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WELCOME

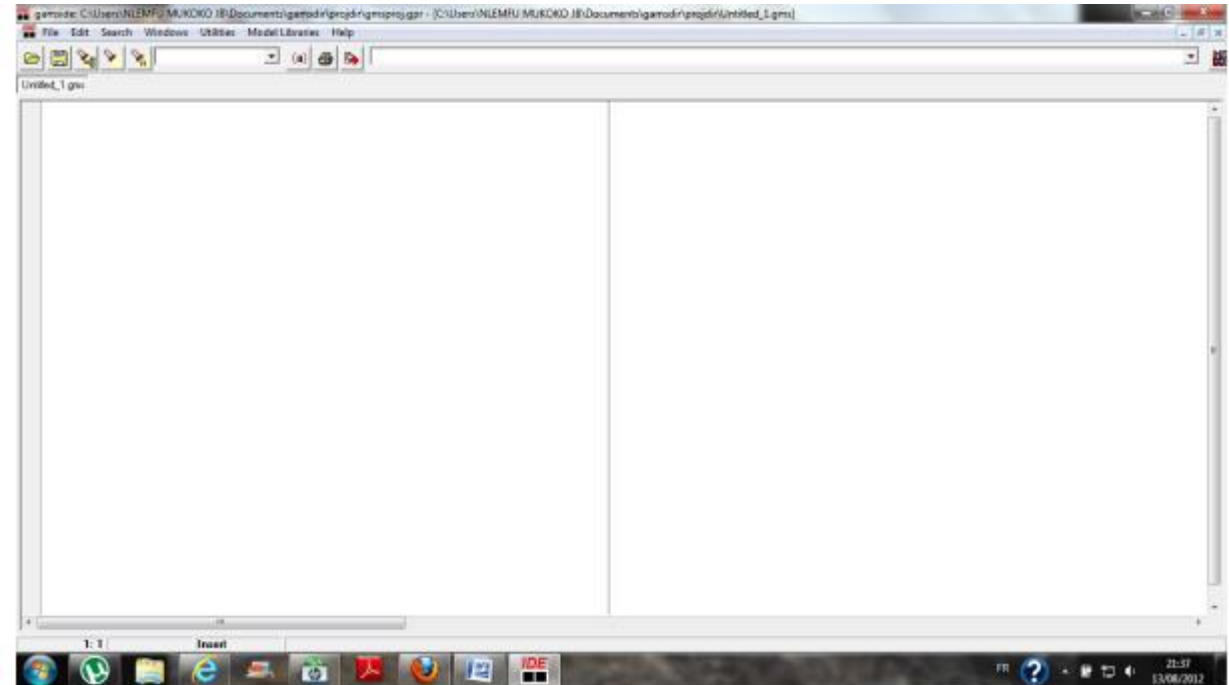
Session 10

Implementation of the AUTA model in
GAMS

Solving & Testing the AUTA Model with GAMS

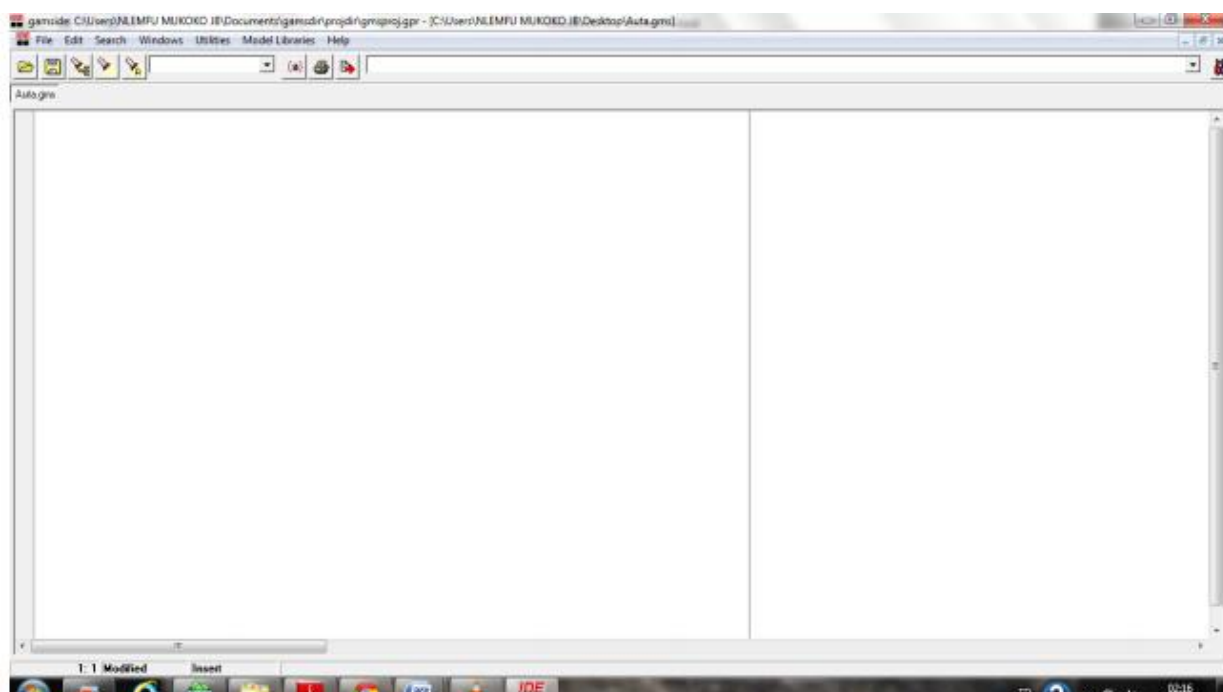
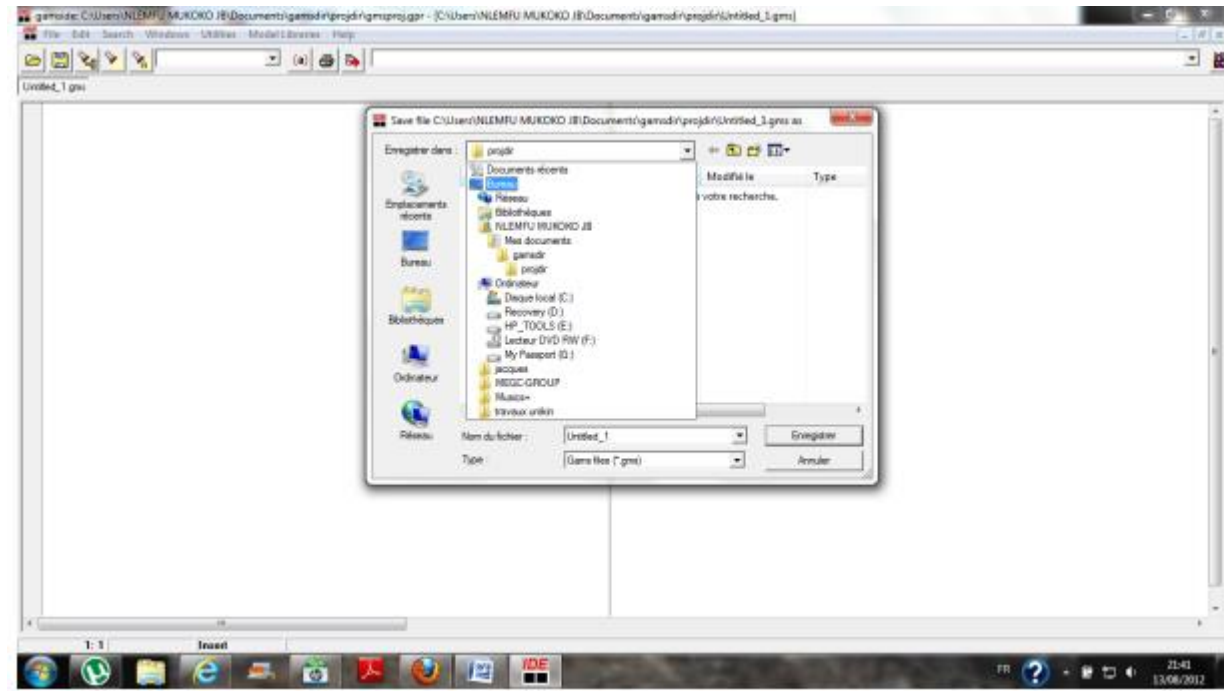
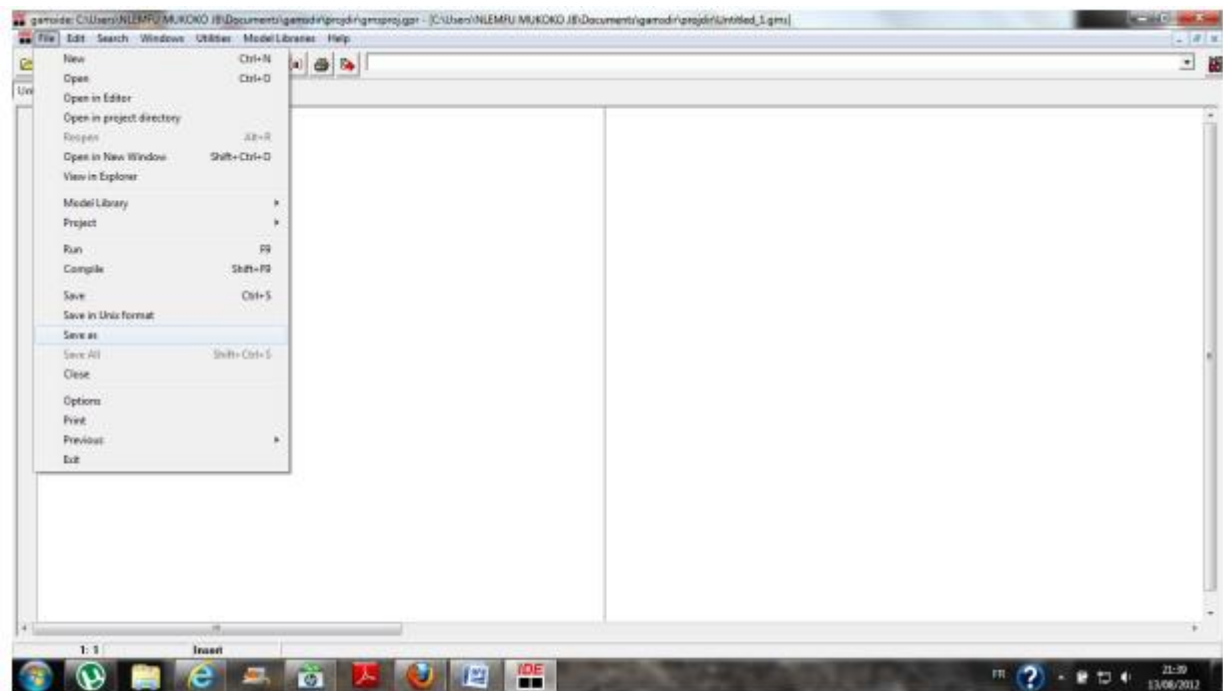
Create file or programming project

After downloading & installing the GAMS software, a shortcut will appear on your desktop (IDE):
<http://www.gams.com/dpwnload/>



- Create a project file under gams:
file/New/

- Name this file: file/save
as/choose location/ Auto/Enter



Outlook

- ***Step 1: Calibration***

- Set: Declare and define the groupings in the model
- Parameter: Declare & define the parameters and variables
- Data positioning
- Display: Allow presentation of data entered

- ***Step 2: Model***

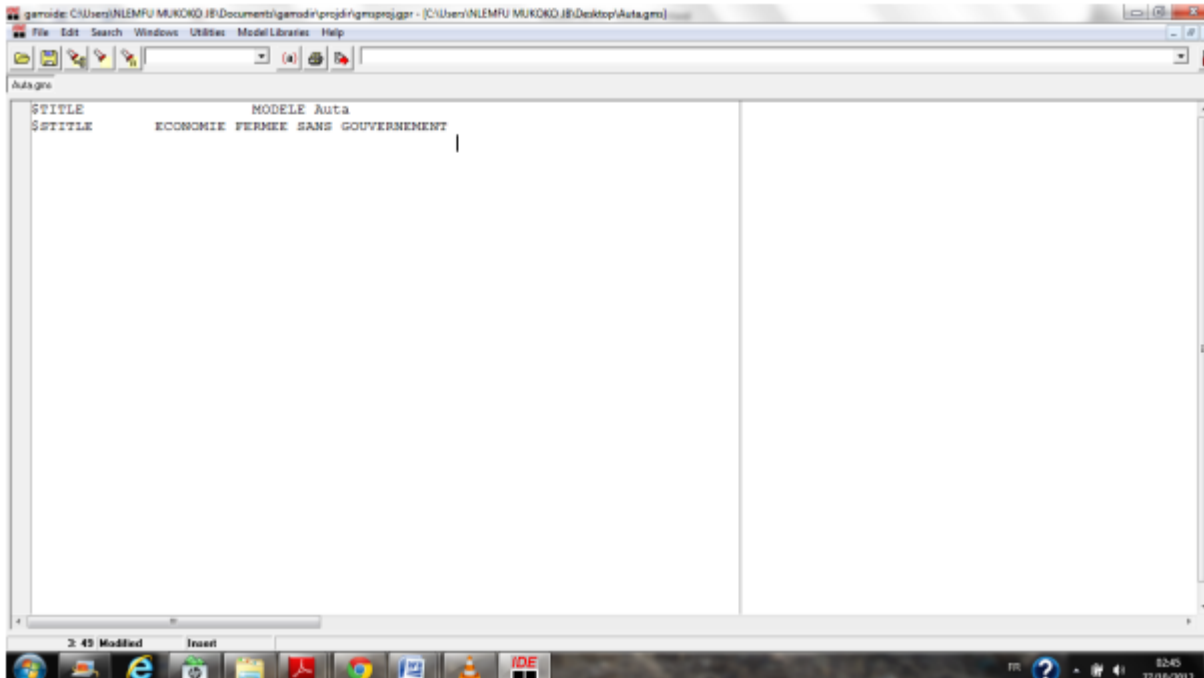
- Variables: Declare variables
- Equations:
- Declare and define equations

- ***Step 3: Resolution***

- Solve: Resolution of model

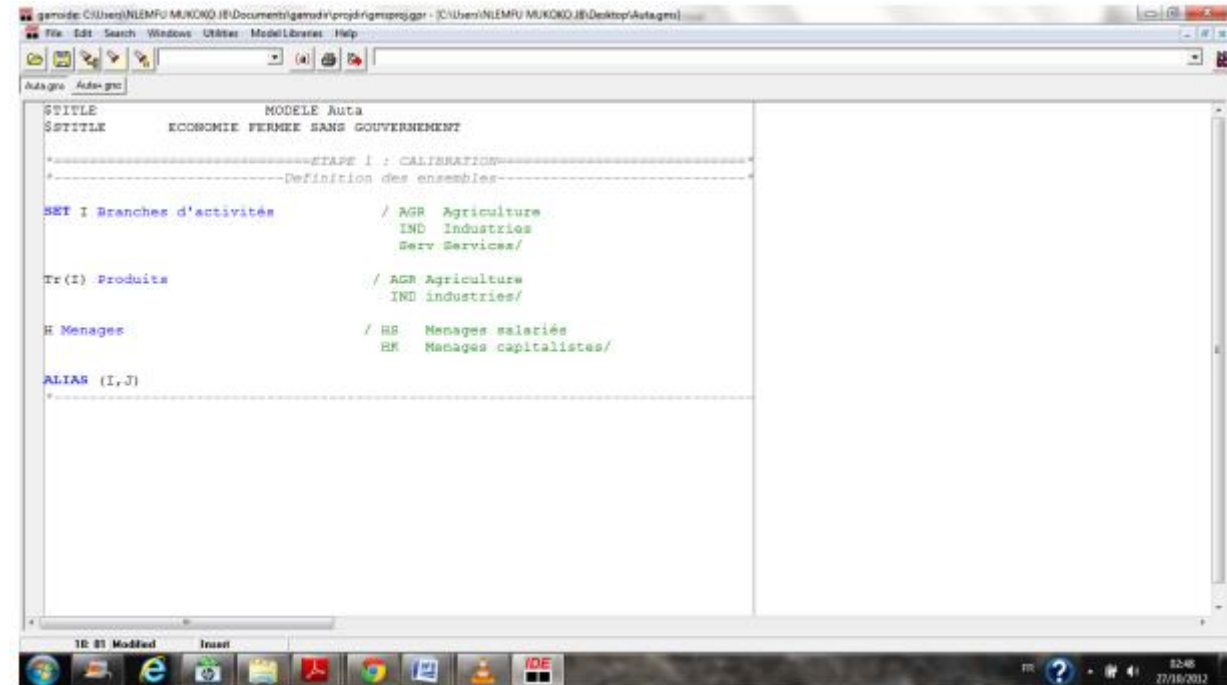
Step 1: Calibration

Give a title or subtitle to your project



```
Autagro
$TITLE          MODELE Auto
$SUBTITLE       ECONOMIE FERMEE SANS GOUVERNEMENT
```

