Introduction to a Market Model

Dr. Davit Stepanyan

Thuenen Institute of Farm Economics, Braunschweig

Introduction to a Market Model

Ex 8: MyMarketModel

UFOP e.V., https://www.ufop.de/files/8216/7507/1560/Cover_EN_VB_2023.png, accessed on 29.08.2024

Based on the course **"Introduction to Simulation Models in Market and Policy Analysis"** by the group for **"International Agricultural Trade and Development" at Humboldt-University Berlin**

Introduction to a Market Model

MyFarm model

- Linear Programming
- Optimal solution in underdetermined equation system

Market model

UFOP e.V., https://www.ufop.de/files/8216/7507/1560/Cover_EN_VB_2023.png, accessed on 29.08.2024

- Equilibrium Model
- One unique solution in fully determined equation system

The mathematical model

$$DEMAND = par\_dem \times PRICE^{elas\_dem}$$

$$SUPPLY = par\_supply \times PRICE^{elas\_supply}$$

$$NX = SUPPLY - DEMAND$$

Parameters:

- Value assigned or calibrated at the beginning.
- Remain unchanged after that.
- Lower case letters.

Variables:

- Changed to find an equilibrium.
- Can be fixed, min/max values can be specified.
- Start values can be assigned.
- Upper case letters.

Start values for variables

- Assignment of values to variables
  - Makes solving easier and quicker. Necessary for calibration.
  - Use .L (=level) suffix

```
*Start values for variables
     SUPPLY.L      = 256;
     DEMAND.L      = 180;
     NX.L          = SUPPLY.L - DEMAND.L;
     PRICE.L       = 400;
```

Values for parameters

- Assign values to parameters

```
el_supply =  0.5;
el_dem    = -0.1;
```

$$DEMAND = par\_dem \times PRICE^{elas\_dem}$$
$$SUPPLY = par\_supply \times PRICE^{elas_{supply}}$$

- What about par_dem and par_supply?

Calibrate parameters

- Calibrate par_dem and par_supply

$$DEMAND = par\_dem \times PRICE^{elas\_dem}$$
$$SUPPLY = par\_supply \times PRICE^{elas\_supply}$$

$$par\_supply = \frac{SUPPLY}{PRICE^{elas\_supply}} \qquad par\_dem = \frac{DEMAND}{PRICE^{elas\_dem}}$$

```
par_supply    = SUPPLY.L/PRICE.L**el_supply;
par_dem       = DEMAND.L/PRICE.L**el_dem;
```

Equations

$$DEMAND = par\_dem \times PRICE^{elas\_dem}$$

$$SUPPLY = par\_supply \times PRICE^{elas\_supply}$$

$$NX = SUPPLY - DEMAND$$

```
q_dem..    DEMAND =E= par_dem * PRICE**el_dem;
q_supply.. SUPPLY =E= par_supply * PRICE**el_supply;
q_nx..     NX     =E=  SUPPLY - DEMAND;
```

Matching equations & variables

- Fully determined system with one unique solution needs: no. of variables = no. of equations

$$DEMAND = par\_dem \times PRICE^{elas\_dem}$$

$$SUPPLY = par\_supply \times PRICE^{elas\_supply}$$

$$NX = SUPPLY - DEMAND$$

- 4 variables: SUPPLY, DEMAND, NX , PRICE
- 3 equations: q_dem, q_supply, q_nx
- One variable needs to be fixed using the .fx suffix
  - NX.fx=76; or PRICE.fx=400;

Solve the model

- Before:

```
Solve myfarm using lp maximizing v_obje;
```

LP (=Linear Programming) for underdetermined systems, optimization models

- Now:

```
Solve market using MCP;
*SOLVE market maximizing price using nlp;
*SOLVE market minimizing price using nlp;
```

MCP (=Mixed Complementarity Problem) for fully determined systems, equilibrium models

NLP (=nonlinear Programming) for underdetermined systems, optimization models with non-linear equations

Ex 8: MyMarket model

To Do:

- Go through the file
- Fill out the missing parts (`*~~~~~~ fill this ~~~~~~~~`):
  - Start values for variables
  - Calibration of parameters
  - Definition of equations
  - Closures (to ensure a square model)
- Run the model
- Together: Try out the different solvers

