$TITLE M8-4b: Small open economy with a benchmark quota  
* modeled as supply/demand for import licenses

$ONTEXT
In this example, units are chosen such that all DOMESTIC prices equal one initially.  
Implied world price of import good X2 P2 = 1/1.2

<table>
<thead>
<tr>
<th>Production Sectors</th>
<th>Consumer</th>
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</thead>
<tbody>
<tr>
<td>Markets</td>
<td>X1</td>
</tr>
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</tr>
<tr>
<td>P1</td>
<td>150</td>
</tr>
<tr>
<td>P2</td>
<td>40</td>
</tr>
<tr>
<td>PL</td>
<td>-100</td>
</tr>
<tr>
<td>PK</td>
<td>-50</td>
</tr>
<tr>
<td>PW</td>
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<tr>
<td>PFX</td>
<td></td>
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<tr>
<td>PLIC</td>
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</tr>
</tbody>
</table>

$OFFTEXT

PARAMETERS

PE2 Export price of good 2
PM1  Import price of good 1
PE1  Export price of good 1
PM2  Import price of good 2
SLIC Supply of import licenses for X2 (M2)
ENDOW Endowment multiplier (size of the economy);

PE1    = 1;
PM2    = 1 / (1.2);
PE2    = PM2 * 0.99;
PM1    = 1.01;
SLIC   = 1;
ENDOW  = 1;

**NONNEGATIVE VARIABLES**

X1  Activity level for sector X1,
X2  Activity level for sector X2,
E1  Activity level for sector E1,
E2  Activity level for sector E2,
M1  Activity level for sector M1,
M2  Activity level for sector M2,
W   Activity level for sector W,
P1  Price index for commodity X,
P2  Price index for commodity Y,
PL  Price index for primary factor L,
PK  Price index for primary factor K,
PW  Price index for welfare (expenditure function),
PFX Read exchange rate index,
CONS Income definition for CONS
PLIC Price of a license (ad valorem tariff equivalent);

**EQUATIONS**

PRF_X1 Zero profit for sector X1
PRF_X2 Zero profit for sector X2
PRF_E1 Zero profit for sector E1
PRF_E2 Zero profit for sector E2
PRF_M1 Zero profit for sector M1
PRF_M2 Zero profit for sector M2
PRF_W Zero profit for sector W

MKT_X1 Supply-demand balance for commodity X1
MKT_X2 Supply-demand balance for commodity X2
MKT_PFX Supply-demand balance for commodity PFX
MKT_L Supply-demand balance for primary factor L
MKT_K Supply-demand balance for primary factor L
MKT_W Supply-demand balance for aggregate demand

I_CONS Income definition for CONS
MKT_LIC Market for import licenses;

* Zero profit conditions

PRF_X1.. 150* PL**(2/3) * PK**(1/3) =G= 150*P1;
PRF_X2.. 40* PL**(0.5) * PK**(0.5) =G= 40*P2;
PRF_E1.. 50*P1 =G= 50*PFX*PE1;
PRF_E2.. 60*P2 =G= 60*PFX*PE2;
PRF_M1.. 50*PFX * PM1 =G= 50*P1;
PRF_M2.. 60*PLIC + 60*PFX*PM2 =G= 60*P2;
PRF_W.. 200*P1**0.5 * P2**0.5 =G= 200*PW;

* Market clearance conditions

MKT_X1.. 150*X1 + 50*M1 =G= 50*E1 + 100*W *PW/P1;
MKT_X2.. 40*X2 + 60*M2 =G= 60*E2 + 100*W*PW/P2 ;
MKT_PFX.. 60*E2*PE2 + 50*E1*PE1 =G= 60*M2*PM2 + 50*PM1*M1;
MKT_W.. 200*W =G= CONS / PW;
MKT_L.. 120*ENDOW =G= 100*X1*P1/PL + 20*X2*P2/PL;
MKT_K.. 70*ENDOW =G= 50*X1*P1/PK + 20*X2*P2/PK;
MKT_LIC..  60*SLIC =G= 60*M2;

*       Income balance

I_CONS..  CONS =E= 120*ENDOW*PL + 70*ENDOW*PK + 60*PLIC*SLIC;

MODEL ALGEBRAIC /PRF_X1.X1, PRF_X2.X2, PRF_E1.E1, PRF_E2.E2,
              PRF_M1.M1, PRF_M2.M2,
              PRF_W.W, MKT_X1.P1, MKT_X2.P2, MKT_PFX.PFX,
              MKT_L.PL, MKT_K.PK, MKT_W.PW,
              MKT_LIC.PLIC, I_CONS.CONS/;

*       Check the benchmark:

X1.L =1;
X2.L =1;
E2.L =0;
M1.L =0;
E1.L =1;
M2.L =1;
W.L =1;

P1.L =1;
P2.L =1;
PFX.L   =1;
PFX.L   =1;
PK.L    =1;
PW.FX   =1;
PL.L    =1;

CONS.L  =200;

PLIC.L = 1/6;

ALGEBRAIC.ITERLIM = 0;
SOLVE  ALGEBRAIC USING MCP;

ALGEBRAIC.ITERLIM = 2000;
SOLVE  ALGEBRAIC USING MCP;

* show what happens if the supply of licenses is greatly expanded

SLIC = 5;
SOLVE  ALGEBRAIC USING MCP;

* show that the quota becomes more restrictive as
* the economy grows

SLIC = 1;
ENDOW = 3;
SOLVE  ALGEBRAIC USING MCP;