Set: Define & declare the groupings of the models



```
Autagro  Autagro
$TITLE          MODELE Auto
$SUBTITLE       ECONOMIE FERMEE SANS GOUVERNEMENT
-----ETAPE 1 : CALIBRATION-----
-----Definition des ensembles-----
SET I Branches d'activit es          / AGR Agriculture
                                       IND Industries
                                       Serv Services/
Tr(I) Produits                      / AGR Agriculture
                                       IND industries/
H Menages                           / HH Menages salari es
                                       HM Menages capitalistes/
ALIAS (I,J)
-----
```

Parameter: Declare and define the parameters and variables of the base year

```
garride: C:\Users\NLEMPU\MUOKO\IF\Documents\garride\projdir\garrideproj - [C:\Users\NLEMPU\MUOKO\IF\Desktop\Autagr.m]
File Edit Search Windows Utilities ModelLibraries Help
Autagr.m Autagr.m

-----Definition des parametres-----
PARAMETER
*Fonction de production Cobb douglas
A(I)      Coefficient d'echelle de la Fonction Cobb-Douglas
alpha(I) COEFFICIENT DE PARTAGE (COBB DOUGLAS)
lo(I)     COEFFICIENT TECHNIQUE (FONCTION LEONTIEF)
v(i)     COEFFICIENT TECHNIQUE (FONCTION LEONTIEF)
aij(I,J) COEFFICIENT ENTREES-SORTIES

*Autres parametres
gamma(I,H) Part du bien i dans la consommation totale (valeur)
pai(H)     Propension marginale a epargner pour le menage h
mu(I)      Part du bien i dans l'investissement total (valeur)
lambda     Part du rev. du capital recu par le menage capitaliste

-----Definition des variables a l'annee de base-----
*Prix
wo         Taux de salaire
zo(I)     Taux de rendement du capital de la branche I
PO(I)     Prix du produit I
PVO(I)    Prix de la valeur ajoutee pour la branche I

*Production
XSO(I)    Production de la branche I
VAO(I)    Valeur ajoutee dans la branche i en volume
DIO(I,J)  Consommation intermediaire du bien i par la branche J
CIO(I)    Consommation intermediaire totale de la branche I

*Facteurs
KDO(I)    Demande du capital par la branche i
LSO       offre totale de travail
LDO(I)    Demande de la main d'oeuvre dans la branche i
```

```
garride: C:\Users\NLEMPU\MUOKO\IF\Documents\garride\projdir\garrideproj - [C:\Users\NLEMPU\MUOKO\IF\Desktop\Autagr.m]
File Edit Search Windows Utilities ModelLibraries Help
Autagr.m Autagr.m

LSO       offre totale de travail
LDO(I)    Demande de la main d'oeuvre dans la branche i

*Demandes
CO(I,H)   Consommation du bien i par le menage h (volume)
INVO(I)   Investissement dans le bien I (volume)
ITO       Investissement total (valeur)
DITO(I)   Demande intermediaire pour le bien I

*Revenu et epargne
YMO(H)    Revenu du menage h
YFO       Revenu des firmes
SMO(H)    Epargne du menage h
SFO       Epargnes des firmes
DIVO      Dividendes
?
```

Assigning the data: At this point, enter the data from the SAM into the model. Be sure to assign all data to the different endogenous variables. To orientate yourself, by every table there are indicators that are given on the lines and columns of the MCS (see below)

```

-----Entree des donnees a l'annee de base-----
* Variable DJD(I,J) : donnees tirees de la MCS croisement lignes 6,7,8 et colonnes
*6,7 et 8

TABLE DIO(I,J) Tableau entrees sorties

      AGR      IND      SERV
AGR    120.0    2526.9    275.5
IND    1544.0   21709.1   5815.5
SERV   136.0    11264.0   3349.0
J

-----
* Variable xso : donnees tirees de la MCS total colonnes 6,7 et 8
* Variable vao : ldo+kdo
* variable ldo : donnees tirees de la MCS croisement ligne 1 et colonnes 6,7 et 8
*variable kdo : donnees tirees de la MCS croisement ligne 2 et colonnes 6,7 et 8
*variable invo : donnees tirees de la MCS croisement lignes 6 et 7, et colonne 8
* variables ro et po par hypotheses = 1,

TABLE DP(*,I) autres donnees par branche d'activite

      AGR      IND      SERV
XSO    9000.0   54400.0   30700.0
VAO    7200.0   18900.0   21260.0
LDO    5760.0   7560.0    15540.0
KDO    1440.0   11340.0   5720.0
INVO   1098.6   9887.4
ro     1.0      1.0      1.0
po     1.0      1.0      1.0

```

```

-----
*variable co(i,h) : donnees tirees de la MCS croisement lignes 6,7 et 8, et
*colonnes 3 et 4

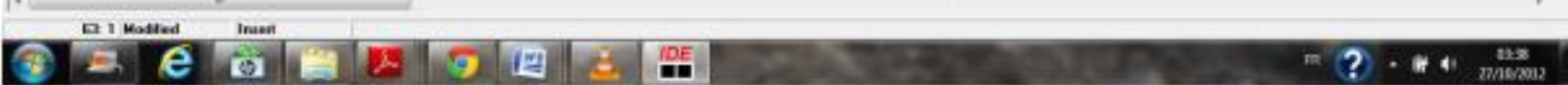
TABLE CO(I,H) Consommation des menages

      HS      HR
AGR    4329.0   650.0
IND    11544.0  3900.0
SERV   10101.0  5850.0
J

-----
*variable YMD : donnees tirees de la MCS: pour le menage HS c'est le total
* ligne 3 et pour HR c'est le total de la ligne 4.
*variable xmo : donnees tirees de la MCS: pour le menage hr c'est le croisement
*ligne 3 et colonne 3; pour le menage ht c'est le croisement ligne 3 et colonne 4
TABLE MENAGE(*,H) Autres donnees pour les menages

      HS      HR
YMD    28860.0  13000.0
xMD    2886.0   2600.0

```



garoide: C:\Users\NLEMFU MUKOKO JF\Documents\garoide\projdir\gmp\projgpr - (C:\Users\NLEMFU MUKOKO JF\Desktop\Autagms)

File Edit Search Windows Utilities ModelLibraries Help

Autagms Autagms

TABLE MENAGE(+,8) Autres donnees pour les menages

	HS	HK
ZMO	28860.0	13000.0
SNO	2886.0	2600.0

* Scalar c est pour saisir les variables qui n ont pas d'indices et donc ne
 *disposent que d'une seule valeur. wo =1 par hypothese; dive : croisement ligne 4
 *colonne 5. YFO : total ligne 5; sfo : croisement ligne 5 et colonne 5;
 *ITO : total colonne 9. lambda (part de revenu du capital allouee au menage
 *capitaliste : croisement ligne 4 et colonne 2.
 *

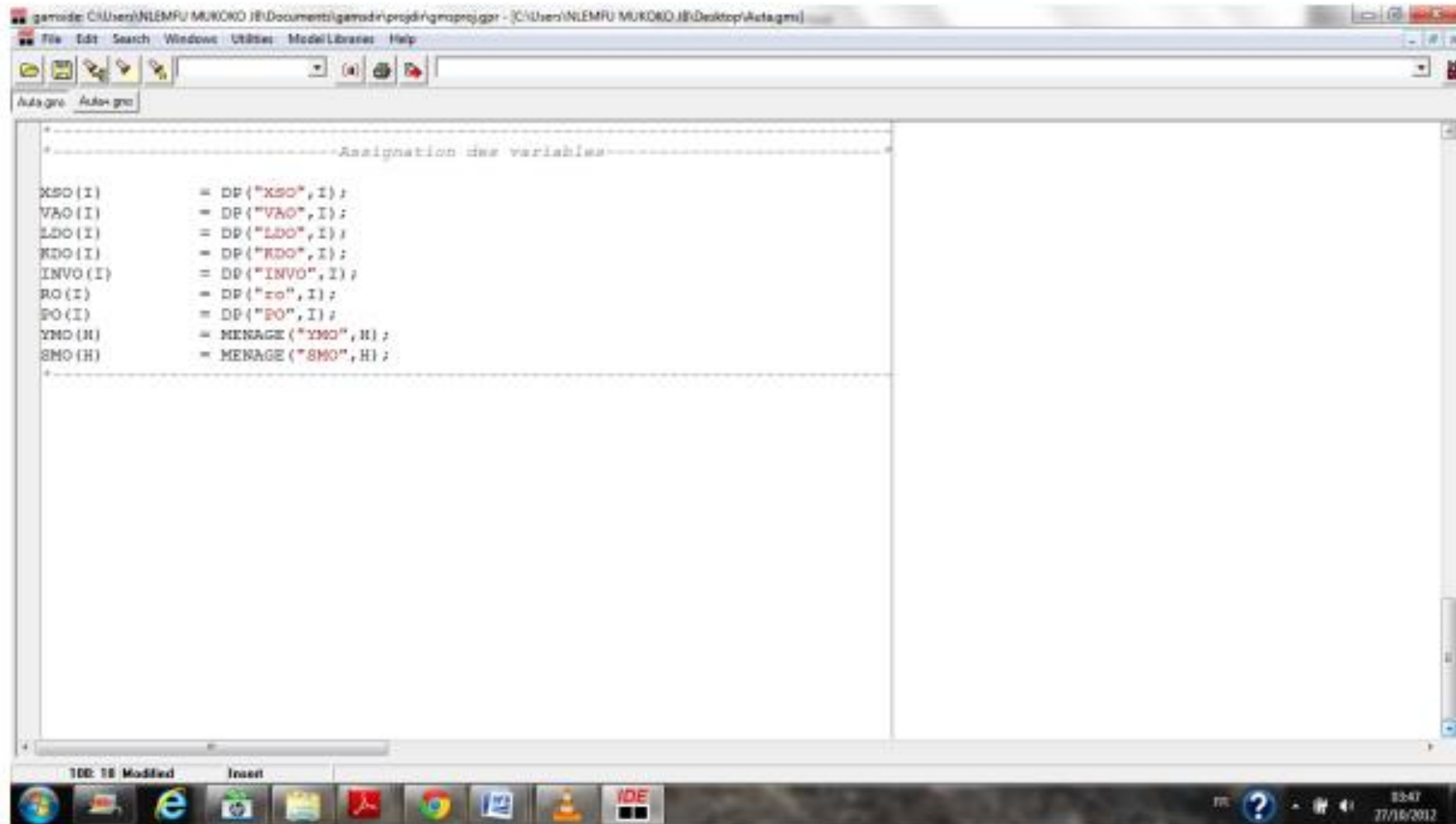
SCALAR

WO	/	1.0	/
DIVO	/	1900.0	/
YFO	/	7400.0	/
SFO	/	5500.0	/
ITO	/	10886.0	/
lambda	/	11100.0	/

C2:1 Modified Insert

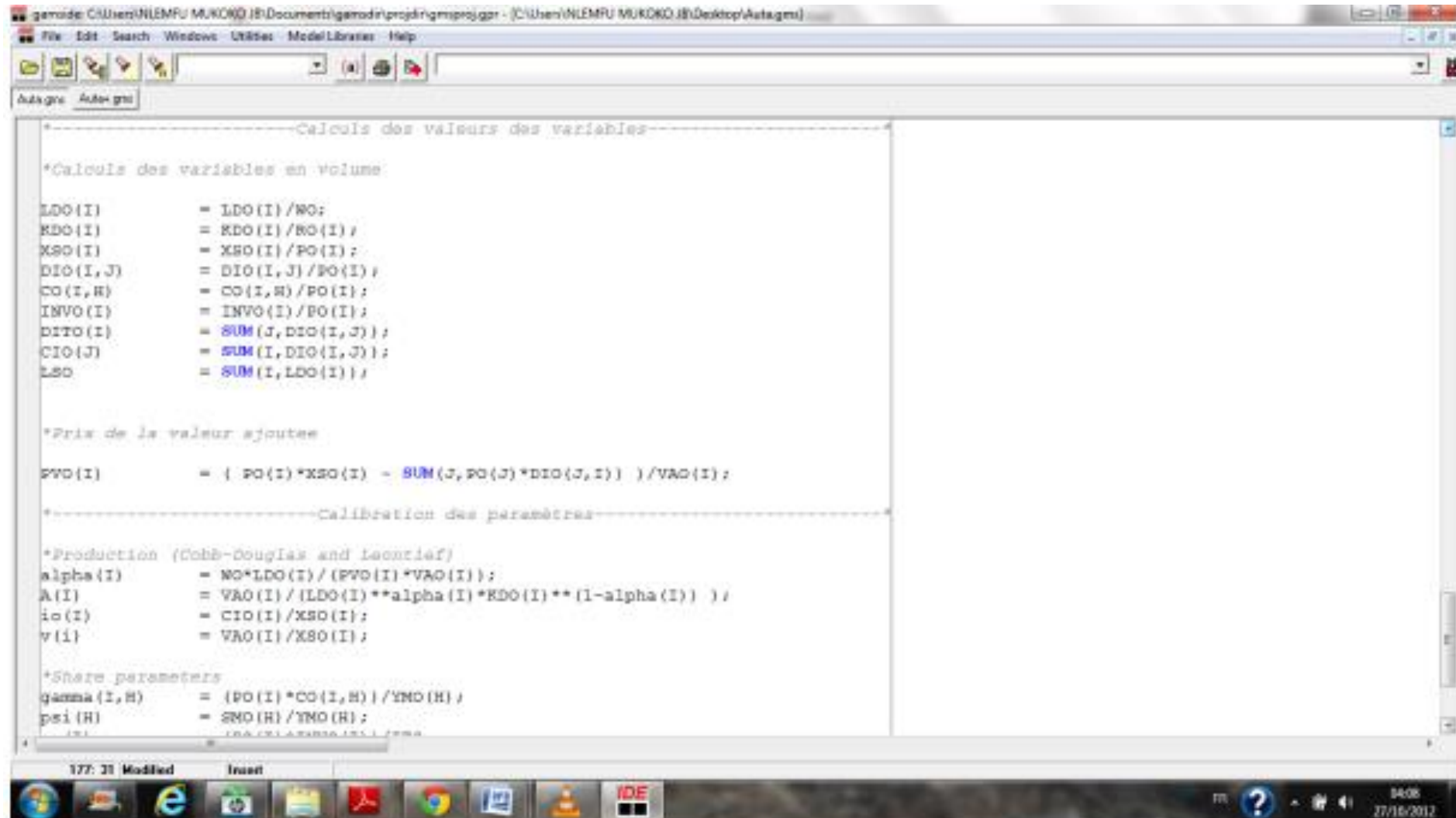
15:40 27/10/2012

Now that all the data from the SAM is integrated in the model, we must assign variables to them. This assignment is realized only for the variables contained within the tables << TABLE DP(*,I)>> and <<TABLES HOUSEHOLD(*,H)>>.



```
-----Assignment des variables-----
XSO(I)      = DP("XSO", I) ;
VAO(I)      = DP("VAO", I) ;
LDO(I)      = DP("LDO", I) ;
KDO(I)      = DP("KDO", I) ;
INVO(I)     = DP("INVO", I) ;
RO(I)       = DP("ro", I) ;
PO(I)       = DP("PO", I) ;
YMO(H)      = MENAGE("YMO", H) ;
SMO(H)      = MENAGE("SMO", H) ;
```