Content today

Extending the MyFarm LP model

- Ex. 5: Crop nutrient need
- Ex. 6: Fertilizer pricing
- Ex. 7: Shocks to fertilizer prices

Compile time conditionals

Introduction to a Market Model (PE)

- Ex. 8: MyMarketModel

Introduction to the CAPRI market model

- Ex. 9: run the CAPRI market model (didactic version)

Introduction to the CAPRI market model

Ex. 9: run the CAPRI market model (didactic version)

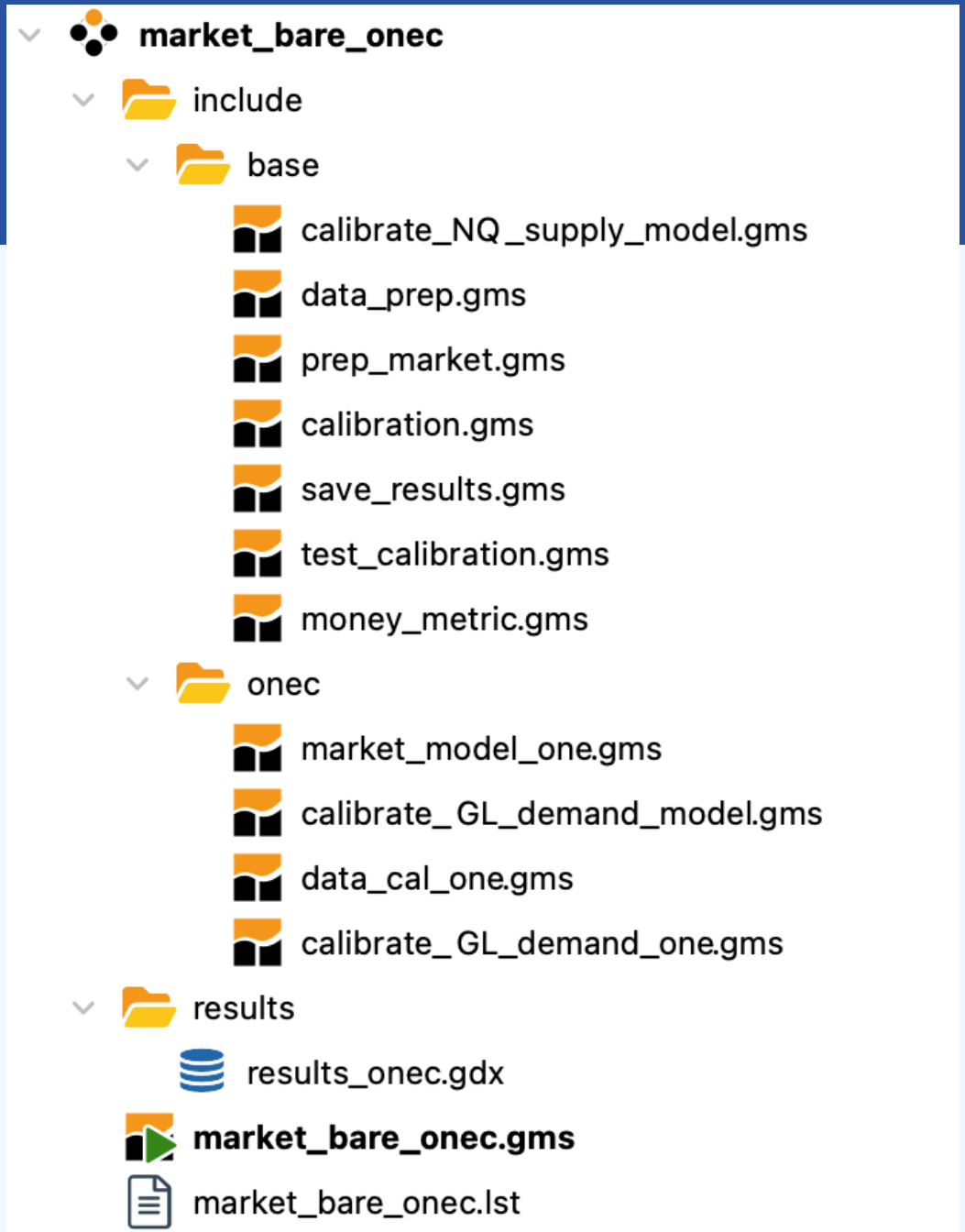
Based on the course "**Didactic model prepared for the CAPRI training session 2019**, Seville, Spain, by **Mihaly Himics**."

