

Formulation of a Simple Market Clearing

STEPS

1. Set definitions

2. Data entry

3. Variables specification

4. Equations specification

a. declaration

b. algebraic structure specification

5. Model statement

6. Solve statement

Formulation of a Simple Market Clearing

- Demand: $P \geq P_d = 6 - 0.3 \cdot Q_d$
- Supply: $P \leq P_s = 1 + 0.2 \cdot Q_s$
- Equilibrium: $Q_s \geq Q_d$ and $P, Q_s, Q_d \geq 0$

POSITIVE VARIABLE

```
P           Equilibrium price
Qd          Quantity demanded
Qs          Quantity supply      ;
```

EQUATION

```
DemandPrice      Demand equation
SupplyPrice      Supply equation
Qbalance         Equilibrium equation ;
```

```
DemandPrice..   P           =G= 6-0.3*Qd      ;
SupplyPrice..   1+0.2*Qs     =G= P           ;
Qbalance..      Qs          =G= Qd          ;
```

```
MODEL EQUIL     /DemandPrice.Qd
                SupplyPrice.Qs
                Qbalance.P / ;
```

```
OPTION MCP      = PATH      ;
SOLVE EQUIL     using MCP   ;
```

Formulation of a Simple Market Clearing

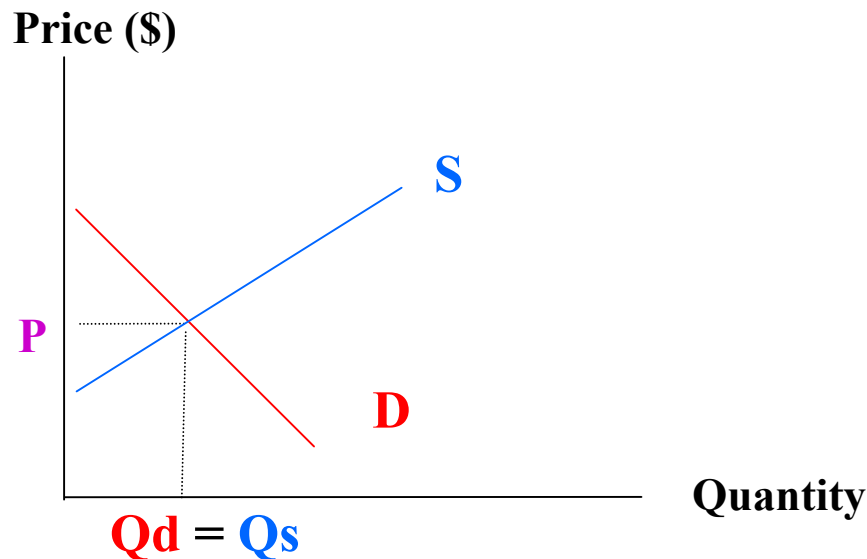
IF

$$Q_d > 0 \text{ then } P = 6 - 0.3 \cdot Q_d$$

$$Q_s > 0 \text{ then } P = 1 + 0.2 \cdot Q_s$$

$$P > 0 \text{ then } Q_s = Q_d$$

} Implies that $P_d = P_s = P$



GAMS Solution

■ Solution

		LOWER	LEVEL	UPPER	MARGINAL
----	EQU DemandPrice	6.000	6.000	+INF	10.000
----	EQU SupplyPrice	-1.000	-1.000	+INF	10.000
----	EQU Qbalance	.	.	+INF	3.000

		LOWER	LEVEL	UPPER	MARGINAL
----	VAR P	.	3.000	+INF	.
----	VAR Qd	.	10.000	+INF	.
----	VAR Qs	.	10.000	+INF	.