Calculate variables in volume and other parameters



```
gemsof: C:\Users\NLEMPU MUKOKO\Documents\gemodir\projdir\gemprojgr - (C:\Users\NLEMPU MUKOKO\Documents\projdir\gemprojgr)
File Edit Search Windows Utilities ModelLibraries Help
Autogr... Autogr...

-----Calculs des valeurs des variables-----

*Calculs des variables en volume:
LDO(I)      = LDO(I)/WO;
KDO(I)      = KDO(I)/KO(I);
XSO(I)      = XSO(I)/PO(I);
DIO(I, J)   = DIO(I, J)/PO(I);
CO(I, H)    = CO(I, H)/PO(I);
INVO(I)     = INVO(I)/PO(I);
DITO(I)     = SUM(J, DIO(I, J));
CIO(J)      = SUM(I, DIO(I, J));
LSO         = SUM(I, LDO(I));

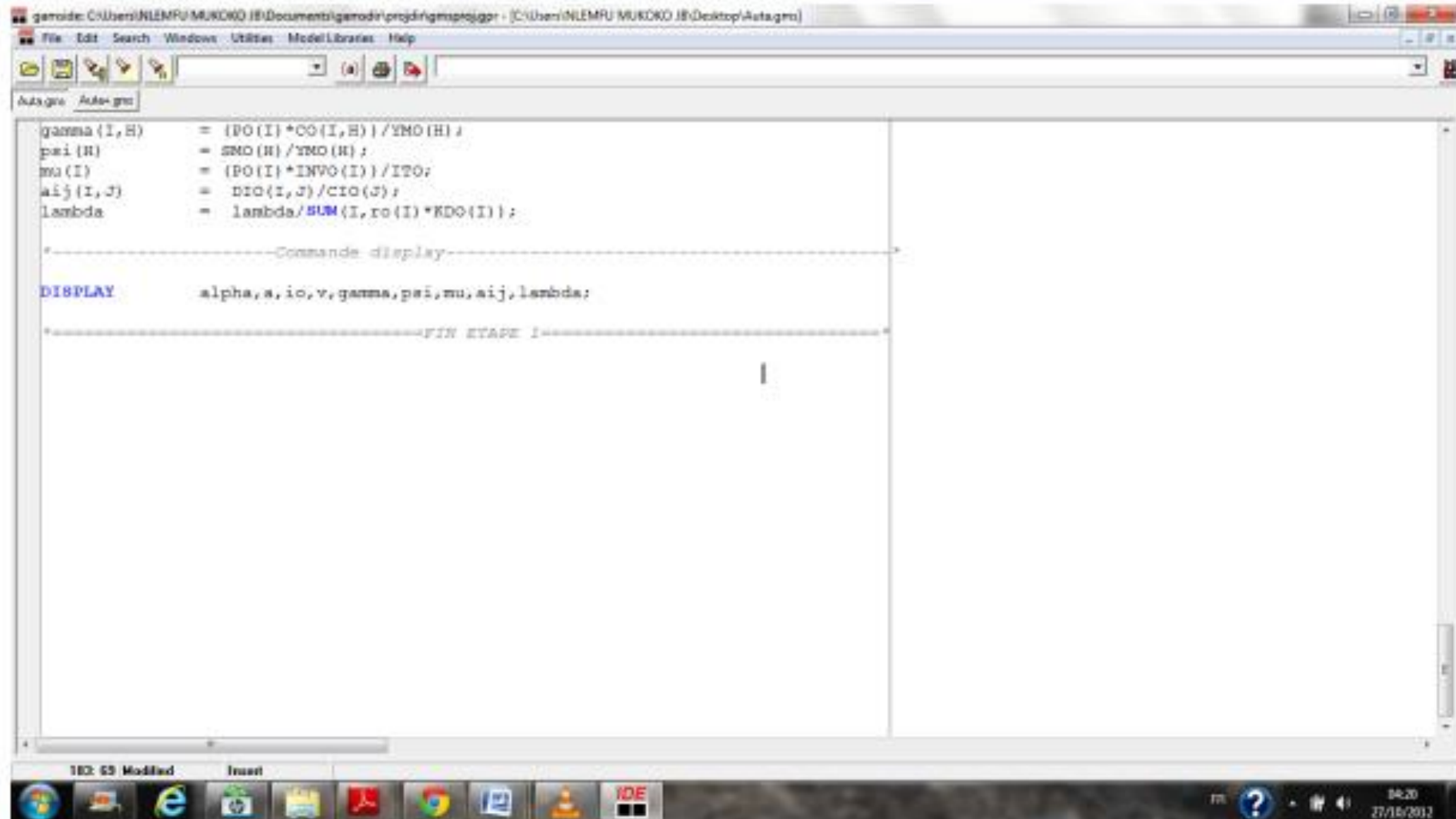
*Prix de la valeur ajoutee
PVD(I)      = ( PO(I)*XSO(I) - SUM(J, PO(J)*DIO(J, I)) )/VAO(I);

-----Calibration des parametres-----

*Production (Cobb-Douglas and Leontief)
alpha(I)    = WO*LDO(I) / (PVD(I)*VAO(I));
A(I)        = VAO(I) / (LDO(I)**alpha(I)*KDO(I)**(1-alpha(I)) );
io(I)       = CIO(I)/XSO(I);
v(i)        = VAO(I)/XSO(I);

*Share parameters
gamma(I, H) = (PO(I)*CO(I, H)) / YMO(H);
psi(H)      = SMO(H) / YMO(H);
```

Command display: permit to



The screenshot shows a GAMS IDE window titled "garnode: C:\Users\NLEMRU\MUKOKO\IB\Documents\garnode\projdir\gmsproj\gpr - [C:\Users\NLEMRU\MUKOKO\IB\Desktop\Autagms]". The menu bar includes "File", "Edit", "Search", "Windows", "Utilities", "Model Libraries", and "Help". The toolbar contains icons for file operations and execution. The main editor area shows the following GAMS code:

```
gamma(I,H) = (PO(I)*CO(I,H))/YMO(H);
pai(H) = SMO(H)/YMO(H);
mu(I) = (PO(I)+INVO(I))/ITO;
aij(I,J) = DIO(I,J)/CIO(J);
lambda = lambda/SUM(I,ro(I)*KDO(I));

-----Commande display-----
DISPLAY alpha,a,io,v,gamma,pai,mu,aij,lambda;

-----FIN ETAPE 1-----
```

The status bar at the bottom indicates "100: 65 Modified" and "Insert" mode. The Windows taskbar at the very bottom shows the system tray with the time "14:20" and date "27/10/2012".

Step 2: Model

- Variables: Declare the variables of the model

```
-----ETAPE 2 : MODELE-----
-----Definitions des Variables-----
VARIABLES
*Prix
W Taux de salaire
R(I) Taux de rendement du capital de la branche I
P(I) Prix du produit I
PV(I) Prix de la valeur ajoutee pour la branche I
*Production
XS(I) Production de la branche I
VA(I) Valeur ajoutee dans la branche i en volume
DI(I,J) Consommation intermediaire du bien i par la branche J
CI(I) Consommation intermediaire totale de la branche I
*Facteurs
KD(I) Demande du capital par la branche i
LS Offre totale de travail
LD(I) Demande de la main d'oeuvre dans la branche i
*Demandes
C(I,H) Consommation du bien i par le menage h (volume)
INV(I) Investissement dans le bien I (volume)
IT Investissement total (valeur)
DIT(I) Demande intermediaire pour le bien I
*Revenu et epargne
```

```
*Revenu et epargne
YM(H) Revenu du menage h
YF Revenu des firmes
SM(H) Epargne du menage h
SF Epargnes des firmes
DIV Dividendes
*Autres variables
EV(H) Variation equivalente
LEON Variable de verification dela loi de walras
J
```

- Equations: Declare & define equations

```

-----Declaration des equations-----
EQUATIONS

*Equation de Production
EQSUPPLY(I)  fonction de production pour la branche i
EQVAD(I)     valeur ajoutee de la branche i
EQCI(I)      consommation intermed totale pour la branche i
EQDI(I,J)    consommation intermed. du bien i par la branche j
EQLDEM(I)    demande de la main d'oeuvre par la branche i

*Equations de Revenus et epargnes
EQINCHS      revenu des menages salaries
EQINCHK      revenu des menages capitalistes
EQINCF       Revenu des firmes
EQSAVR(H)    Epargne des menages h
EQSAVE       Epargne des firmes

*Equation de Demandes
EQCONSH(I,H) consommation du bien i par le menage h
EQINVEST(I)  Investissement dans le bien i
EQINTDEM(I)  demande intermed. pour le bien i

*Equations de prix
EQPRVA(I)    prix de la valeur ajoutee
EQRETR(I)    taux de rendement de capital de la branche i

*Equations d'equilibre
EQCMABS(TR)  Equilibre sur le marche de biens
EQLS         Equilibre de marche de travail
EQIS         Equilibre epargne-investiissement

```

```

-----Definition des equations-----
*Equations d'equilibre
EQCMABS(TR)  Equilibre sur le marche de biens
EQLS         Equilibre de marche de travail
EQIS         Equilibre epargne-investiissement

*Autres
EQVAR(R)     Evaluation of the equivalent variation
EQNALRAS     Controle

```

```

gerade: C:\Users\NLEMPU_MUKOKO\B\Documents\gerade\projdir\projdir - [C:\Users\NLEMPU_MUKOKO\B\Desktop\Autagro]
File Edit Search Windows Utilities Model Libraries Help
Autagro Autagro

-----d finition des  quations-----
*Production
EQSUPPLY(I).. XS(I) =E= VA(I)/v(I);
EQVAD(I).. VA(I) =E= A(I)*LD(I)**alpha(I)*KD(I)**(1-alpha(I));
EQCI(I).. CI(I) =E= io(I)*VA(I)/v(I);
EQDI(I,J).. DI(I,J) =E= aij(I,J)*CI(J);
EQLDEM(I).. LD(I) =E= PV(I)*alpha(I)*VA(I)/w;

*Revenus et  pargne
EQINCHS.. YM("BS") =E= w*SUM(I,LD(I));
EQINCHR.. YM("BR") =E= lambda*SUM(I,r(I)*KD(I)) + DIV;
EQINCF.. YF =E= (1-lambda)*SUM(I,r(I)*KD(I));
EQSAVR(H).. SM(H) =E= psi(H)*YM(H);
EQSAVF.. SF =E= YF - DIV;

*Demandes
EQCONSH(I,H).. C(I,H) =E= gamma(I,H)*YN(H)/P(I);

```

```

gerade: C:\Users\NLEMPU_MUKOKO\B\Documents\gerade\projdir\projdir - [C:\Users\NLEMPU_MUKOKO\B\Desktop\Groupe Merg .Acta+internet\Autagro]
File Edit Search Windows Utilities Model Libraries Help
Autagro Autagro

*Demandes
EQCONSH(I,H).. C(I,H) =E= gamma(I,H)*YN(H)/P(I);
EQINVEST(I).. INV(I) =E= nu(I)*IT/P(I);
EQINZDEM(I).. DIT(I) =E= SUM(J, a1j(I,J)*CI(J));

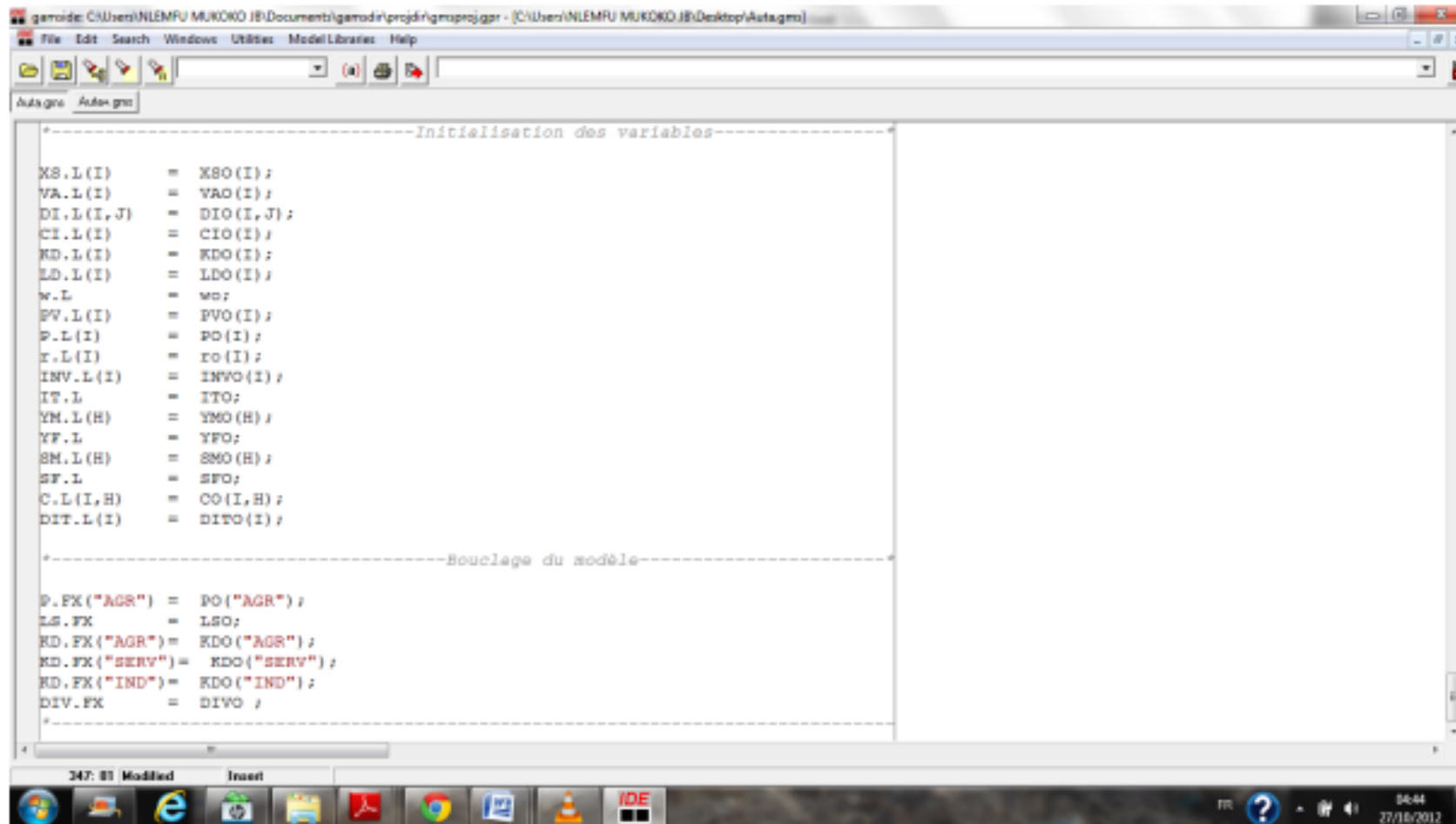
*Prix
EQPRVA(I).. PV(I) =E= ( P(I)*XS(I) - SUM(J,DI(J,I)*P(J)) )/VA(I);
EQPRTR(I).. r(I) =E= ( PV(I)*VA(I) - w*LD(I) )/KD(I);

*Conditions d' quilibre
EQDOMAS(TR).. XS(TR) =E= SUM(H,C(TR,H))+DIT(TR)+INV(TR);
EQLS.. LS =E= SUM(I,LD(I));
EQIS.. IT =E= SUM(H,SM(H)) + SF;

*Loi de valras
EQVAR(H).. YV(H) =E= YN(H)* PROD(TR, ((PO(TR)/P.L(TR))**gamma(tr,H)) - YMO(H));
EQWALRAS.. LEON =E= XS("Serv") - SUM(H,C("Serv",H)) - DIT("Serv");