Introduction to the CAPRI market model

- The didactic model has the same names of files, step variables, parameters etc. as the market model in CAPRI
- It should be used to read and understand GAMS program code, execute it and examine values in the parameters

Introduction to the CAPRI market model

- One product, three regions model
- Supply functions derived from Normalized Quadratic profit functions
- Generalized Leontief demand system
- Two-stage Armington (CES formulation) (bilateral Trade)
- No processing industry, no feed, no biofuels... => demand is only human consumption (What else do consume?).
- Tariffs are exogenous, only ad-valorem (see p_tarAdVal)
- Two equivalent formulations for the market model
  - NLP Non-linear maximization of a dummy objective
  - MCP (Mixed Complementarity Problem) with orthogonality constraints


market_bare_onec
include
base
calibrate_NQ _supply_model.gms
data_prep.gms
prep_market.gms
calibration.gms
save_results.gms
test_calibration.gms
money_metric.gms
onec
market_model_one.gms
calibrate_ GL_demand_model.gms
data_cal_one.gms
calibrate_ GL_demand_one.gms
results
results_onec.gdx
market_bare_onec.gms
market_bare_onec.lst

Ex 9: Run the model

Run the didactic CAPRI market model: Main file market_bare_onec.gms

1. Check the listing file to see if the model m_GlobalMarket runs successfully.

Help

market_bare_onec.gms | market_bare_onec.lst | results_onec.gdx | market_model_one.gms

```
  C o m p i l a t i o n
  Include File Summary
  E x e c u t i o n
> Display
  Equation Listing    SOLVE GL_demandSystem Using NLP From line 1069
> Equation
  Column Listing      SOLVE GL_demandSystem Using NLP From line 1069
> Column
  Range Statistics    SOLVE GL_demandSystem Using NLP From line 1069
  Model Statistics    SOLVE GL_demandSystem Using NLP From line 1069
  Solution Report     SOLVE GL_demandSystem Using NLP From line 1069
> SolEQU
> SolVAR
  E x e c u t i o n
> Display
  Range Statistics    SOLVE m_trimElas Using NLP From line 1274
  Model Statistics    SOLVE m_trimElas Using NLP From line 1274
  Solution Report     SOLVE m_trimElas Using NLP From line 1274
> SolEQU
> SolVAR
  E x e c u t i o n
> Display
  Equation Listing    SOLVE m_GlobalMarket Using MCP From line 1558
> Equation
  Column Listing      SOLVE m_GlobalMarket Using MCP From line 1558
> Column
  Range Statistics    SOLVE m_GlobalMarket Using MCP From line 1558
  Model Statistics    SOLVE m_GlobalMarket Using MCP From line 1558
  Solution Report     SOLVE m_GlobalMarket Using MCP From line 1558
  E x e c u t i o n
v Display
    PS_CAL
    PS_Y
    p_welfareRes
```

```
Model Statistics    SOLVE m_GlobalMarket Using MCP From line 1558


MODEL STATISTICS

BLOCKS OF EQUATIONS          16     SINGLE EQUATIONS           54
BLOCKS OF VARIABLES          17     SINGLE VARIABLES           63
NON ZERO ELEMENTS           183     NON LINEAR N-Z            105
CODE LENGTH                 423     CONSTANT POOL              62