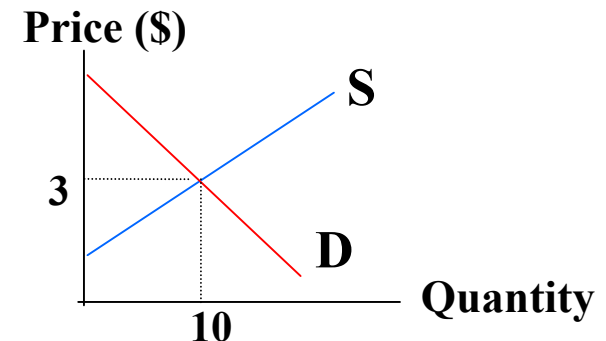
----	VARIABLE	P.L	=	3.000	Equilibrium price
	VARIABLE	Qd.L	=	10.000	Quantity demanded
	VARIABLE	Qs.L	=	10.000	Quantity supply

■ At Equilibrium:

$$P_d = P_s = P \Rightarrow P_d = 6 - 0.3 \cdot 10 = 3$$

$$P_s = 1 + 0.2 \cdot 10 = 3$$

$$Q_d = Q_s = 10$$



Dissecting GAMS – Variable naming

■ Variable Specification

GAMS requires variables in each problem to be identified. In the example, we have variables **P**, **Qd**, **Qs**

POSITIVE VARIABLE

P	Equilibrium price	
Qd	Quantity demanded	
Qs	Quantity supply	;

2 types of variables

VARIABLE

unrestricted variables

POSITIVE VARIABLE

restricted variables to be nonnegative

$$\mathbf{P} \geq \mathbf{0}$$

$$\mathbf{Qd} \geq \mathbf{0}$$

$$\mathbf{Qs} \geq \mathbf{0}$$

Dissecting GAMS – Equation naming

- **Equation Specification** consists of two parts.

(1) Naming equations:

GAMS requires the modeler name each equation, which is active in the model. In the example, the equations are named in the **EQUATION** line

EQUATION

```
DemandPrice  
SupplyPrice  
Qbalance
```

```
Demand equation  
Supply equation  
Equilibrium equation ;
```

Text comments

The name for each equation can be anything up to 31 characters.

Dissecting GAMS – Equation algebra

(2) Specifying algebraic structure:

: After naming equations, the exact algebraic structure of equations must be specified by using `..` notation.

DemandPrice <code>..</code>	P	<code>=G=</code>	$6 - 0.3 * Qd$;	P	<code>≥</code>	$6 - 0.3 * Qd$
SupplyPrice <code>..</code>	$1 + 0.2 * Qs$	<code>=G=</code>	P	;	P	<code>≤</code>	$1 + 0.2 * Qs$
Qbalance <code>..</code>	Qs	<code>=G=</code>	Qd	;	Qs	<code>≥</code>	Qd

This algebraic form involves use of a special syntax to tell the exact form of the equation that may actually be an inequality.

`=E=` indicates an equality constraint

`=L=` indicates a less than or equal to constraint

`=G=` indicates a greater than or equal to constraint

Dissecting GAMS – Model & complementarity

■ Model Specification

MODEL statement is used to identify models that will be solved. It involves 2 steps

: give name of the model (e.g. EQUIL)

: specify equations that will be included in the model in slashes / /

MCP = Mixed Complementary Problem

MCP uses ‘.’ as complementary

```
MODEL EQUIL      /DemandPrice.Qd  
                  SupplyPrice.Qs  
                  Qbalance.P / ;
```

```
MODEL EQUIL      /DemandPrice.Qd  
                  SupplyPrice.Qs / ;
```

Omitting Qbalance equation

Dissecting GAMS

■ Solve Specification

SOLVE causes GAMS to use a solver to **the model named (EQUIL)** immediately after the SOLVE statement.

```
SOLVE   EQUIL using MCP ;
```

MCP = Mixed Complementary Problem

That model must already have been defined in a **MODEL** statement.

```
MODEL EQUIL   /DemandPrice.Qd  
                SupplyPrice.Qs  
                Qbalance   .P / ;
```

Dissecting GAMS

■ ; Specification

GAMS requires to terminate each statement with a ; .

