$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

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

$OFFTEXT

PARAMETERS

 POLINT   polution 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
```

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 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;
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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;


OPTION MPEC = nlpec;
POLLUTE.ITERLIM = 0;
SOLVE POLLUTE USING MPEC MAXIMIZING WELFARE;


TX.L = 0.3;
WELFARE.L = 1.2;


POLLUTE.ITERLIM = 1000;
SOLVE POLLUTE USING MPEC MAXMIZING WELFARE;


* make pollution worse


POLINT = 1.5;


SOLVE POLLUTE USING MPEC MAXMIZING WELFARE;
```