GENERATION TIME      =        0.063 SECONDS      4 MB  46.5.0 a671108d WEX-WEI
GAMS 46.5.0  a671108d May 8, 2024           WEX-WEI x86 64bit/MS Windows - 05/14/25 15:19:36 Page 18
shortcapri
Solution Report     SOLVE m_GlobalMarket Using MCP From line 1558


               S O L V E      S U M M A R Y

     MODEL   m_GlobalMarket
     TYPE    MCP
     SOLVER  PATH                FROM LINE  1558

**** SOLVER STATUS     1 Normal Completion
**** MODEL STATUS      1 Optimal

 RESOURCE USAGE, LIMIT          0.016 10000000000.000
 ITERATION COUNT, LIMIT         0    2147483647
 EVALUATION ERRORS              0             0
54 row/cols, 168 non-zeros, 5.76% dense.

Path 5.0.07 (Wed May  8 03:39:22 2024)
Written by Todd Munson, Steven Dirkse, Youngdae Kim, and Michael Ferris

INITIAL POINT STATISTICS
Maximum of X. . . . . .  6.4232e+04 var: (v_GLDemandFS(R3))
Maximum of F. . . . . .  5.8388e-09 eqn: (XiS_(R1,'X1'))
Maximum of Grad F . . . . . .  4.1305e+03 eqn: (XiS_(R2,'X1'))
                                    var: (v_GLDemandGiS(R2,'X1'))

INITIAL JACOBIAN NORM STATISTICS
Maximum Row Norm. . . . . .  4.2830e+03 eqn: (XiS_(R2,'X1'))
Minimum Row Norm. . . . . .  1.7669e-03 eqn: (SupBalM_(R1,'X1'))
Maximum Column Norm . . . . . .  4.1315e+03 var: (v_GLDemandGiS(R2,'X1'))
Minimum Column Norm . . . . . .  6.8586e-03 var: (v_expQuant(R2,'X1'))

FINAL STATISTICS
Inf-Norm of Complementarity . .  5.8388e-09 eqn: (XiS_(R1,'X1'))
Inf-Norm of Normal Map. . . . .  5.8388e-09 eqn: (XiS_(R1,'X1'))
Inf-Norm of Minimum Map . . . .  5.8388e-09 eqn: (XiS_(R1,'X1'))
Inf-Norm of Fischer Function. .  5.8388e-09 eqn: (XiS_(R1,'X1'))
Inf-Norm of Grad Fischer Fcn. .  1.3758e-05 eqn: (GLDemandGiS_(R1,'X1'))
Two-Norm of Grad Fischer Fcn. .  1.5081e-05

FINAL POINT STATISTICS
Maximum of X. . . . . .  6.4232e+04 var: (v_GLDemandFS(R3))
Maximum of F. . . . . .  5.8388e-09 eqn: (XiS_(R1,'X1'))
Maximum of Grad F . . . . . .  4.1305e+03 eqn: (XiS_(R2,'X1'))
                                    var: (v_GLDemandGiS(R2,'X1'))


**** REPORT SUMMARY :        0     NONOPT
                             0 INFEASIBLE
                             0  UNBOUNDED
                             0  REDEFINED
                             0     ERRORS
GAMS 46.5.0  a671108d May 8, 2024           WEX-WEI x86 64bit/MS Windows - 05/14/25 15:19:36 Page 19
shortcapri
E x e c u t i o n


----   1780 PARAMETER PS_CAL  price in calib. point

            X1        inpe
```

Ex 9: Run the model

Run the didactic CAPRI market model: Main file market_bare_onec.gms

1. Check the listing file to see if the model m_GlobalMarket runs successfully.
2. Analyze also the GDX file results_onec.gdx in the result folder and:
    1. Confirm that we have one agricultural product (see set XX). What is the second product?

Ex 9: Run the model

Run the didactic CAPRI market model: Main file

... model

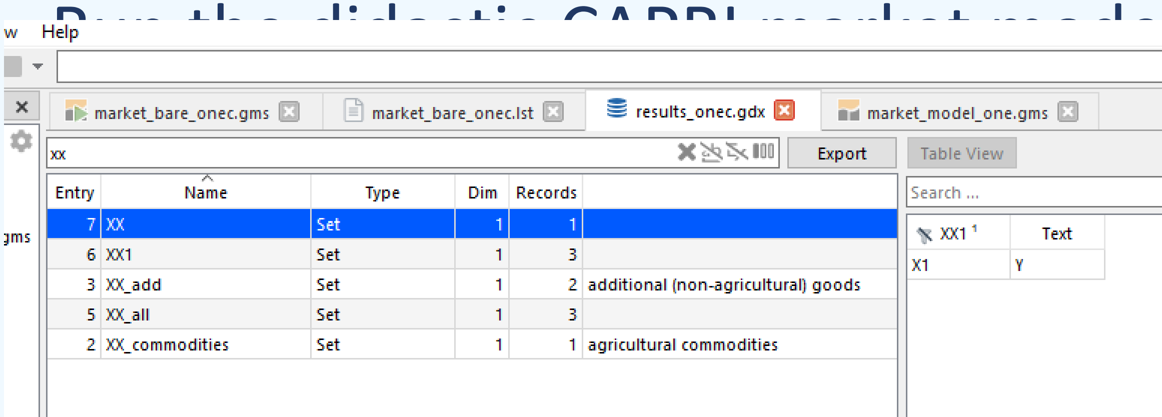
... y.