```

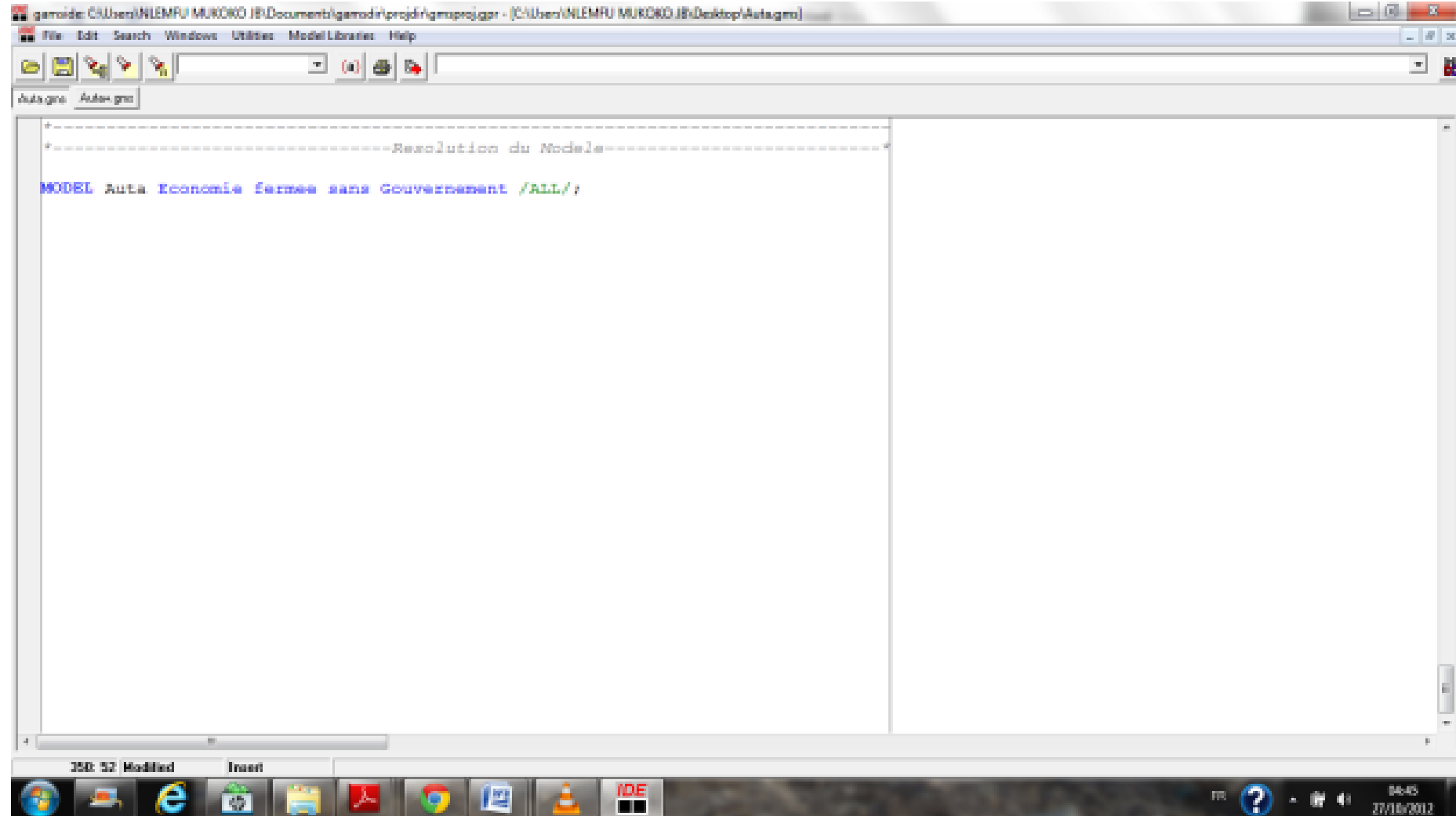
- Initialization of variables



```
-----Initialisation des variables-----
XB.L(I) = XBO(I) ;
VA.L(I) = VAO(I) ;
DI.L(I,J) = DIO(I,J) ;
CI.L(I) = CIO(I) ;
KD.L(I) = KDO(I) ;
LD.L(I) = LDO(I) ;
w.L = w ;
PV.L(I) = PVO(I) ;
P.L(I) = PO(I) ;
r.L(I) = ro(I) ;
INV.L(I) = INVO(I) ;
IT.L = ITO ;
YM.L(H) = YMO(H) ;
YF.L = YFO ;
SM.L(H) = SMO(H) ;
SF.L = SFO ;
C.L(I,H) = CO(I,H) ;
DIT.L(I) = DITO(I) ;

-----Bouclage du modèle-----
P.FX("AGR") = PO("AGR") ;
LS.FX = LSO ;
KD.FX("AGR") = KDO("AGR") ;
KD.FX("SERV") = KDO("SERV") ;
KD.FX("IND") = KDO("IND") ;
DIV.FX = DIVO ;
```


Model: Define the model

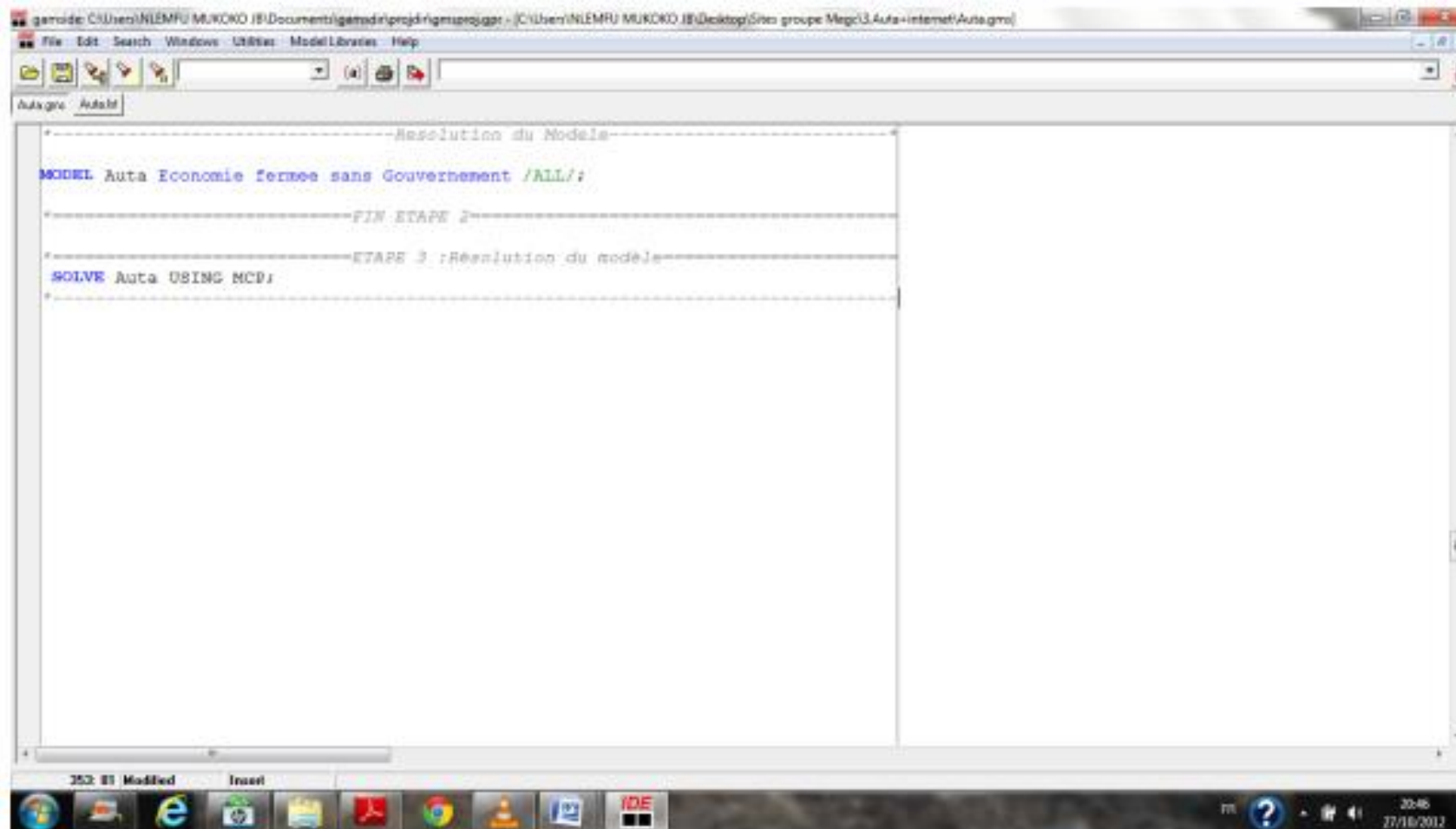


The screenshot shows a GAMS IDE window with the following content:

```
-----Resolution du Modele-----  
MODEL AuLa Economie fermee sans Gouvernement /ALL/;
```

The window title bar indicates the file path: `gamside: C:\Users\NLEMPU MUKORO\Documents\gamside\projdir\gmsproj\gpr - [C:\Users\NLEMPU MUKORO\Desktop\Autagms]`. The menu bar includes File, Edit, Search, Windows, Utilities, Model Libraries, and Help. The toolbar contains icons for file operations and execution. The status bar at the bottom shows '250: 52 Modified' and 'Insert' mode. The Windows taskbar at the bottom includes icons for Internet Explorer, GAMS, and other applications, with the system clock showing 14:45 on 27/10/2012.

Step 3: Resolution of the Model

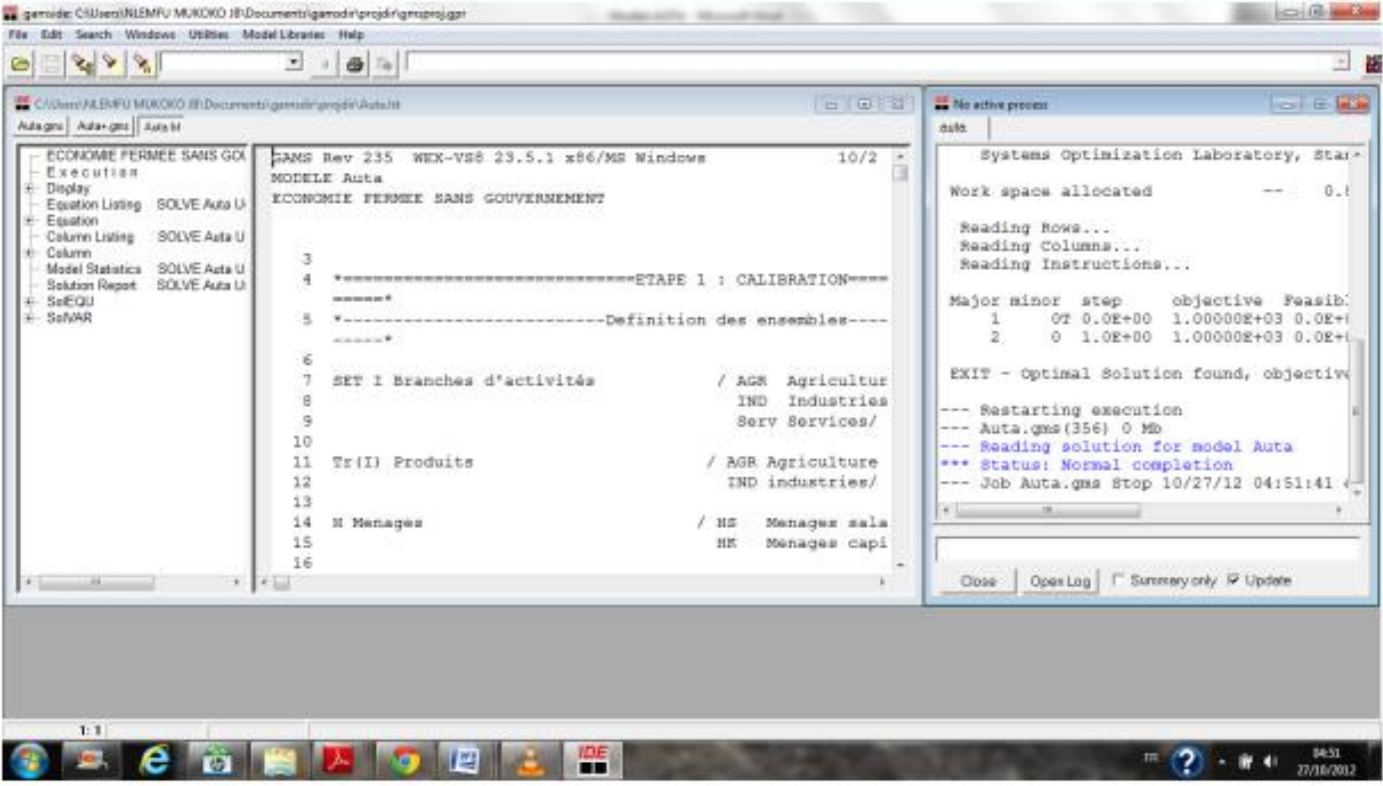
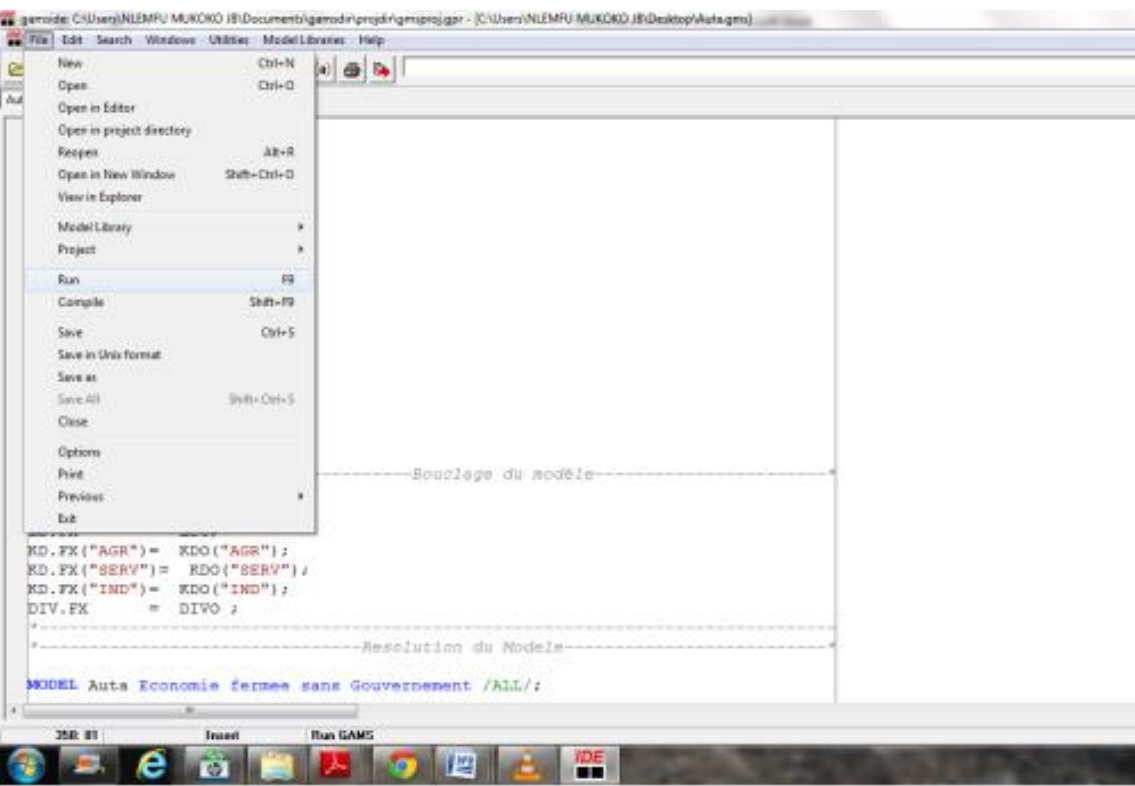


The screenshot shows a GAMS IDE window with the following content:

