



Introduction to a Market Model

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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



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- 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`

$$DEMAND = par_dem \times PRICE^{elas_dem}$$

$$SUPPLY = par_supply \times PRICE^{elas_supply}$$

$$par_supply = \frac{SUPPLY}{PRICE^{elas_supply}}$$

$$par_dem = \frac{DEMAND}{PRICE^{elas_dem}}$$

$$par_supply = SUPPLY.L / PRICE.L^{**}el_supply;$$

$$par_dem = DEMAND.L / PRICE.L^{**}el_dem;$$

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**;

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

**SOLVE market maximizing price using nlp;*

**SOLVE market minimizing price using nlp;*

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.

```

C o m p i l a t i o n
I n c l u d e   F i l e   S u m m a r y
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
> 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 ae71108d WEX-WEI
GAMS 46.5.0 ae71108d 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 100000000000.000
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 ae71108d 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

```

R
n
1

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

Download the file `market_model_onec.gms` in the `results` folder. Main file

1. Confirm the model (see set `XX` in the `market_model_onec.gdx` in the `results` folder)

| Entry | Name | Type | Dim | Records | |
|-------|----------------|------|-----|---------|-------------------------------------|
| 7 | XX | Set | 1 | 1 | |
| 6 | XX1 | Set | 1 | 3 | |
| 3 | XX_add | Set | 1 | 2 | additional (non-agricultural) goods |
| 5 | XX_all | Set | 1 | 3 | |
| 2 | XX_commodities | Set | 1 | 1 | agricultural commodities |

| Entry | Name | Type | Dim | Records | |
|-------|----------------|------|-----|---------|-------------------------------------|
| 7 | XX | Set | 1 | 1 | |
| 6 | XX1 | Set | 1 | 3 | |
| 3 | XX_add | Set | 1 | 2 | additional (non-agricultural) goods |
| 5 | XX_all | Set | 1 | 3 | |
| 2 | XX_commodities | Set | 1 | 1 | agricultural commodities |

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.

The screenshot shows the GAMS software interface with a list of model entities. The list includes the following entries:

| Entry | Name | Type | Dim | Records | Description |
|-------|--------------|----------------|-----|---------|------------------------------------------|
| 1 | R | Set | 1 | 3 | regions |
| 4 | basCalCur | Set | 1 | 3 | time |
| 8 | R1 | Alias | 1 | 0 | Aliased with R |
| 9 | R2 | Alias | 1 | 0 | Aliased with R |
| 10 | RUNR | Alias | 1 | 0 | Aliased with R |
| 16 | p_dpCESTrade | Parameter | 3 | 12 | |
| 17 | p_tradeFlows | Parameter | 4 | 6 | Physical import flows, destination first |
| 18 | p_doubleZero | Parameter | 4 | 0 | Double zero agreements |
| 19 | p_impPrice | Parameter | 4 | 9 | import price |
| 21 | p_tarAdVal | Parameter | 3 | 6 | Ad-valorem tariffs |
| 26 | p_rhoArm1 | Parameter | 2 | 3 | Substitution parameter first stage |
| 27 | p_rhoArm2 | Parameter | 2 | 3 | Substitution parameter second stage |
| 28 | p_results | Parameter | 5 | 174 | reporting parameter |
| 33 | ProdNQ_ | Equation (=e=) | 2 | 3 | Supply function from NQ profit function |

the model.

the
product
in

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

| R ¹ | R ² | XX ³ | Level | Marginal | Lower | Upper | Scale |
|----------------|----------------|-----------------|-------|----------|-------|-------|-------|
| R1 | R1 | X1 | 0 | 0 | 0 | 0 | 1 |
| R1 | R2 | X1 | 95 | 0 | 0 | +INF | 1 |
| R1 | R3 | X1 | 89 | 0 | 0 | +INF | 1 |
| R2 | R1 | X1 | 72 | -0 | 0 | +INF | 1 |
| R2 | R2 | X1 | 0 | 0 | 0 | 0 | 1 |
| R2 | R3 | X1 | 58 | 0 | 0 | +INF | 1 |
| R3 | R1 | X1 | 70 | -0 | 0 | +INF | 1 |
| R3 | R2 | X1 | 64 | -0 | 0 | +INF | 1 |
| R3 | R3 | X1 | 0 | 0 | 0 | 0 | 1 |