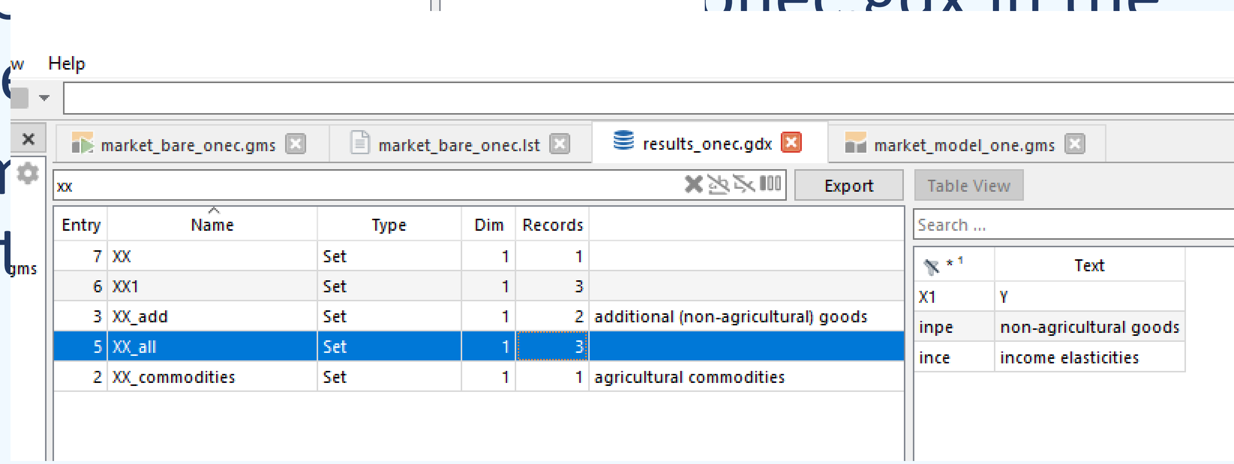
... onec.gdx in the

2. Analyze ... result folde...

   1. Confirm ...

      (see set...