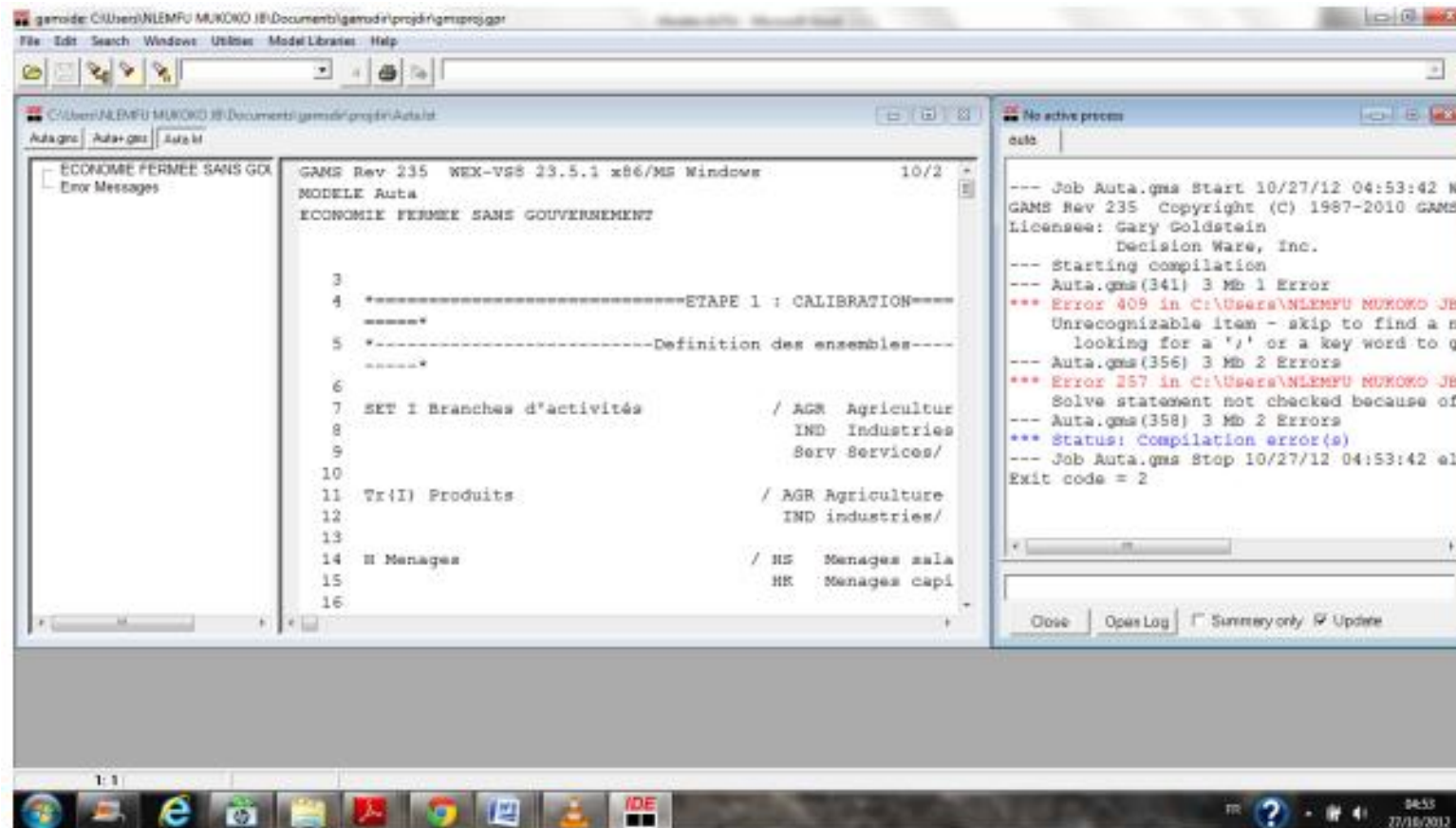
```
-----Resolution du Modèle-----  
MODEL Auto Economie fermee sans Gouvernement /ALL/;  
-----FIN ETAPE 2-----  
-----ETAPE 3 :Resolution du modèle-----  
SOLVE Auto USING MCP;
```

The window title bar indicates the file path: `C:\Users\NLEMRU MUKOKO\Documents\gams\proj\drigms\projgpr - (C:\Users\NLEMRU MUKOKO\Documents\groupe Magc\3.Auto+internet\Auto.gms)`. The menu bar includes `File Edit Search Windows Utilities Model Libraries Help`. The status bar at the bottom shows `352: 81 Modified Insert` and the system tray displays the date `27/10/2012` and time `20:46`.

At this point, we finished with programming of our model. To solve it go to: **File/Run** or click on **F9**



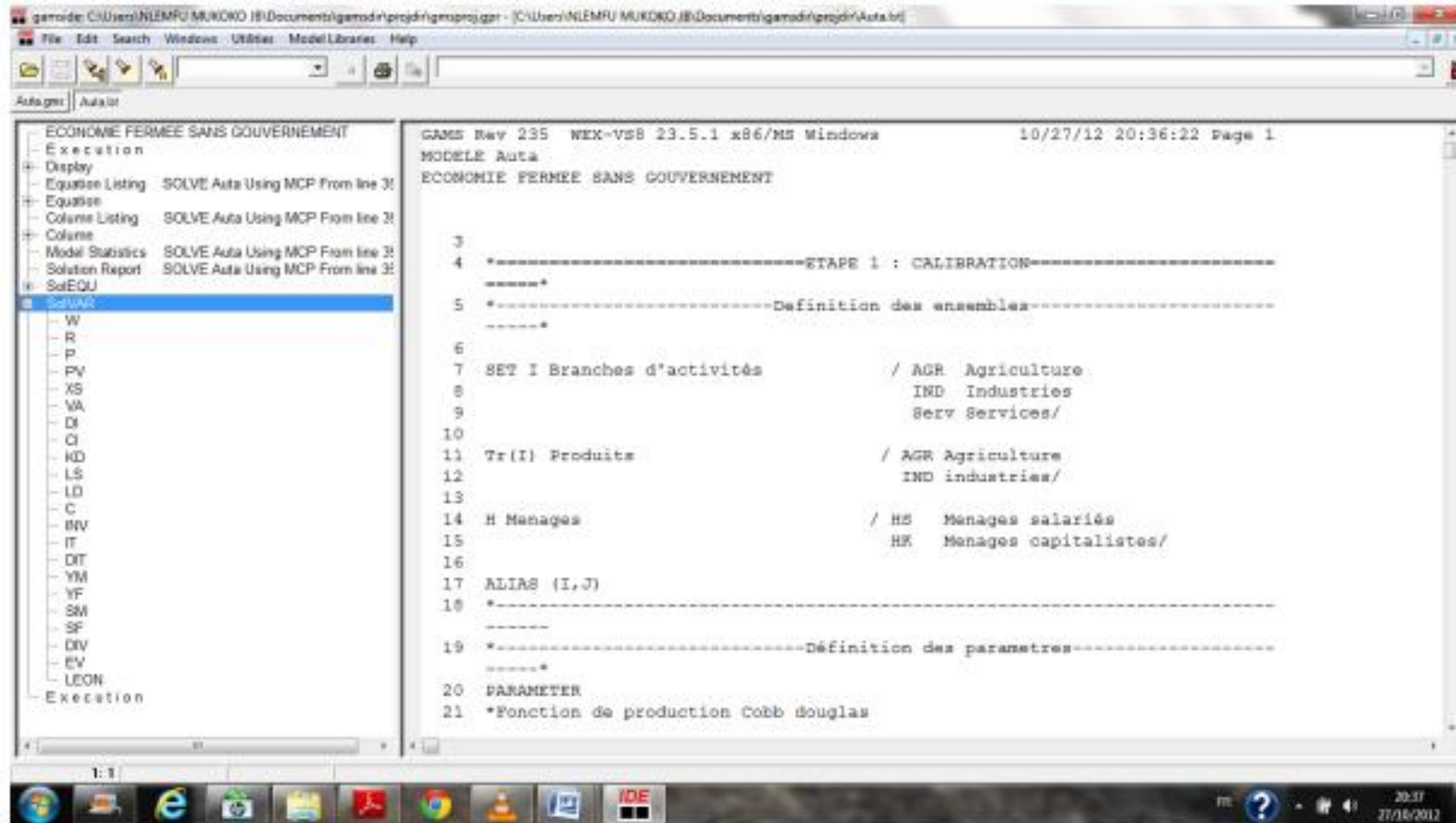
- To prove the model is running without errors, bring your attention to the window to the right of your screen “No active process” and the following message will appear: <<status: Normal Completion>>. In case of errors, you will have the following appear in red as shown below and the message <<status: Normal completion>> will not appear:



If the model functions correctly and the message <<Status; Normal completion appears>> appears, the next question is how to interpret the results of our programming? It suffices to look at the upper left corner of your screen, next to the name of the file <<Auta.gms>>. There, you will notice a file with the same name but with a different extension <<Auta.Lst>>. There you will find the gams results. Simply click on it and you will have the following appear:

```
garodir: C:\Users\NLEMFU\MUKOKO\Documents\garodir\projdir\projgpr - [C:\Users\NLEMFU\MUKOKO\Documents\garodir\projdir\Auta.bl]
File Edit Search Windows Utilities Model Libraries Help
Autogms | Autalst
ECONOMIE FERMEE SANS GOUVERNEMENT
Execution
Display
Equation Listing SOLVE Auta Using MCP From line 3!
Equation
Column Listing SOLVE Auta Using MCP From line 3!
Column
Model Statistics SOLVE Auta Using MCP From line 3!
Solution Report SOLVE Auta Using MCP From line 3!
SolEQU
SolVAR
Execution
PAGES Rev 235 WEX-VSB 23.5.1 x86/MS Windows 10/27/12 20:36:22 Page 1
MODELE Auta
ECONOMIE FERMEE SANS GOUVERNEMENT
3
4 *****ETAPE 1 : CALIBRATION*****
5 *****
6 *****Définition des ensembles*****
7 *****
8
9
10
11 SET I Branches d'activités / AGR Agriculture
12 IND Industries
13 Serv Services/
14
15
16
17 Tr(I) Produits / AGR Agriculture
18 IND industries/
19
20
21
22 H Menages / HS Menages salariés
23 HK Menages capitalistes/
24
25
26
27 ALIAS (I,J)
28 *****
29 *****Définition des paramètres*****
30 *****
31
32 PARAMETER
33 *Fonction de production Cobb Douglas
```

To view the results click on **SoIVAR**. You will have the different results by variables



- It is sufficient to click on the variable to view its result

The screenshot displays the GAMS software interface. The main window shows the results of an optimization problem. The title bar indicates the file path: 'garnode: C:\Users\NLEMPU MUKOKO J\Documents\garnod\projdir\gmsprojdir - (C:\Users\NLEMPU MUKOKO J\Documents\garnod\projdir\Auto.bl)'. The menu bar includes 'File', 'Edit', 'Search', 'Windows', 'Utilities', 'Model Libraries', and 'Help'. The toolbar contains various icons for file operations and model management.

The main display area shows the following results:

```

ECONOMIE FERMEE SANS GOUVERNEMENT
Execution
Display
Equation Listing SOLVE Auto Using NLP From line 35
Equation
Column Listing SOLVE Auto Using NLP From line 35
Column
Model Statistics SOLVE Auto Using NLP From line 35
Solution Report SOLVE Auto Using NLP From line 35
SolEQU
SolVAR
W
R
P
PV
XS
VA
DI
CI
ND
LS
LD
C
INV
IT
DIT
YM
YF
SM
SF
DIV
EV
OMEGA
LEON

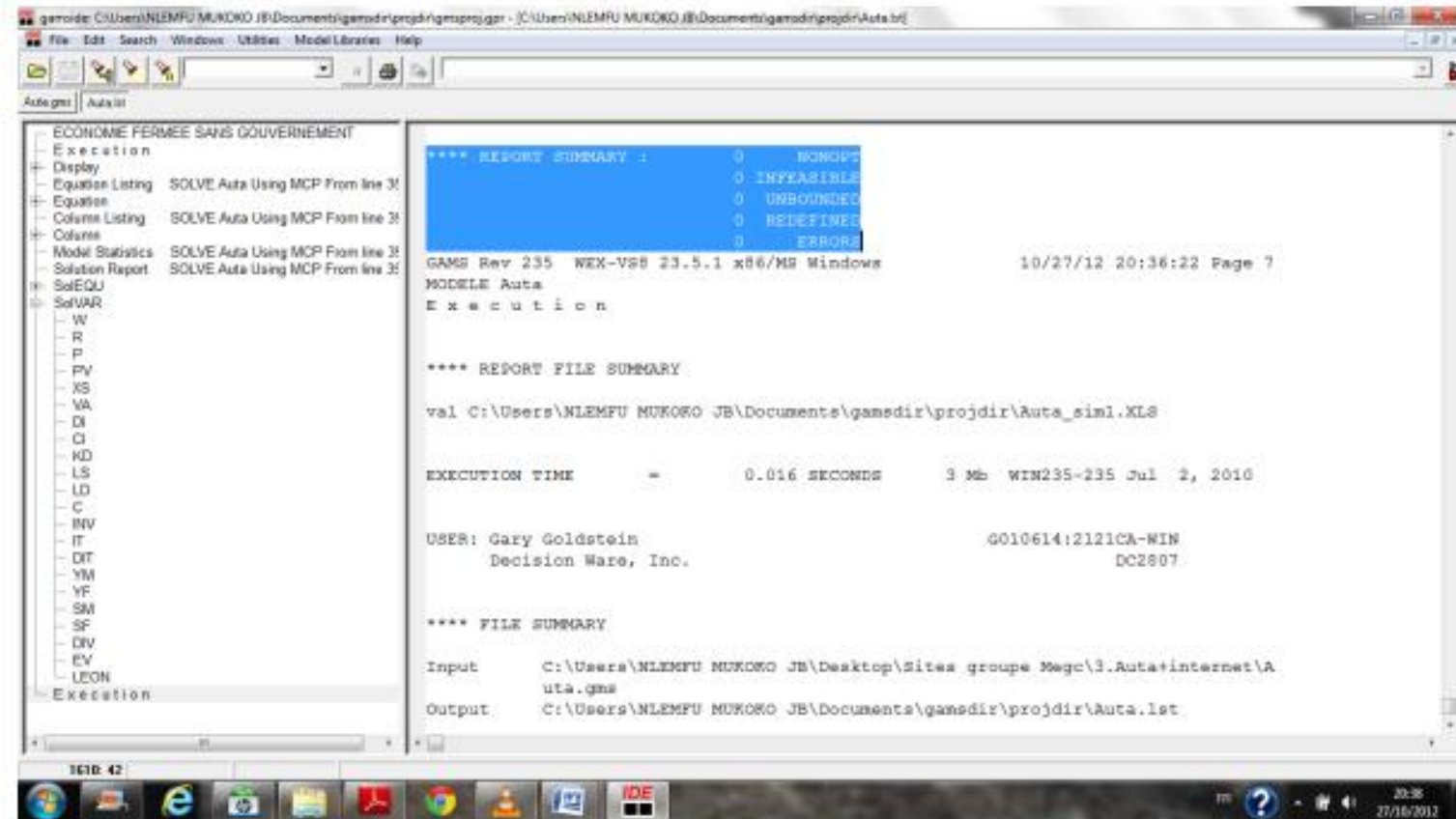
```

	LOWER	LEVEL	UPPER	MARGINAL
--- EQU OBJ	1000.000	1000.000	1000.000	1.000
--- EQU EQWALRAS	.	.	.	EPS
OBJ Fonction objectif				
EQWALRAS Controle				
	LOWER	LEVEL	UPPER	MARGINAL
--- VAR W	-INF	1.000	+INF	.
W Taux de salaire				
--- VAR R Taux de rendement du capital de la branche I				
	LOWER	LEVEL	UPPER	MARGINAL
AGR	-INF	1.000	+INF	.
IND	-INF	1.000	+INF	EPS
Serv	-INF	1.000	+INF	EPS
--- VAR P Prix du produit I				
	LOWER	LEVEL	UPPER	MARGINAL
AGR	1.000	1.000	1.000	EPS
IND	-INF	1.000	+INF	.

The bottom status bar shows '1276: 1' and the system tray includes a help icon, a question mark, and the date '25/05 22/10/2012'.