POSITIVE VARIABLE

```
P           Equilibrium price
Qd          Quantity demanded
Qs          Quantity supply ;
```

EQUATION

```
DemandPrice Demand equation
SupplyPrice  Supply equation
Qbalance     Equilibrium equation ;
```

```
DemandPrice.. P           =G= 6-0.3*Qd ;
SupplyPrice.. 1+0.2*Qs     =G= P       ;
Qbalance..    Qs          =G= Qd      ;
```

```
MODEL EQUIL /DemandPrice.Qd
              SupplyPrice.Qs
              Qbalance.P / ;
```

```
OPTION MCP = PATH ;
SOLVE EQUIL using MCP ;
```

;

is a very important part of the syntax. The omission often causes many syntax errors.

Dissecting GAMS – Finding errors

```
DemandPrice..   P           =G= 6-0.3*Qd
SupplyPrice..   1+0.2*Qs     =G= P
Qbalance..      Qs          =G= Qd
```

;

;

Error Messages

```
--- Starting compilation
--- SMALLMCP.GMS(14) 1 Mb 1 Error
*** Error 409 in C:\TASANA\685CGEPROJECT\SMALLMCP.GMS
Unrecognizable item - skip to find a new statement
looking for a ';' or a key word to get started again
--- SMALLMCP.GMS(22) 1 Mb 2 Errors
*** Error 257 in C:\TASANA\685CGEPROJECT\SMALLMCP.GMS
Solve statement not checked because of previous errors
--- SMALLMCP.GMS(24) 1 Mb 5 Errors
*** Error 141 in C:\TASANA\685CGEPROJECT\SMALLMCP.GMS
Symbol neither initialized nor assigned
A wild shot: You may have spurious commas in the explanatory
text of a declaration. Check symbol reference list.
```

GAMS IDE - GAMS log

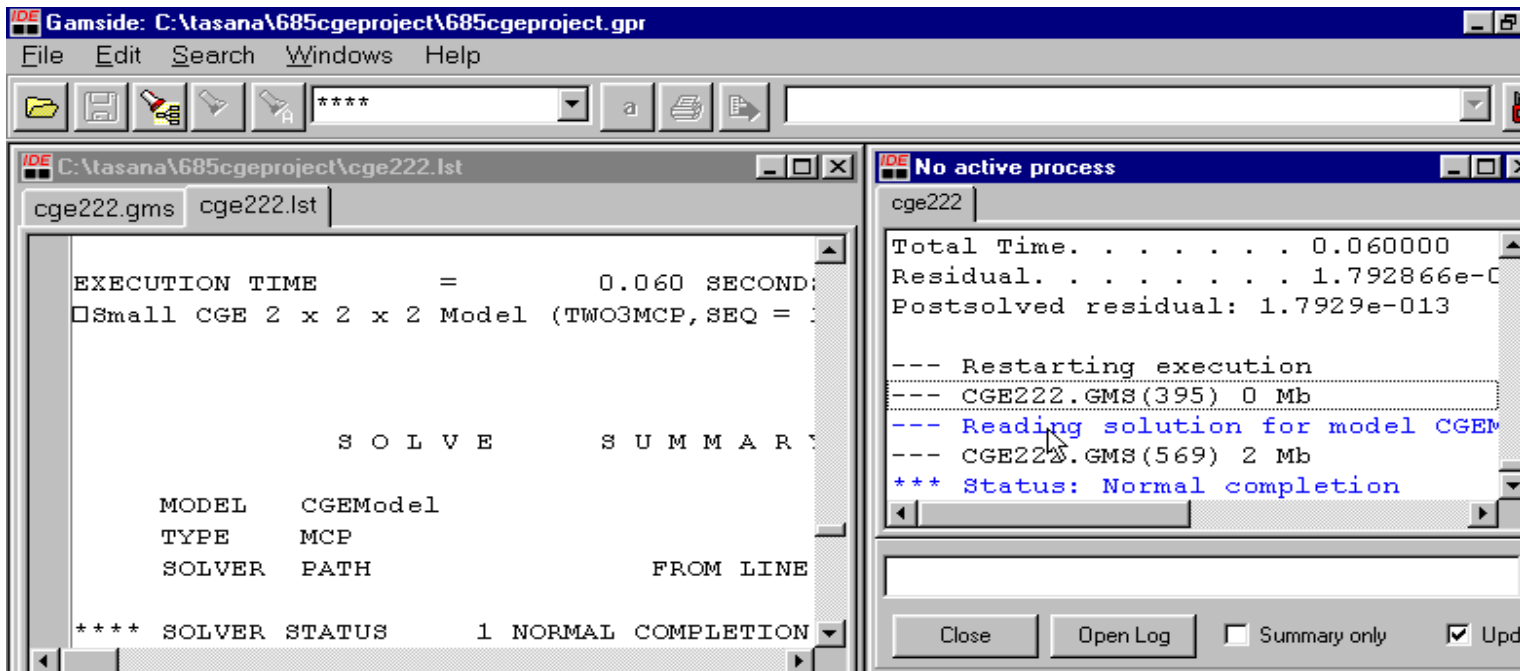
6. Run GAMSIDE (con't)

```
--- Starting compilation                => check if your file is ok
--- SMALLMCP.GMS (26) 1 Mb             => (26) indicate line it is on
--- Starting execution                 => execute your file
--- SMALLMCP.GMS (20) 2 Mb
--- Generating model EQUIL            => set up the problem
--- SMALLMCP.GMS (22) 2 Mb            => size of the problem
---      3 rows, 3 columns, and 6 non-zeroes.
--- SMALLMCP.GMS (22) 2 Mb
--- Executing PATH                    => start solver and gives a
                                       name for which solver is
                                       used
--- Restarting execution               => GAMS restarts
--- SMALLMCP.GMS (22) 0 Mb
--- Reading solution for model EQUIL
--- SMALLMCP.GMS (25) 2 Mb
*** Status: Normal completion         => GAMS stops without errors
```