Ex 9: Run the model

Run the didactic CAPRI market model: Main file market_bare_onec.gms

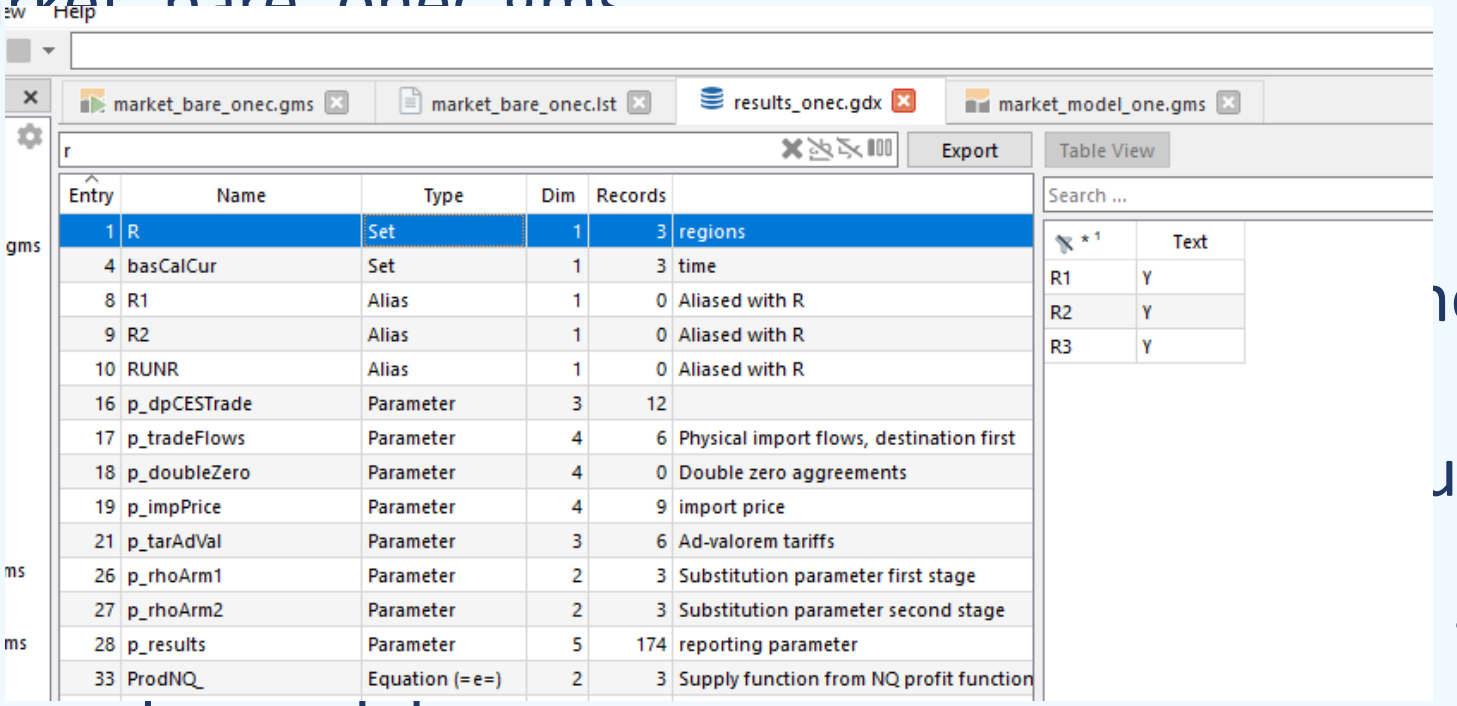
1. Check the listing file to see if the model m_GlobalMarket runs successfully.
2. Analyze also the GDX file results_onec.gdx in the result folder and:
    1. Confirm that we have one agricultural product (see set XX). What is the second product?
    2. Confirm that we have three regions defined in the model.

Ex 9: Run the model

Run the didactic CAPRI market model: Main file market_bare_onec.gms

1.

2.



ne

uct

in

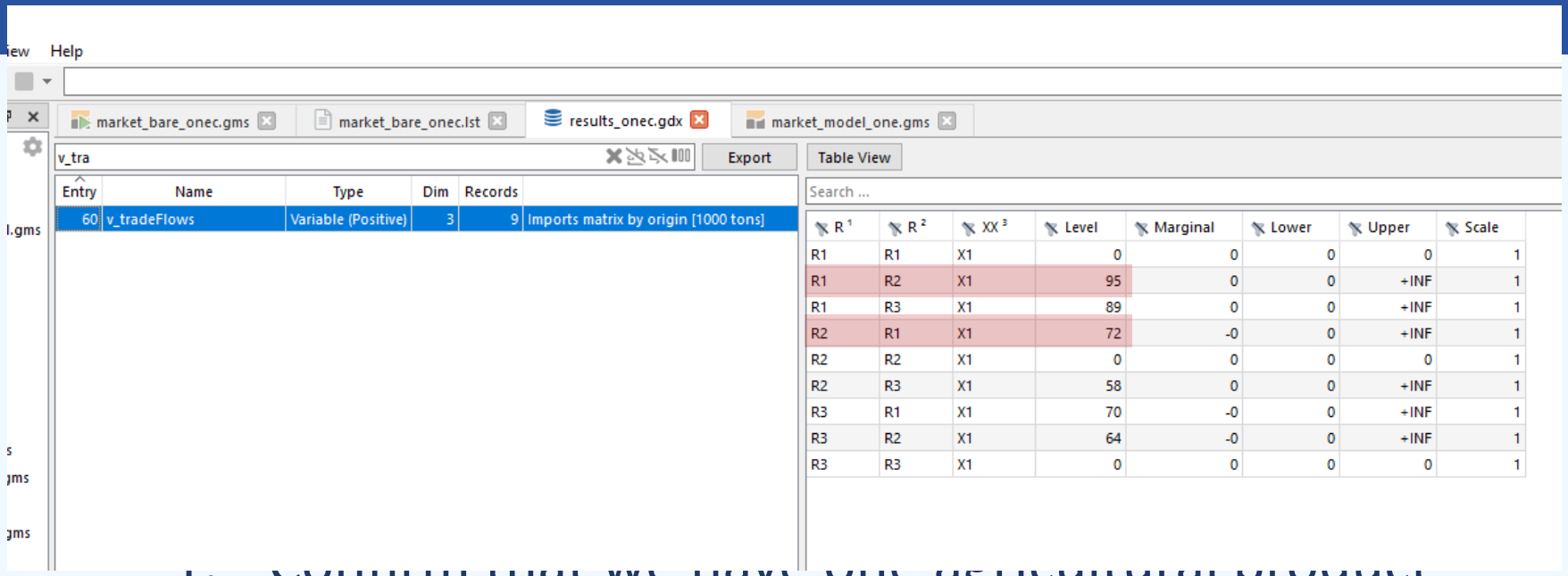
the model.