- You will notice that the information introduced at the first step were reinstated by the model after the resolution. Verify all variables by the same procedure. If it is the case, the model is well calibrated, that is to say the model is good and it is ready for simulations

- An alternative way of verifying the model is well calibrated is by clicking on “Execution”. If you it is calibrate you will see the following appear: Bring your attention to the **REPORT SUMMARY: 0 NONOPT ; 0 INFEASIBLE; 0 UNBOUNDED and 0 ERRORS.** IF IT’S THE CASE. If it is the case, the model is well calibrated, there are no errors/ non optimal solutions. You are ready to start the simulations

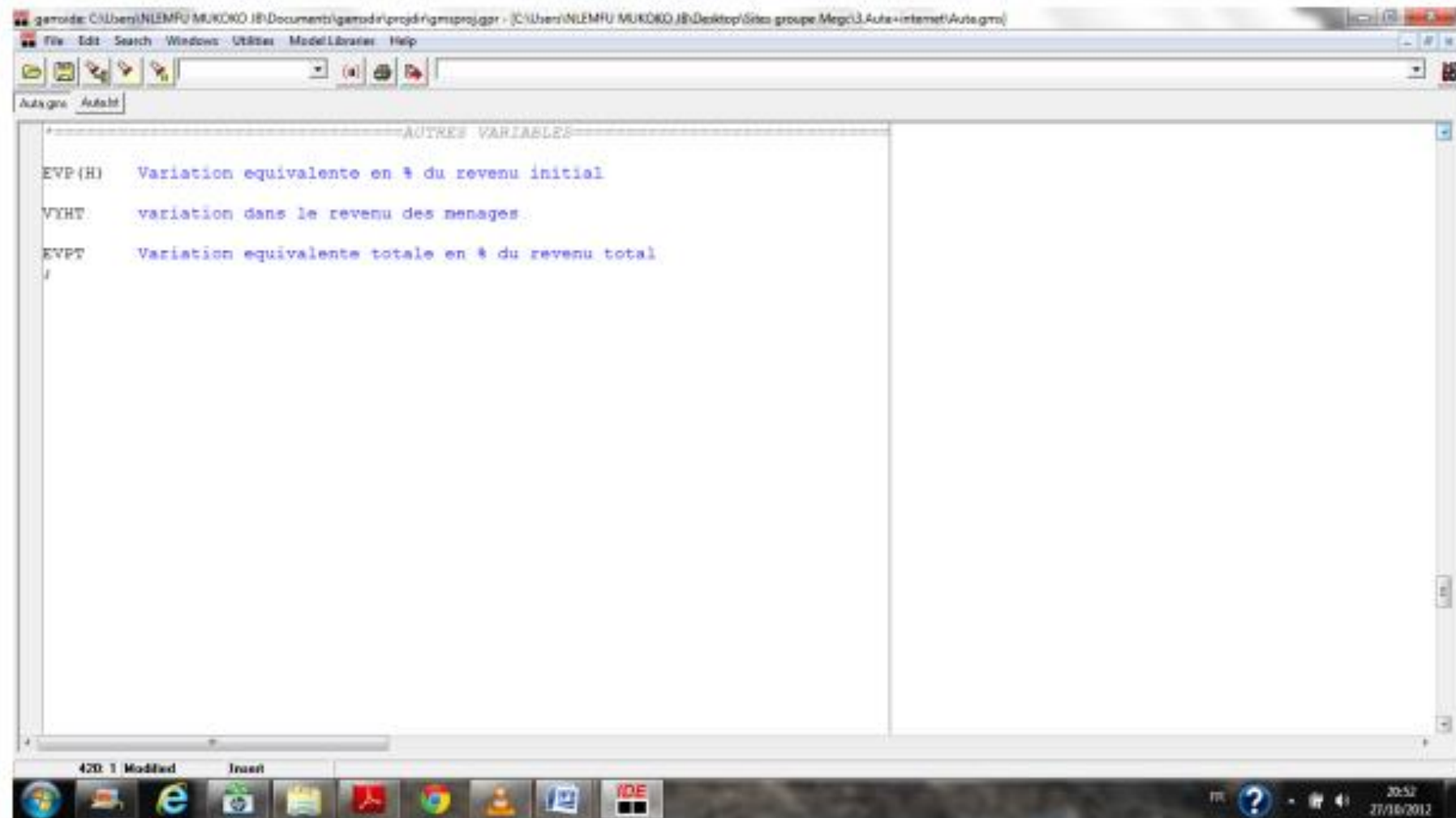


- Notice it is not always easy to read the results on the file **lst**
- An alternative way of reading the results of the model is to communicate the GAMS software to Excel table for an output sheet of the results in the form of an Excel sheet. In this effect, the following following procedure is important:
- Declare the variables in variation

```

SOLVE Auto MAXIMIZING OMEGA USING NLP;
*****FIN DE LA PROGRAMMATION DU MODELE*****
-----Sortie des résultats sous fichier excel-----
PARAMETERS
-----VARIABLES DE PRIX-----
VALN
valR(I)
valPVA(I)
valP(I)
-----FONCTION DE PRODUCTION-----
VolXS(I)
VolVA(I)
VolLD(I)
VolLS
VolRD(I)
-----Revenus-Epargne-----
valYM(H)
valYE
valSM(H)
valSF
-----Demandes-----
VolCM(I,H)
Voldit(I)
VolINV(tr)
valIT
valCI(I)
valDI(I,J)

```



Calculation of the variations in percentage

```
-----calculs des variations en %-----
valW      = 100*(w.L - w0) /w0 ;
valR(I)   = 100*(R.L(I) - RO(I)) /RO(I) ;
valPVA(I) = 100*(pv.L(I) - pv0(I)) /pv0(I) ;
valP(I)   = 100*(P.L(I) - PO(I)) /PO(I) ;

VolXS(I)  = 100*(XS.L(I) - XSO(I)) /XSO(I) ;
VolVA(I)  = 100*(VA.L(I) - VAO(I)) /VAO(I) ;
VolLD(I)  = 100*(LD.L(I) - LDO(I)) /LDO(I) ;
VolLS     = 100*(LS.L - LSO) /LSO ;
VolRD(I)  = 100*(KD.L(I) - RDO(I)) /RDO(I) ;

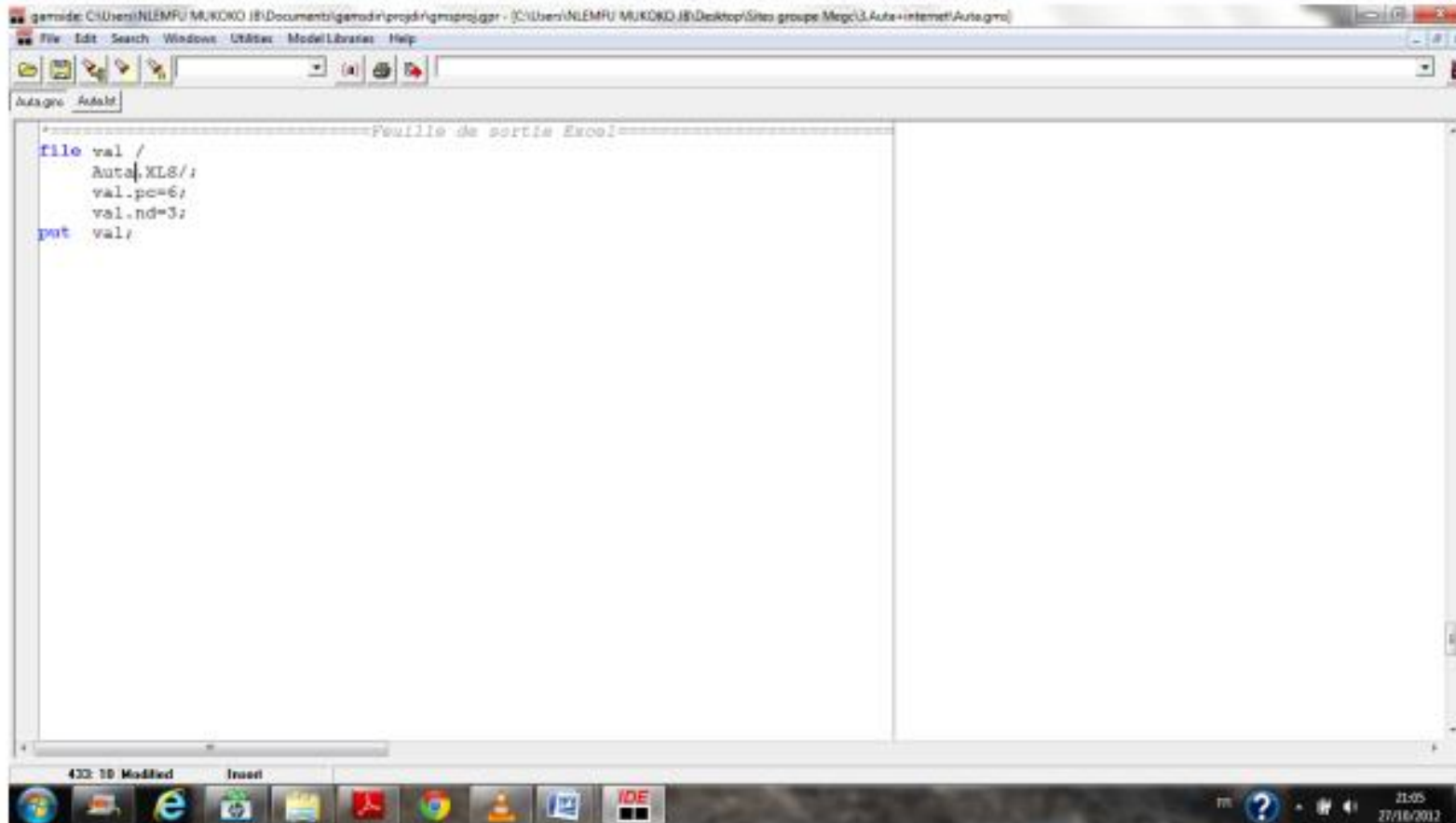
valYM(H)  = 100*(YM.L(H) - YMO(H)) /YMO(H) ;
valYE     = 100*(YF.L - YFO) /YFO ;

valSM(H)  = 100*(sM.L(H) - SMO(H)) /SMO(H) ;
valSF     = 100*(sF.L - sFO) /sFO ;

VolCM(I,H) = 100*(C.L(I,H) - CO(I,H)) /CO(I,H) ;
Voldit(I)  = 100*(dit.L(I) - dit0(I)) /dit0(I) ;
VolINV(tr) = 100*(INV.L(tr) - INVO(tr)) /INVO(tr) ;
valIT      = 100*(IT.L - ITO) /ITO ;
valCI(I)   = 100*(CI.L(I)-CIO(I))/CIO(I);
valDI(I,j) = 100*(DI.L(i,j)-DIO(i,j))/DIO(i,j);
```

```
-----AUTRES-----
EVP(H)     = (EV.L(H) /YMO(H)) *100;
VYHT       = (SUM(H, YM.L(H)) -SUM(H, YMO(H))) /SUM(H, YMO(H)) *100;
EVPT       = SUM(H, EV.L(H)) /SUM(H, YMO(H)) *100;
```

- Creating the output sheet of the results



```
file val /  
  Auta.xls;  
  val.pc=6;  
  val.nd=3;  
put val;
```

FILE Val/
Auta.xls/
Val.pc=6;
Val.nd=4;
Put val;

- Creating the tables of the results

```

*
put 'MODELE Auto : Modèle à économie fermée sans Gouvernement'//;
put '//';
put 'TABLEAU 1 : LES PRIX '//;
put 'Variables' put 'Branche' put 'Branche' put 'Reference' put 'Simulation' put 'Variation ent'//;
put 'w' put ' ' put ' ' put 'w0' put 'w.1' put 'valw' /;
loop(i, put 'r' put i.tl put ' ' put 'r0(i)' put 'r.1(i)' put 'valr(i)'//);
loop(i, put 'pv' put i.tl put ' ' put 'pv0(i)' put 'pv.1(i)' put 'valpva(i)'//);
loop(i, put 'p' put i.tl put ' ' put 'p0(i)' put 'p.1(i)' put 'valp(i)'//);
*
put '//';
put 'TABLEAU 2 : LA PRODUCTION'//;
put 'Variables' put 'Branche' put 'Branche' put 'Reference' put 'Simulation' put 'Variation ent'//;
loop(i, put 'xs' put i.tl put ' ' put 'xs0(i)' put 'xs.1(i)' put 'Volxs(i)'//);
loop(i, put 'va' put i.tl put ' ' put 'va0(i)' put 'va.1(i)' put 'Volva(i)'//);
loop(i, put 'ld' put i.tl put ' ' put 'ld0(i)' put 'ld.1(i)' put 'Volld(i)'//);
put 'LS' put ' ' put ' ' put 'LS0' put 'LS.1' put 'Volls' /;
loop(i, put 'kd' put i.tl put ' ' put 'kd0(i)' put 'kd.1(i)' put 'Volkd(i)'//);
loop(i, put 'CI' put i.tl put ' ' put 'CI0(i)' put 'CI.1(i)' put 'valCI(i)'//);
loop((i,j), put 'DI' i.tl,j.tl, put 'DI0(i,j)' put 'DI.1(i,j)' put 'valDI(i,j)'//);
*
put '//';
put 'TABLEAU 3 : REVENUS ET EPARGNES'//;
put 'Variables' put 'Branche' put 'Branche' put 'Reference' put 'Simulation' put 'Variation ent'//;

loop(h, put 'ym' put h.tl put ' ' put 'ym0(h)' put 'ym.1(h)' put 'valym(h)'//);
put 'YF' put ' ' put ' ' put 'YF0' put 'YF.1' put 'valYE' /;
loop(h, put 'sm' put h.tl put ' ' put 'sm0(h)' put 'sm.1(h)' put 'valsm(h)'//);
put 'SF' put ' ' put ' ' put 'SF0' put 'SF.1' put 'valSF' /;

```

```
geroide: C:\Users\NLEMPU MUKORO JIB\Documents\geroide\proj\geroproj\ger - (C:\Users\NLEMPU MUKORO JIB\Desktop\Sites\groupes\Meq\3.Auto-internet\Auto.gro)
File Edit Search Windows Utilities ModelLibraries Help
Autogro Autotbl

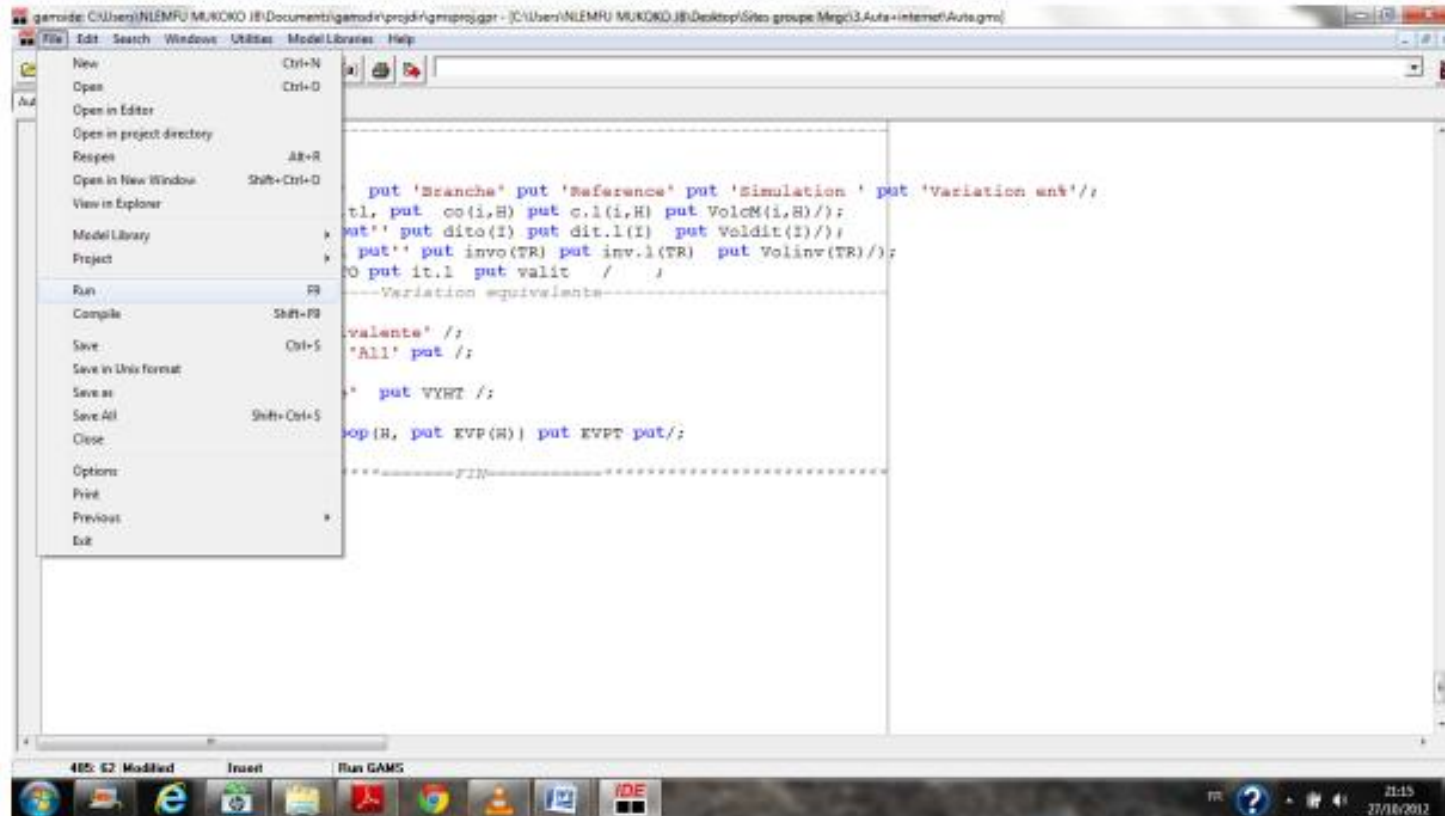
-----
put' /;
put 'TABLEAU 4 : DEMANDES' /;
put 'variables' put 'Branche' put 'Branche' put 'reference' put 'Simulation ' put 'Variation ent' /;
loop(i,H), put 'C' i.tl.h.tl, put co(i,H) put c.l(i,H) put VolcM(i,H) /;
loop(i, put'DIT' put i.tl put'' put dite(i) put dit.l(i) put Voldit(i) /;
loop(TR, put'INV' put TR.tl put'' put inve(TR) put inv.l(TR) put Volinv(TR) /;
put'IT ' put'' put'' put ITO put it.l put valit / '
-----Variation equivalents-----
put' /;
put 'TABLE 6 : variation equivalents' /;
put '' loop(H, put H.TL) put 'All' put /;

put 'Change in nominal income' put VYBT /;

put 'Equivalent variation' loop(H, put EVP(H)) put EVPT put /;

-----
4
```

- Thus, we have finished the programming of our model
- To solve the model, follow the same procedure as before, as in:
File/Run or F9
- **Apply the same procedures to verify if “the model ran”**



gamdir: C:\Users\NLEMPU MUKORO JB\Documents\gamdir\projdir\projgmr - (C:\Users\NLEMPU MUKORO JB\Documents\gamdir\projdir\Auto.bat)

File Edit Search Windows Utilities Model Libraries Help

Autgms Autalst

ECONOMIE FERMEE SANS GOUVERNEMENT

Execution

Display

Equation Listing SOLVE Auto Using MCP From line 3!

