gamapstar_ss, istar_ss,
psiL,gL,tcotsoce0,tcotsocs0,tkm0,tp0,ttva0,tob0,tob_star0,psi_theta,psi_pstar,psi_cstar,psi_phi,psi_beta,psi_rho,psi_kappa,psi_chi,psi_n;

Then, we give the numerical values of the parameters

```
// taux d'imposition These values will be used for the permanent shocks on the taxation rates
tcotsoce0=0.0;    // cotisations sociales employeur
tcotsocs0=0;                // cotisations sociales salariés
tke0=0.0;
tkm0=0.0;                  // impôt sur les revenus de la location du capital
tob0=0.0;                  // impôt sur les revenus obligataires
ttva0=0.0;                 // taux de TVA 0.0105
tp0=0;                     // impôt sur la production
tob_star0=0;
```

trem0=0.0;   // Rémanences

The numerical values of all the other parameters

```
zeta=0.65; // persitance du taux d'intérêt nominal, politique monétaire
h = 0.9244;     // persistance de la consommation
sigma=0.6;          // élasticité substitution N-K
rho_ss=4;              // élasticité demande de travail
Lambda_calib=0.0887; // =phi*rho/(rho-1) (issu du programme calib)0.088
//phi_ss=(rho_ss-1)/rho_ss*Lambda_calib;
phi_ss=0.066;
beta=0.995;         // préférence pour le présent
delta=0.025;        // taux trimestriel de dépréciation du capital (6.67)
theta_ss=7.51 ;      // élasticité de substitution entre les biens produits par les diff. entreprises
nu=1;               // paramètre de détermination des prix étrangers
kappa=0.4545;         //préférence domestique dans CES consommation
eta=1.5;            // élasticité de substitution dans CES consommation
gama=0.8344;          // paramètre technique dans la fonction de production
tau=0.92;            // fonction de réaction de la politique monétaire
taustar=0.34;
l_bar=1;            // normalisation du temps disponible

// Paramètres rigidités
psiw=1001;           // salaires :293
psip=6.5;           // prix : 4.7
psipbar=6.5;        // prix étrangers : 4.7
psiL=10.7;           // travail : 13.1
chi=7.34;           // investissement : 74

// Paramètres liés aux AR
psi_theta=0.388;
psi_E = 0.80;
psi_A = 0.9913;
psi_pstar=0.3030;
```

```
psi_cstar=0.937;
psi_phi=0.3356;
psi_beta=0.1999;
psi_rho=0.51;
psi_kappa=0.983;
psi_chi=0;
psi_n=0.9449;

// Prime de risque
alpha1=0.05;
alpha2=0.01;

// Croissance au steady state
gepsilon=1;
gaman_ss=exp(0.0011);
gamapstar_ss=exp(0.0048);
gamaE_ss=exp(0.0044);

// croissance stationnaire dans les termes de rigidités
gi=gamaE_ss*gaman_ss;
gL=gaman_ss;
gpd=gamapstar_ss*gepsilon;
gpbar=gpd*gepsilon^(-nu);
gw=gpd*gamaE_ss;

cstar_ss=0.7566;      //consommation étrangère au steady state
A_star = 1;
istar_ss=gamaE_ss*gaman_ss*gamapstar_ss/beta-1; // taux d'intérêt cible "étranger"
```

