

\$TITLE: M6-6b.GMS: Pollution modelled as an MPEC to solve for optimal TX

\$ONTEXT

*Follows from M6-5a: two goods and one factor, one consumer  
 Pollution is generated by the production of X, pollution reduces utility  
 Pollution is modeled as a reduction in the endowment of CLEAN AIR  
 Initial endowment of clear air is 200, with 100 reduced by X pollution  
 and 100 entering utility.  
 Solves for the welfare maximizing level of the pollution tax*

Markets	Production Sectors			Consumers
	X	Y	W	
PX	100		-100	
PY		100	-100	
PW			300	-300
PL	-100	-100		200
PCA			-100	(200 - 100)

\$OFFTEXT

**PARAMETERS**

POLINT      pollution intensity multiplier;

POLINT = 1;

## VARIABLES

WELFARE     welfare  
TX           pollution tax on X;

## POSITIVE VARIABLES

X           activity level for X production  
Y           activity level for Y production  
W           activity level for the "production" of welfare from X Y

PX           price of good X  
PY           price of good Y  
PCA          price of clean air  
PW           price of a unit of welfare (real consumer-price index)  
PL           price of labor

CONS         income of the representative consumer  
POL          pollution;

## EQUATIONS

OBJ          Objective function: maximize welfare  
PRF\_X        zero profit for sector X  
PRF\_Y        zero profit for sector Y

PRF\_W zero profit for sector W (Hicksian welfare index)

MKT\_X supply-demand balance for commodity X

MKT\_Y supply-demand balance for commodity Y

MKT\_CA market for clean air (determines shadow value PCA)

MKT\_L supply-demand balance for primary factor L

MKT\_W supply-demand balance for aggregate demand

I\_CONS income definition for CONS

PPOL pollution caused by production - consumption of X;

\* *Zero profit inequalities*

OBJ.. WELFARE =E= W;

PRF\_X..  $100 * PL * (1 + TX) =G= 100 * PX;$

PRF\_Y..  $100 * PL =G= 100 * PY;$

PRF\_W..  $200 * (PX^{**}(1/3) * PY^{**}(1/3) * PCA^{**}(1/3)) =G= 200 * PW;$

\* *Market clearance inequalities*

MKT\_X..  $100 * X =G= 100 * W * PW / PX;$

MKT\_Y..  $100 * Y =G= 100 * W * PW / PY;$

MKT\_CA.. 200-100\*POL =G= 100 \* W \* PW / PCA;

MKT\_W.. 300\*W =E= CONS / PW;

MKT\_L.. 200 =G= 100\*X + 100\*Y;

\* *Income balance equations (don't forget tax revenue)*

I\_CONS.. CONS =E= 200\*PL + (200-100\*POL)\*PCA + TX\*100\*X\*PL;

PPOL.. 100\*POL =G= POLINT\*100\*X;

**MODEL** POLLUTE / OBJ, PRF\_X.X, PRF\_Y.Y, PRF\_W.W,  
MKT\_X.PX, MKT\_Y.PY, MKT\_CA.PCA, MKT\_L.PL,  
MKT\_W.PW, I\_CONS.CONS, PPOL.POL /;

\* *Chose a numeraire: real consumer price index*

PW.FX = 1;

\* *Set initial values of variables:*

X.L=1; Y.L=1; W.L=1;

PX.L=1; PY.L=1; PL.L=1; POL.L = 1; PCA.L = 1;

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CONS.L=300; WELFARE.L = 1;
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OPTION MPEC = nlpec;
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POLLUTE.ITERLIM = 0;
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```
SOLVE POLLUTE USING MPEC MAXIMIZING WELFARE;
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TX.L = 0.3;
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WELFARE.L = 1.2;
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POLLUTE.ITERLIM = 1000;
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```
SOLVE POLLUTE USING MPEC MAXMIZING WELFARE;
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* make pollution worse
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POLINT = 1.5;
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```
SOLVE POLLUTE USING MPEC MAXMIZING WELFARE;
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