Equation

Column Listing SOLVE Auto Using MCP From line 3!

Column

Model Statistics SOLVE Auto Using MCP From line 3!

Solution Report SOLVE Auto Using MCP From line 3!

SolEQU

SolVAR

- W
- R
- P
- Pv
- XS
- VA
- DI
- CI
- KD
- LS
- LD
- C
- INV
- IT
- DT
- YM
- YF
- SM
- SF
- DIV
- EV
- LEON

Execution

```

*** REPORT SUMMARY :
0 NONOPT
0 INFEASIBLE
0 UNBOUNDED
0 REDEFINED
0 ERRORS

GAME Rev 235 WEX-VSB 23.5.1 x86/MS Windows 10/27/12 20:36:22 Page 7
MODELE Auto
Execution

**** REPORT FILE SUMMARY

val C:\Users\NLEMPU MUKORO JB\Documents\gamdir\projdir\Auto_sim1.XLS

EXECUTION TIME = 0.016 SECONDS 3 Mb WIN235-235 Jul 2, 2010

USER: Gary Goldstein G010614:2121CA-WIN
Decision Ware, Inc. DC2807

**** FILE SUMMARY

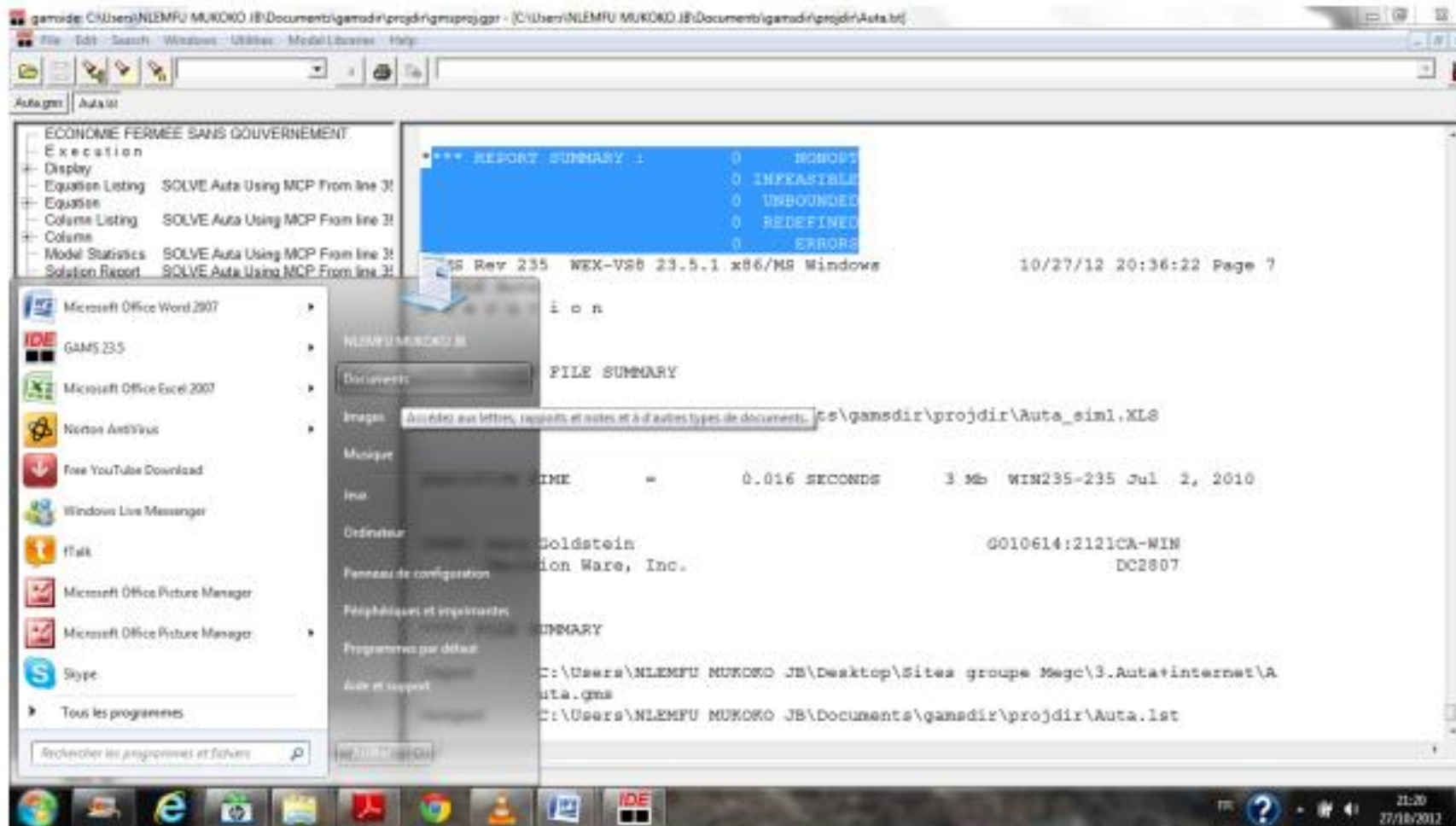
Input C:\Users\NLEMPU MUKORO JB\Desktop\Site groupe Megc\3.Auto+internet\A
uta.gms
Output C:\Users\NLEMPU MUKORO JB\Documents\gamdir\projdir\Auto.lst

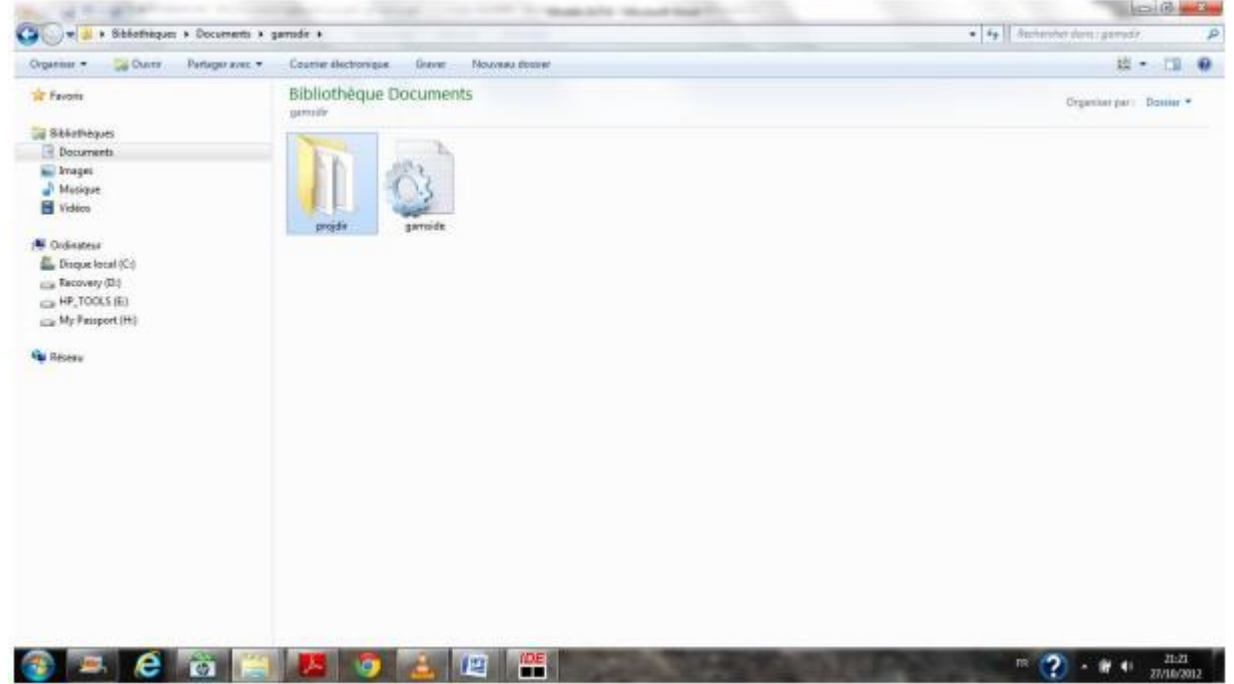
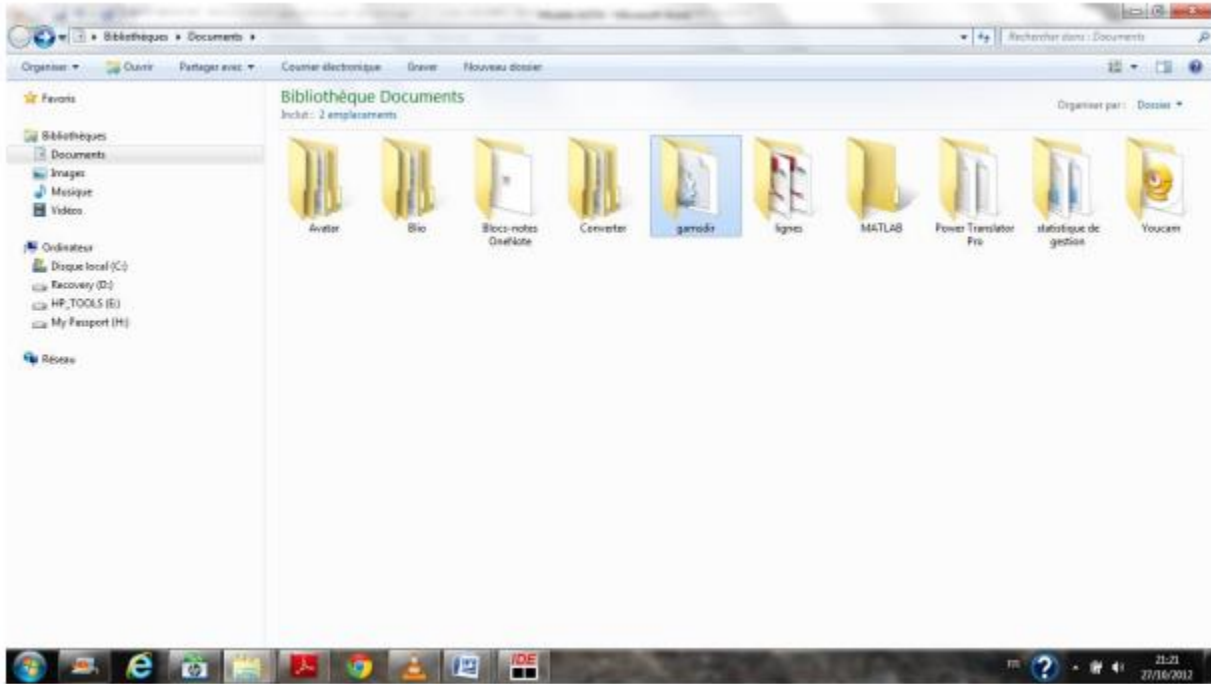
```

1618: 42

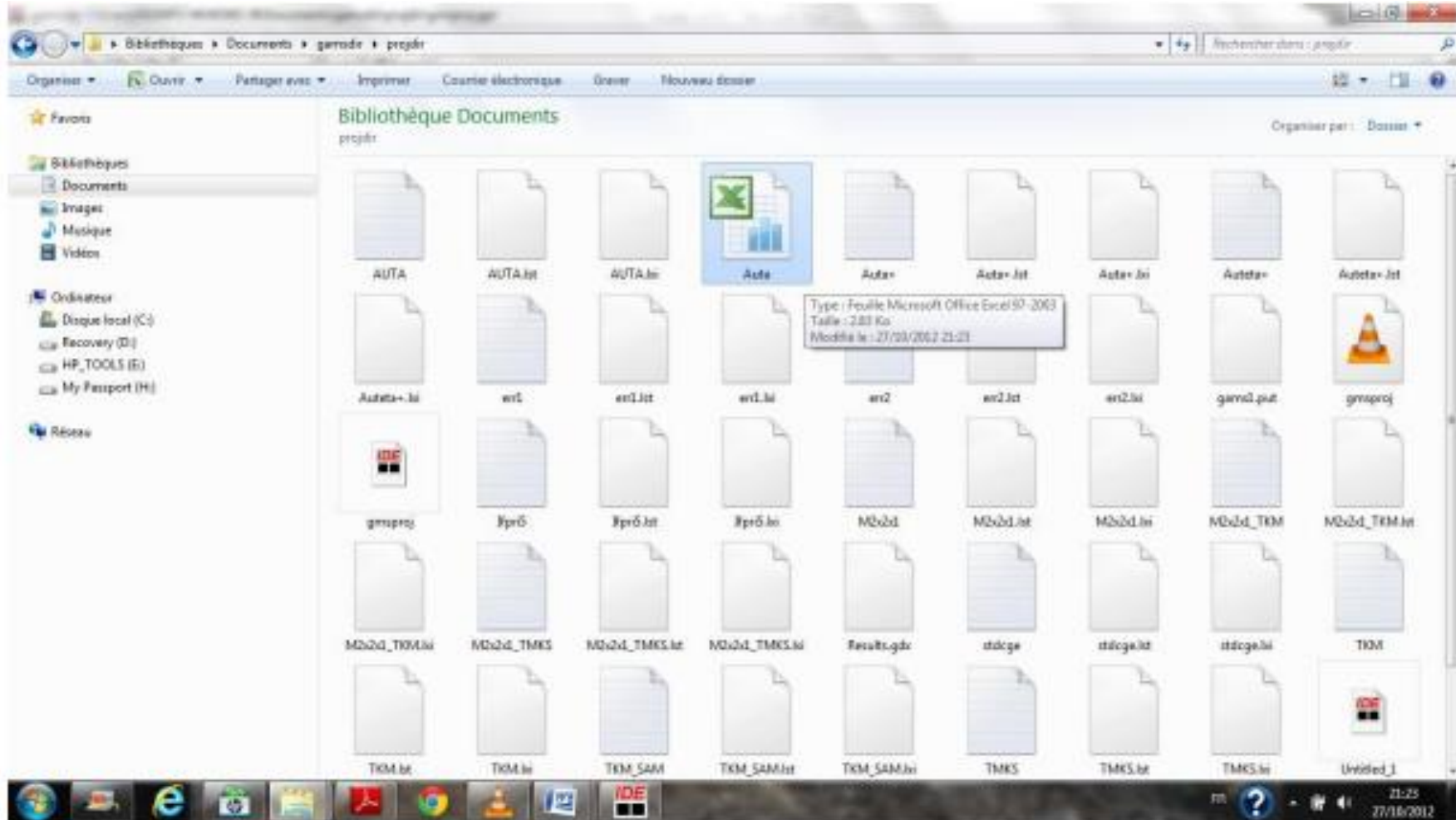
11:15 27/10/2012

- We can also directly verify in the results via <<Auta.xls>>, go to:
Mydocuments/Gamdir/projdir/auta.xlsx