Then, we write the equations of the model

```
model;

// Règle monétaire Eq. 7
```

```
gamaepsilon=1;

// Politique monétaire de la BCE: Eq. 8
istar = zeta*istar(-1) + (1-zeta)*(istar_ss + tau*((gamapc)^0.21*(gamapstar)^0.79-gamapstar_ss));

// dynamique des chocs
theta = theta_ss;

// Programme des ménages
// bdstar->bd_star (dans Maple, on n'a pas dérivé / bd_star, qui entre dans la prime de risque)
// bd_star = epsilon*B*/(N.Pc)

// CPO1 Eq. 12
//1/c-lambda*(1+1/2*psiw*(w_tild*gamaE*qc*gamapd/(w_tild(-1)*qc(-1))-gw)^2) = 0;
gamaE/(c*gamaE-h*c(-1))-lambda*(1+1/2*psiw*(w_tild*gamaE*qc*gamapd/(w_tild(-1)*qc(-1))-gw)^2)-beta*h*gamaE/(c(1)*gamaE(1)*gamaE-h*c*gamaE) = 0;

// CPO2 Eq. 13
phi*rho*l/(w_tild*gamaE*qc*(l_bar-l))-lambda*(psiw*(w_tild*gamaE*qc*gamapd/(w_tild(-1)*qc(-1))-gw)*c*gamapd/(w_tild(-1)*qc(-1))-l/(gamaE*qc)+rho*l/(gamaE*qc))+beta*lambda(1)*psiw*(w_tild(1)*gamaE(1)*qc(1)*gamapd(1)/(w_tild*qc)-gw)*c(1)*w_tild(1)*gamaE(1)*qc(1)*gamapd(1)/(gamaE*w_tild^2*qc^2) = 0;

// CPO3 Eq. 14
-lambda+beta*lambda(1)*(1+interet)*qc/(gamaE(1)*gaman(1)*qc(1)*gamapd(1)) = 0;

// CPO4 Eq. 15
-lambda+beta*lambda(1)*(1+istar)*(1-alpha1*(exp(alpha2*bd_star)-1)/(exp(alpha2*bd_star)+1))*qstar(1)*qc/(qstar*gamapstar(1)*gamaE(1)*gaman(1)*qc(1)) = 0;

// CPO5 Eq. 16
```

-lambda/qc*(1+trem)+lambda*mu*(exp(-1/2*chi*(invest*gamaE*gaman/invest(-1)-gi)^2)-invest*chi*(invest*gamaE*gaman/invest(-1)-gi)*gamaE*gaman*exp(-1/2*chi*(invest*gamaE*gaman/invest(-1)-gi)^2)/invest(-1))+beta*lambda(1)*mu(1)*invest(1)^2*chi(1)*(invest(1)*gamaE(1)*gaman(1)/invest-gi)*gamaE(1)*gaman(1)*exp(-1/2*chi(1)*(invest(1)*gamaE(1)*gaman(1)/invest-gi)^2)/(invest^2) = 0;

// CPO6 Eq. 17

-lambda*mu+beta*(lambda(1)*Rk_tild(1)*(1-tkm(1))/(gaman(1)*gamaE(1))+lambda(1)*mu(1)*(1-delta)/(gaman(1)*gamaE(1))) = 0;

// Programme des entreprises (cf CPO.mw, Maple)

// CPO7 Eq. 18

//-(1+tcotsoce)*w_tild*qc+lambda1_tild*A*(1-gama)*(y/(A*l))^(1/sigma) = 0;

-(1+tcotsoce)*w_tild*qc-psiL*(l*gaman/l(-1)-gL)*(1+tcotsoce)*w_tild*qc*l*gaman/l(-1)-1/2*psiL*(l*gaman/l(-1)-gL)^2*(1+tcotsoce)*w_tild*qc+lambda1_tild*A*(1-gama)*(y/(A*l))^(1/sigma)+beta*lambda(1)*gaman(1)*qc*psiL*(l(1)*gaman(1)/l-gL)*(1+tcotsoce(1))*w_tild(1)*l(1)^2/(lambda*l^2) = 0;

// CPO8 Eq. 19

-Rk_tild*(1+tke)*qc+lambda1_tild*A*gama*(y*gaman*gamaE/(A*k(-1)))^(1/sigma) = 0;