GAMS IDE - Navigation with IDE

6. Run GAMSIDE (con't)

- : double click on lines in the process window to access output
- : positioning of your access is determined by the color of the line
 - blue lines => open *.LST file and jump to line in *.LST file
 - black lines => open *.LST file and jump to a location of previous blue line
 - red lines => jump to *.gms file (your program) where errors occur



The screenshot displays the GAMS IDE interface. The main window shows the GAMS model execution output for 'cge222.lst'. The output includes the following text:

```
EXECUTION TIME      =      0.060 SECONDS
□Small CGE 2 x 2 x 2 Model (TWO3MCP, SEQ = ...

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

MODEL      CGEModel
TYPE       MCP
SOLVER     PATH              FROM LINE

**** SOLVER STATUS      1 NORMAL COMPLETION
```

The process window, titled 'No active process', shows the execution details for 'cge222'. The output includes the following text:

```
Total Time. . . . . 0.060000
Residual. . . . . 1.792866e-0
Postsolved residual: 1.7929e-013

--- Restarting execution
--- CGE222.GMS (395) 0 Mb
--- Reading solution for model CGEM
--- CGE222.GMS (569) 2 Mb
*** Status: Normal completion
```

The process window also features buttons for 'Close', 'Open Log', and a checkbox for 'Summary only' which is checked. There is also an 'Upd' button partially visible.

GAMS Solution

■ Solution

		LOWER	LEVEL	UPPER	MARGINAL
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----	EQU Qbalance	.	.	+INF	3.000

		LOWER	LEVEL	UPPER	MARGINAL
----	VAR P	.	3.000	+INF	.
----	VAR Qd	.	10.000	+INF	.
----	VAR Qs	.	10.000	+INF	.

----	VARIABLE	P.L	=	3.000	Equilibrium price
	VARIABLE	Qd.L	=	10.000	Quantity demanded
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■ At Equilibrium:

$$P_d = P_s = P \Rightarrow P_d = 6 - 0.3 \cdot 10 = 3$$

$$P_s = 1 + 0.2 \cdot 10 = 3$$

$$Q_d = Q_s = 10$$