1. Confirm that we have one agricultural product (see set XX). What is the second product?

2. C

3. H

```

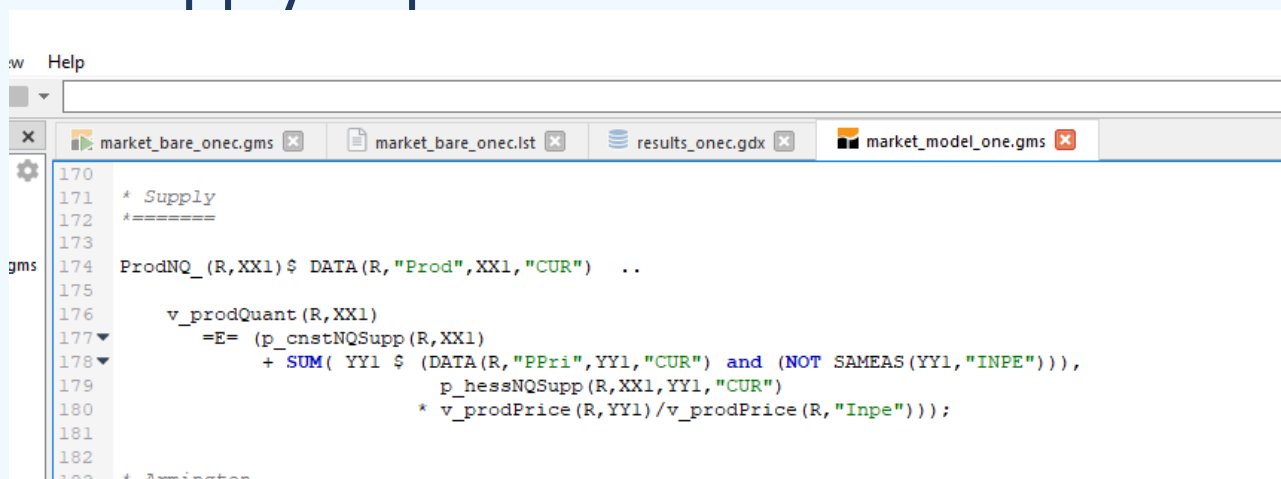
parameters
20     data(*,*,*,*)                "an equivalent of the capri data cube (stores m
21
22
23     p_dpCESTrade(R,*,XX)
24     p_tradeFlows(R,R,XX,basCalCur)  "Physical import flows, destination first"
25     p_doubleZero(R,R,XX,basCalCur)  "Double zero agreements"
26     p_impPrice(R,R,XX,basCalCur)    "import price"
27     p_trc(R,R,XX,basCalCur)        "transportation cost"
  
```

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?



```
170
171 * Supply
172 *=====
173
174 ProdNQ_ (R,XX1)$ DATA(R,"Prod",XX1,"CUR") ..
175
176     v_prodQuant (R,XX1)
177     =E= (p_cnstNQSupp (R,XX1)
178         + SUM( YY1 $ (DATA(R,"PPri",YY1,"CUR") and (NOT SAMEAS(YY1,"INPE"))),
179             p_hessNQSupp (R,XX1,YY1,"CUR")
180             * v_prodPrice (R,YY1)/v_prodPrice (R,"Inpe")));
181
182
183 * Armington
```

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

market_bare_onec.gms | market_bare_onec.lst | results_onec.gdx

v_tra | Export | Table View

| Entry | Name | Search ... |
|-------|--------------|------------|
| 60 | v_tradeFlows | Variab |

| | R ¹ | R ² | XX ³ | Level | Margi |
|----|----------------|----------------|-----------------|-------|-------|
| R1 | R1 | X1 | | 0 | |
| R1 | R2 | X1 | | 95 | |
| R1 | R3 | X1 | | 89 | |
| R2 | R1 | X1 | | 72 | |
| R2 | R2 | X1 | | 0 | |
| R2 | R3 | X1 | | 58 | |
| R3 | R1 | X1 | | 70 | |
| R3 | R2 | X1 | | 64 | |
| R3 | R3 | X1 | | 0 | |

market_bare_onec.gms | market_bare_onec.lst | results_onec.gdx

v_imp | Export | Table View

| Entry | Name | Search ... |
|-------|------------|------------|
| 52 | v_impPrice | Variab |

| | R ¹ | R1 ² | XX ³ | Level | Ma |
|----|----------------|-----------------|-----------------|-------|----|
| R1 | R1 | X1 | | 0 | |
| R1 | R2 | X1 | | 1064 | |
| R1 | R3 | X1 | | 867 | |
| R2 | R1 | X1 | | 1078 | |
| R2 | R2 | X1 | | 0 | |
| R2 | R3 | X1 | | 964 | |
| R3 | R1 | X1 | | 1078 | |
| R3 | R2 | X1 | | 1064 | |
| R3 | R3 | X1 | | 0 | |

FTA between R1 and R2

market_bare_onec.gms | market_bare_onec.lst | results_onec.gdx

v_tra | Export | Table View

| Entry | Name | Search ... |
|-------|--------------|------------|
| 60 | v_tradeFlows | Variab |

| | R ¹ | R ² | XX ³ | Level | Margi |
|----|----------------|----------------|-----------------|-------|-------|
| R1 | R1 | X1 | | 0 | |
| R1 | R2 | X1 | | 226 | |
| R1 | R3 | X1 | | 58 | |
| R2 | R1 | X1 | | 188 | |
| R2 | R2 | X1 | | 0 | |
| R2 | R3 | X1 | | 38 | |
| R3 | R1 | X1 | | 66 | |
| R3 | R2 | X1 | | 55 | |
| R3 | R3 | X1 | | 0 | |

market_bare_onec.gms | market_bare_onec.lst | results_onec.gdx

v_imp | Export | Table View

| Entry | Name | Search ... |
|-------|------------|------------|
| 52 | v_impPrice | Variab |

| | R ¹ | R1 ² | XX ³ | Level | Margi |
|----|----------------|-----------------|-----------------|-------|-------|
| R1 | R1 | X1 | | 0 | |
| R1 | R2 | X1 | | 862 | |
| R1 | R3 | X1 | | 845 | |
| R2 | R1 | X1 | | 863 | |
| R2 | R2 | X1 | | 0 | |
| R2 | R3 | X1 | | 939 | |
| R3 | R1 | X1 | | 1079 | |
| R3 | R2 | X1 | | 1078 | |
| R3 | R3 | X1 | | 0 | |