Ch. 4 Endogenous Policy Model

Code File: endog.gms

Description:
This is the endogenous pollution policy variant of Ch. 4 of the book.
A single country is represented. It produces and consumes a non-zero amount of both dirty good X and good Y. The technology for each is Cobb-Douglas but with different factor shares. Dirty good production includes the production of pollution. Utility is also Cobb-Douglas. The market clearing conditions state that endowments must be used up in goods production and that income from endowments equals total expenditure on goods. Good Y is the numeraire good.
As we change the price of dirty good X we can simulate the effect of trade liberalization on production and consumption of each good where trade liberalization is taken to be a reduction in ice-berg transportation costs (as shown in Ch. 3 of text).

Model:

Variables:

L, K - labor and capital endowments

r, w - rent, wage

τ - pollution permit price

β - labor share in dirty good

σ - labor share in clean good

X_s, X_d - supply/demand of dirty good

Z_x, Z_s - pollution supply/demand in dirty good production

α - pollution share in dirty good

Y_s, Y_d - supply/demand of clean good

L_x, K_x - labor, capital used in dirty good production

L_y, K_y - labor, capital used in clean good production

p_x, p_y - prices of dirty, clean good

ω - share of expenditure on dirty good

u - total utility

i - total income

γ - disutility of pollution parameter

Supply side equations

$$X_s = Z_x^{\alpha}(L_x^{\beta}K_x^{(1-\beta)})^{1-\alpha}$$
$$\tau Z_x = \alpha p_x X_s$$
$$rK_x = p_x(1-\alpha)(1-\beta)X_s$$
$$wL_x = p_x(1-\alpha)\beta X_s$$

$$Y_s = L_y^{\sigma}K_y^{(1-\sigma)}$$
$$rK_y = p_y(1-\sigma)Y_s$$
$$wL_y = p_y\sigma Y_s$$

Demand side equations

$$u = \omega\log(X_d) + (1-\omega)\log(Y_d) - \frac{Z_s^{\gamma}}{\gamma}$$

$$p_x X_d = \omega i$$
$$p_y Y_d = (1-\omega)i$$
$$\tau = iZ_s^{(\gamma-1)}$$

Clearing conditions

$$K = K_x + K_y$$
$$L = L_x + L_y$$
$$wL + rK + \tau Z_x = p_x X_d + p_y Y_d$$
$$Z_s = Z_x$$

Output:

The model is run repeatedly for an increasing price of the dirty good.
In the initial cycles the country is a dirty good importer (*index*≤8). Trade liberalization causes the world price of the dirty good to drop and (reading the table in reverse order) we see:

- demand for dirty good increases, supply decreases, imports increase
- utility increases
- pollution intensity increases
- pollution permit price decreases
- pollution and marginal damage decrease

In later increments (*index*≥9) we are an exporter of the dirty good. When we are an exporter of the dirty good, trade liberalization increases price and:

- demand for the dirty good drops then increases, supply increases and
- exports increase
- utility increases
- pollution intensity decreases

- pollution permit price increases
- pollution and marginal damage increase

Output from the run using the following parameters is contained in the subsequent table:

```
parameter
* tweak these to experiment with model
beta   labor share in f     / 0.3 /,
sigma  labor share in y     / 0.7 /,
alpha  f share in x         / 0.2 /,
omega  income share of x    / 0.6 /,
gamma  convexity            / 2 /,
l      labor endowment              / 1 /,
k      capitalendowment     / 1 /,
xprice price of good x              / 1 /
yprice price of good y              / 1 /
xinc   price increment of x         / .05 /;
```

Index	X price	Xd	Xs	Mx	pMx	Yd	Ys	Utility	e	Tau	Polln	MD
1	1.050	0.608	0.238	0.370	0.388	0.425	0.814	-0.664	0.911	0.231	0.217	0.231
2	1.100	0.590	0.280	0.310	0.341	0.433	0.774	-0.680	0.852	0.258	0.239	0.258
3	1.150	0.575	0.321	0.254	0.292	0.441	0.733	-0.693	0.806	0.285	0.259	0.285
4	1.200	0.563	0.361	0.201	0.241	0.450	0.691	-0.703	0.768	0.312	0.278	0.312
5	1.250	0.552	0.400	0.152	0.190	0.460	0.650	-0.711	0.737	0.339	0.295	0.339
6	1.300	0.543	0.437	0.106	0.137	0.471	0.608	-0.716	0.711	0.366	0.311	0.366
7	1.350	0.535	0.473	0.062	0.084	0.482	0.566	-0.720	0.688	0.392	0.326	0.392
8	1.400	0.529	0.507	0.022	0.031	0.494	0.525	-0.721	0.669	0.419	0.339	0.419
9	1.450	0.524	0.540	-0.016	-0.023	0.507	0.484	-0.722	0.651	0.445	0.352	0.445
10	1.500	0.520	0.571	-0.051	-0.077	0.520	0.443	-0.720	0.636	0.472	0.363	0.472
11	1.550	0.516	0.601	-0.085	-0.132	0.534	0.402	-0.718	0.622	0.499	0.374	0.499
12	1.600	0.514	0.630	-0.116	-0.186	0.548	0.362	-0.714	0.609	0.526	0.384	0.526
13	1.650	0.512	0.658	-0.146	-0.241	0.563	0.322	-0.709	0.597	0.553	0.393	0.553
14	1.700	0.510	0.684	-0.174	-0.296	0.578	0.282	-0.704	0.586	0.580	0.401	0.580
15	1.750	0.509	0.710	-0.201	-0.352	0.594	0.242	-0.697	0.576	0.607	0.409	0.607
16	1.800	0.508	0.735	-0.226	-0.407	0.610	0.203	-0.690	0.567	0.635	0.416	0.635
17	1.850	0.508	0.759	-0.250	-0.463	0.627	0.164	-0.682	0.558	0.663	0.423	0.663
18	1.900	0.508	0.782	-0.273	-0.519	0.644	0.125	-0.674	0.549	0.692	0.430	0.692
19	1.950	0.509	0.804	-0.295	-0.576	0.662	0.086	-0.665	0.541	0.720	0.435	0.720
20	2.000	0.510	0.826	-0.316	-0.633	0.679	0.047	-0.656	0.534	0.749	0.441	0.749