// CPO9 Eq. 20

y_d-theta*y_d-psip*(gamapd-gpd)*gamapd*y_d-1/2*psip*(gamapd-gpd)^2*y_d+1/2*psip*(gamapd-gpd)^2*theta*y_d+lambda1_tild*theta*y_d+beta*lambda(1)*qc*gamapd(1)*psip*(gamapd(1)-gpd)*y_d(1)/(lambda*qc(1)) = 0;

// CPO10 Eq. 21

gamaepsilon*x-gamaepsilon*thetastar*x-psipbar*(qb*gamapd/(gamaepsilon*qb(-1))-gpbar)*qb*gamapd*x/qb(-1)-1/2*psipbar*(qb*gamapd/(gamaepsilon*qb(-1))-gpbar)^2*gamaepsilon*x+1/2*psipbar*(qb*gamapd/(gamaepsilon*qb(-1))-gpbar)^2*gamaepsilon*thetastar*x+lambda1_tild*thetastar*gamaepsilon*x/qb+beta*lambda(

```
1)*qc*gamapd(1)*psipbar*(qb(1)*gamapd(1)/(gamaepsilon(1)*qb)-
gpbar)*gamaepsilon*qb(1)^2*x(1)/(lambda*qc(1)*gamaepsilon(1)*qb^2) = 0;

//fonction de production Eq. 5
y = A * ( gama*(k(-1)/(gamaE*gaman))^((sigma-1)/sigma) + (1-gama)*l^((sigma-
1)/sigma))^(sigma/(sigma-1));

//équation d'exportation Eq. 6
x = (qb/((1-kappa)*qstar))^(-eta)*cstar;

//accumulation du capital Eq. 4
(1-delta)*k(-1)/(gaman*gamaE)+invest*exp(-1/2*chi*(invest*gamaE/invest(-1)-
gi/gaman_ss)^2) = k;

//demande domestique de bien domestique Eq. 10
y_d = c_d + invest;

//consommation domestique agrégée Eq. 1
c = (kappa*c_d^((eta-1)/eta)+(1-kappa)*m^((eta-1)/eta))^(eta/(eta-1));

//consommation domestique en bien étranger Eq. 2
m = ((1+ttva)*qstar/qc/(1-kappa))^(-eta)*c;

//consommation domestique de bien domestique Eq. 3
c_d = ((1+ttva)/qc/kappa)^(-eta)*c;

//équilibre sur le marché des biens Eq. 9
y = y_d + x;

//balance des paiements Eq. 11
qb*x - qstar*m = qc*bd_star - (1+istar(-1)*(1-tob(-1)))*bd_star(-1)/gaman/gamaE*qc(-
1)*qstar/qstar(-1)/gamapstar;
```

```
//************** Bloc estimé par VAR(2) Allgne, Pays-Bas, Italie, Espagne
*****************
// Inflation étrangère AR(1)
gamapstar = gamapstar_ss + 0.19*(cstar(-1)-cstar_ss) - 0.25*(gamapstar(-1)-gamapstar_ss) -
0.23*(istar - istar_ss);
// Consommation étrangère
cstar = cstar_ss + 0.73*(cstar(-1)-cstar_ss) + 0.28*(gamapstar(-1)-gamapstar_ss) - 0.27*(istar
- istar_ss);
// Inflation prix conso
gamapc=qc/qc(-1)*gamapd;

// Productivité
gamaE = gamaE_ss;

// dynamique de A
A = A_star;

// Variations du taux de change
gamaepsilon = qstar/qstar(-1)*gamapd/gamapstar;

// variables exogènes
thetastar = theta_ss;
gaman = gaman_ss;

tcotsoce    = tcotsoce_aux;
tcotsocs    = tcotsocs_aux;
tkm         = tkm_aux;
ttva        = ttva_aux;
tob_star    = tob_star_aux;
tob         = tob_aux;
tp          = tp_aux;
trem        = trem_aux;
tke         = tke_aux;
```

```
phi=phi_ss;
rho=rho_ss;

// balance commerciale
balcom = qb*x - qstar*m;

end;
```