Ex 9: Run the model

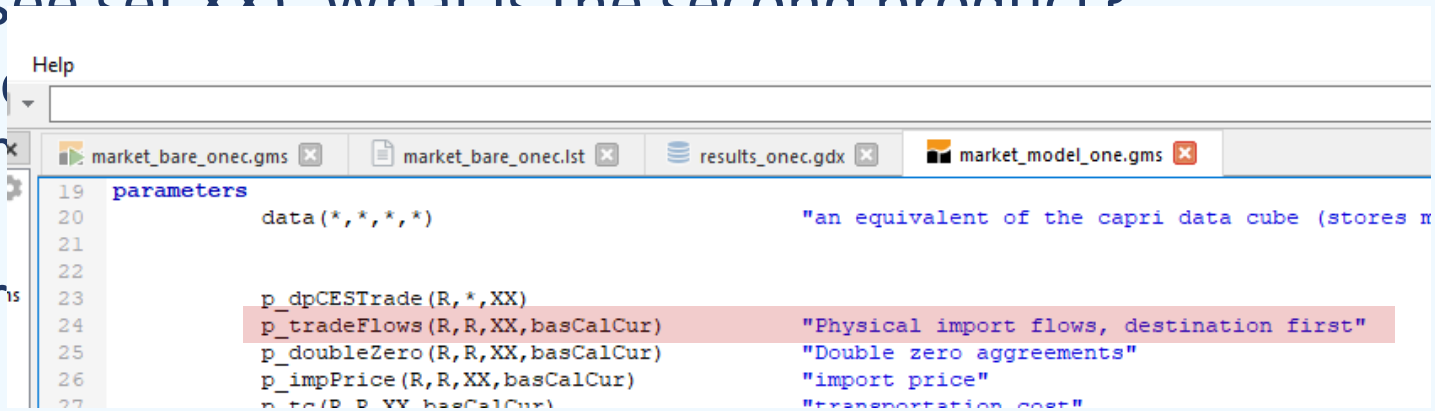
Run the didactic CAPRI market model: Main file market_bare_onec.gms

1. Check the listing file to see if the model m_GlobalMarket runs successfully.
2. Analyze also the GDX file results_onec.gdx in the result folder and:
    1. Confirm that we have one agricultural product (see set XX). What is the second product?
    2. Confirm that we have three regions defined in the model.
    3. How much does the R1 import from R2 and R2 from R1?