- Click on <<Auta.xls>> and then <<yes>>



Autos - Microsoft Excel

Accueil Insertion Mise en page Formules Données Révision Affichage Compléments

100

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	MODELE Autos : Modèle à économie fermée sans Gouvernement															
2																
3	TABLEAU 1 : LES PRIX															
4	Variables	Branche	Branche	Reference	Simulation	Variation en%										
5	w			1	1	0										
6	r	AGR		1	1	0										
7	r	IND		1	1	0										
8	r	Serv		1	1	0										
9	Pv	AGR		1	1	0										
10	Pv	IND		1	1	0										
11	Pv	Serv		1	1	0										
12	P	AGR		1	1	0										
13	P	IND		1	1	0										
14	P	Serv		1	1	0										
15																
16	TABLEAU 2 : LA PRODUCTION															
17	Variables	Branche	Branche	Reference	Simulation	Variation en%										
18	Xs	AGR		9000	9000	0										
19	Xs	IND		54400	54400	0										
20	Xs	Serv		30700	30700	0										
21	Va	AGR		7200	7200	0										
22	Va	IND		18900	18900	0										
23	Va	Serv		21260	21260	0										
24	Ld	AGR		5760	5760	0										
25	Ld	IND		7560	7560	0										
26	Ld	Serv		15540	15540	0										
27	LS			28860	28860	0										
28	KD	AGR		1440	1440	0										
29	KD	IND		11340	11340	0										

Autos

100%

2508 27/10/2012

Auto - Microsoft Excel

Accueil Insertion Mise en page Formules Données Révision Affichage Compléments

IB3

Variables	Branche	Branche	Reference	Simulation	Variation en%
C	AGR	HS	4329	4329	0
C	AGR	HK	650	650	0
C	IND	HS	11544	11544	0
C	IND	HK	3900	3900	0
C	Serv	HS	10101	10101	0
C	Serv	HK	5050	5050	0
DIT	AGR		2922.4	2922.4	0
DIT	IND		29088.6	29088.6	0
DIT	Serv		14749	14749	0
INV	AGR		1098.6	1098.6	0
INV	IND		9887.4	9887.4	0
IT			10986	10986	0

TABLE 6 : variation équivalente			
	HS	HK	All
Change in no		0	
Equivalent v		0	0

PROGRAMME PAR
BLAISE NIEMFU
blaise_niemfu@yahoo.fr
octobre 2012

100% 27/10/2012

- Viewing the results, we notice that the values of the variables introduced with the entry of data (see reference column) were reinstated (see simulations column) and the last column is only the calculation of the variation in percentage between these two columns. This variation at the last column is 0% everywhere; it proves that our model reproduced the situation of reference and that it is ready for simulations

Simulations

- We have retained two simulation plans: the first simulation (Sim 1) holds a 10% increase in the volume of labor and the second simulation (Sim 2) analyzes the case of a 10% increase in capital specific to the branch of services

Simulation 1

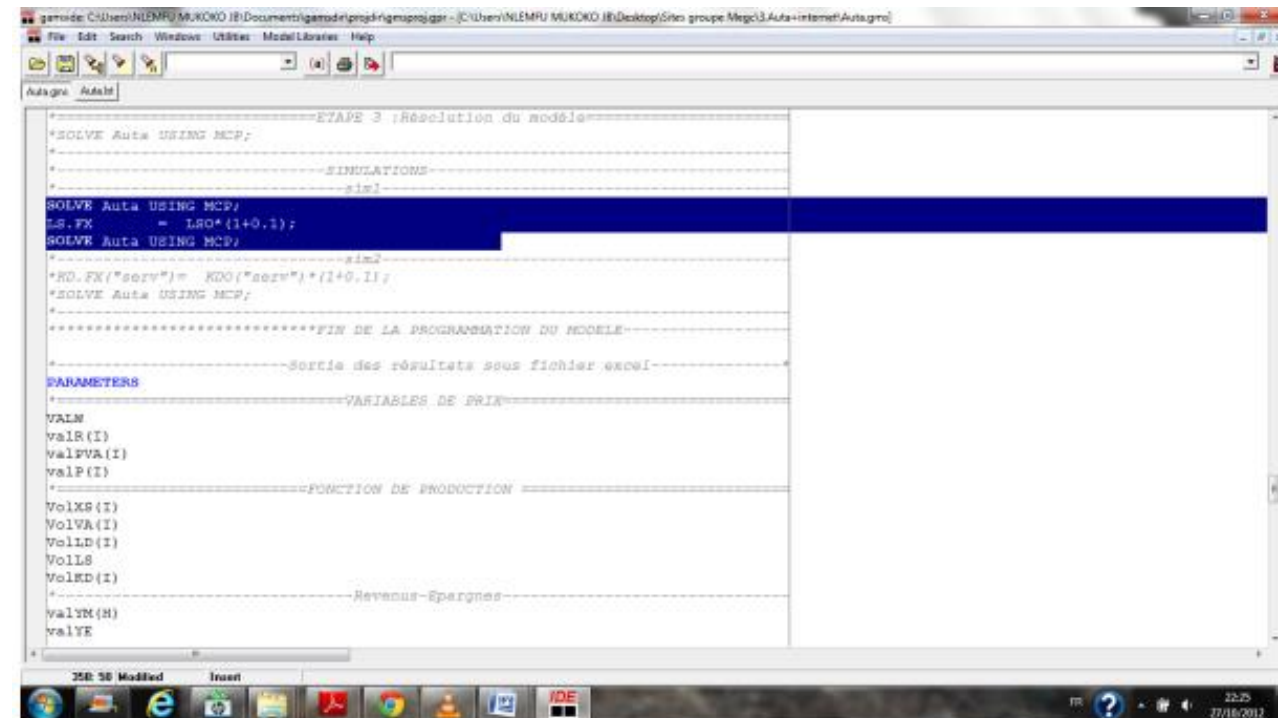
- 10% increase in labor volume.
- The concern at this level, is how to introduce this simulation in our model. As a reminder, the simulations are realized on exogenous variables as highlighted above. In the occurrence, of the case that concerns us, it's the variable labour (LS.FX).

To view the 10% increase, we will have:

Solve Auta using MCP;

LS.FX=LSO*(1+0.1);

Solve Auta using MCP;



```
-----ETAPE 3 :Résolution du modèle-----
*SOLVE Auta USING MCP;
-----
-----SIMULATIONS-----
sim1
SOLVE Auta USING MCP;
LS.FX = LSO*(1+0.1);
SOLVE Auta USING MCP;
sim2
*RD.FX("serv")= RDD("serv")*(1+0.1);
*SOLVE Auta USING MCP;
-----FIN DE LA PROGRAMMATION DU MODELE-----
-----Sortie des résultats sous fichier excel-----
PARAMETERS
-----VARIABLES DE PRIX-----
VALM
valR(I)
valPVA(I)
valP(I)
-----FONCTION DE PRODUCTION-----
VolXS(I)
VolVA(I)
VolLD(I)
VolLS
VolKD(I)
-----Revenus-Eparges-----
valYM(H)
valYE
```


- Change the name of the output sheet on Excel from

FILE Val/
 Auta.xls/;
 Val.pc=6
 val.nd=4
 put val;

To

FILE Val/
 Auta_sim1.xls/;
 Val.pc=6;
 Val.pc=4
 put val;

```

-----Feuille de sortie Excel-----
file val /
  Auta_sim1.XLS/;
  val.pc=6;
  val.nd=3;
put val;

put 'MODELE Auta : Modèle à économie fermée sans Gouvernement';
put '//';
put 'TABLEAU 1 : LES PRIX '//;
put 'Variables' put 'Branche' put 'Branche' put 'Reference' put 'Simulation' put 'Variation en%';
put 'w' put ' ' put ' ' put 'w' put 'w.l' put 'valw' /;
loop(i, put'r' put i.tl put'' put ro(i) put r.l(i) put valr(i)) ;
loop(i, put'pv' put i.tl put'' put pvo(i) put pv.l(i) put valpva(i)) ;
loop(i, put'p' put i.tl put'' put po(i) put p.l(i) put valp(i) /) ;

put'';
put 'TABLEAU 2 : LA PRODUCTION';
put 'Variables' put 'Branche' put 'Branche' put 'Reference' put 'Simulation' put 'Variation en%';
loop(i, put'xs' put i.tl put'' put xso(i) put xs.l(i) put Volks(i) /) ;
loop(i, put'va' put i.tl put'' put vac(i) put va.l(i) put Volva(i) /) ;
loop(i, put'ld' put i.tl put'' put ldo(i) put ld.l(i) put Volld(i) /) ;
put'ls' put ' ' put ' ' put 'lso' put 'ls.l' put 'Volls' /;
loop(i, put'kd' put i.tl put'' put kdo(i) put kd.l(i) put Volkd(i)) ;
loop(i, put'ci' put i.tl put'' put cro(i) put ci.l(i) put valci(i)) ;
loop(i,j, put 'DI' i.tl,j.tl, put DIO(i,j) put DI.l(i,j) put valDI(i,j) /);
  
```

- Next, **File/Run** or **F9** to solve the model and recover the results sheet <<Auta_sim1.xls>> in **Documents/Gamsdir/projdir/**

TABLEAU 1 : LES PRIX

Variables	Branche	Branche	Reference	Simulation	Variation en%
w			1	0.976	-2.399
r	AGR		1	1.063	6.293
r	IND		1	1.109	10.938
r	Serv		1	1.06	6.016
Pv	AGR		1	0.993	-0.72
Pv	IND		1	1.054	5.397
Pv	Serv		1	0.998	-0.203
P	AGR		1	1	0
P	IND		1	1.033	3.308
P	Serv		1	1.005	0.545

TABLEAU 2 : LA PRODUCTION

Variables	Branche	Branche	Reference	Simulation	Variation en%
Xs	AGR		9000	9635.727	7.064
Xs	IND		34400	57259.802	5.257
Xs	Serv		30700	52613.216	6.232
Va	AGR		7200	7708.581	7.064
Va	IND		18500	19893.571	5.257
Va	Serv		21260	22584.918	6.232
Ld	AGR		5760	6272.995	8.906
Ld	IND		7560	8593.086	13.605
Ld	Serv		15540	16879.919	8.622
LS			28860	31746	10
KD	AGR		1440	1440	0
en			11340	11340	0

TABLEAU 3 : REVENUS ET EPARGNES

Variables	Branche	Branche	Reference	Simulation	Variation en%
YM	HS		28860	30984.281	7.361
YM	HK		13000	14005.056	7.731
YF			7400	8070.037	9.055
SM	HS		2886	3098.428	7.361
SM	HK		2600	2801.011	7.731
SF			5500	6170.037	12.182

TABLEAU 4 : DEMANDES

Variables	Branche	Branche	Reference	Simulation	Variation en%
C	AGR	HS	4329	4647.642	7.361
C	AGR	HK	650	700.253	7.731
C	IND	HS	11544	11996.827	3.923
C	IND	HK	3900	4066.971	4.281
C	Serv	HS	10101	10785.668	6.778
C	Serv	HK	5850	6268.086	7.147
DIT	AGR		2922.4	3080.884	5.423
DIT	IND		25068.6	26681.328	5.548
DIT	Serv		14749	15559.463	5.495
INV	AGR		1098.6	1206.948	9.862
INV	IND		5887.4	6254.676	6.344
IT			10586	12069.476	9.862

TABLE 6 : variation equivalente

	HS	HK	All
Change in net	7.476		
Equivalent v	7.361	7.731	7.476

As you can see at the level of the last column, the simulation had an impact on the studied economy. All that is left is to interpret the different variations that were noted

Simulation 2

- 10% increase in capital specific to the services branch.
To view the 10% increase, we will:

Solve Auta using MCP

KD.FX('serv')= KDO ('serv')*(1+0.1);

Solve Auta using MCP

- Change the name of the Excel output sheet file from:

FILE Val/		FILE VAL/
Auta.xls.xls/;		Auta_sim2.xls/;
Val.pc=6;	TO	Val.pc=6;
Val.nd=4;		Val.pc=4
put val;		put val;

- Following the same procedures as we did with simulation 1, we will obtain the results as displayed below

The screenshot shows a Microsoft Excel spreadsheet titled 'Autos_sim2'. The spreadsheet contains two tables of simulation results. The first table, 'TABLEAU 1 : LES PRIX', compares reference values with simulation results for various variables across three branches (AGR, IND, Serv). The second table, 'TABLEAU 2 : LA PRODUCTION', compares reference values with simulation results for production levels across the same three branches. The simulation results generally show small percentage variations from the reference values.

TABLEAU 1 : LES PRIX					
Variables	Branche	Branche	Reference	Simulation	Variation en%
w			1	1	-0.024
r	AGR		1	1.005	0.463
r	IND		1	1.018	1.828
r	Serv		1	0.899	-10.097
Pv	AGR		1	1.001	0.071
Pv	IND		1	1.011	1.081
Pv	Serv		1	0.972	-2.841
P	AGR		1	1	0
P	IND		1	0.999	-0.143
P	Serv		1	0.978	-2.239

TABLEAU 2 : LA PRODUCTION					
Variables	Branche	Branche	Reference	Simulation	Variation en%
Xs	AGR		9000	9035.247	0.391
Xs	IND		54400	54801.012	0.737
Xs	Serv		30700	31247.712	1.784
Va	AGR		7200	7228.198	0.391
Va	IND		18900	19039.322	0.737
Va	Serv		21200	21639.295	1.784
Ld	AGR		5700	5788.211	0.49
Ld	IND		7560	7700.093	1.851
Ld	Serv		15940	15371.695	-3.613
LS			38860	38860	0
KD	AGR		1440	1440	0
KD	IND		11340	11340	0

The screenshot shows a Microsoft Excel spreadsheet with the following data:

Variables	Branche	Branche	Reference	Simulation	Variation en%
55 C	AGR	HS	4329	4327.947	-0.024
56 C	AGR	HK	690	654.521	0.696
57 C	IND	HS	11544	11557.971	0.121
58 C	IND	HK	3900	3932.836	0.842
59 C	Serv	HS	10101	10329.807	2.265
60 C	Serv	HK	5890	6025.591	3.002
61 DIT	AGR		2922.4	2946.412	0.822
62 DIT	IND		29068.6	29338.429	0.928
63 DIT	Serv		14749	14892.334	0.972
64 INV	AGR		1098.6	1106.366	0.707
65 INV	IND		9887.4	9971.775	0.853
66 IT			10986	11063.665	0.707

TABLE 6 : variation equivalente			
	HS	HK	All
70 Change in nominal income	0.199		
71 Equivalent variation	-0.024	0.696	0.199

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We have the results of both our simulations, the only thing left to do is interpret them.

Interpretations

- To interpret the results of our simulations, a theoretical analysis of the probable direct and indirect (or induced) effects caused by the choc is needed. The analysis should put into evidence the dominant effects and the propagation mechanism (pinpoint the training effect) of the simulation in the model. Next, compare the results of this theoretical analysis by those found with the model, thereby drawing the consequences on the points of agreement and divergence.
- Analyze the effects of supply and demand, the mechanisms of the price formation and the origin of the differences between sector.
- Interpret the variation of price in relation to cash and other prices.

Scenario 1: 10% increase in the labor volume

- As an example, for the first simulation, we have:

The decrease in salary is considered as the indirect effect

The indirect effects (or induced) are a result of:

the decrease in salary, which would have an impact on the relative price of capital that increased (r/s); labor intensive sectors being favored because their price decreased (sectorial effect); which would induce different implications on the production sectors (**supply effect**) and household income. The latter (by combining the effects of price, of revenue even substitution), would have an impact on the demand of goods & services

Scenario 2: 10% increase in specific capital in services

- The same analysis can be done for the second simulation:

The direct effect is the decrease in return on capital in the branch of services with as a consequence the substitution of labor by capital (indirect effect) in this branch, which favors sectors like agriculture and labor intensive sectors (benefiting from the freed up labor).

Incidentally, the increase in specific capital in services has an impact on those in the two other branches (agriculture and industry), which becomes relatively rare and therefore return increases.

The combination of all these elements has implications on the formation of price, household income, as well as consumption and savings relative to investments.