Ex 9: Run the model



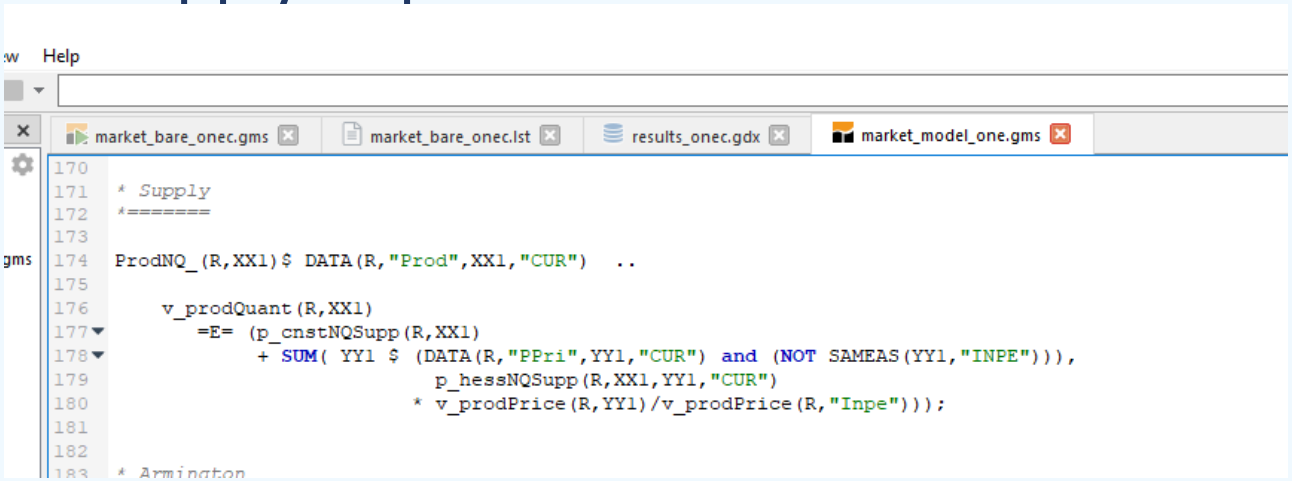
1. Confirm that we have one agricultural product (see set XX). What is the second product?
2. C
m
3. H
fr



Ex 9: Normalized Quadratic profit

Exercise: check the file "include/onec/market_model_one.gms" and answer the questions:

1. Find the supply function and check the parameters and variables in the function. Of what does supply depend on?



Ex 9: Policy Simulation

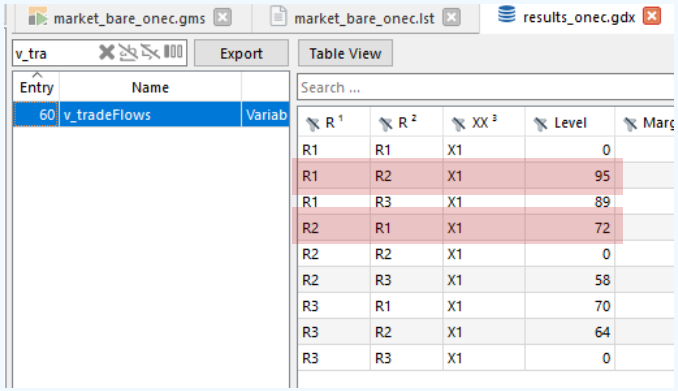
Please review the file market_bare_onec.gms from line 99 to 114 for the following actions:

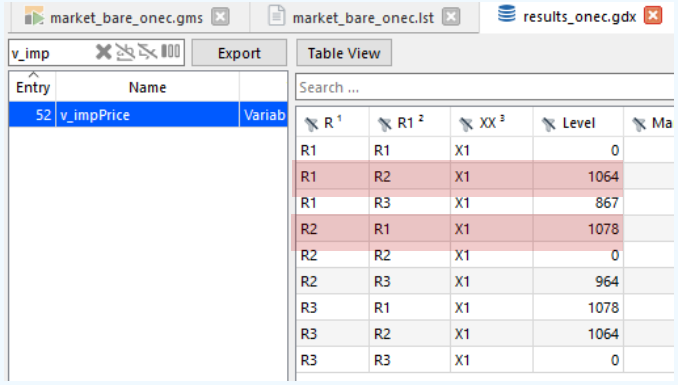
1. Activate the free-trade agreement (FTA) between R1 and R2, which is implemented as a double zero agreement, resulting in no tariff between R1 and R2.
2. What is the role of the parameter p_doubleZero? (look at market_model_one.gms)
3. Run the model again and inspect the GDX output, please report how trade has been changed?

Ex 9: Policy Simulation

3. Run the model again and inspect the GDX output, please report how trade has been changed?

no FTA between R1 and R2





FTA between R1 and R2