GAMS Code for centralized model

S1.gms

```
parameters
alpha1 /0.1/
alpha2 /0.3/
sigma /0.4/
gamma /0.3/;
variables
z1
x3
x4
;
equations
h1
pr1
pr2
ppl
pm1
pm2
Gov
t5
t6
teta
p3
p4
q1
q2
q3
q4
;
h1..     z1=e=alpha1*(2664.19+0.642325*x3-0.518957*x4)+alpha2*(2766.41-0.518957*x3+0.440311*x4)
           +gamma*(4103.01+0.0880475*x3-0.0617957*x4)
           +sigma*gamma*(1327.59+0.03532*x3-0.0168504*x4);
pr1..   488857+0.0087559*power(x3,2)+x3*(132.235-0.013722*x4)-104.751*x4+0.00537515*power(x4,2)=g=1000;
pr2..   421168+0.00512469*power(x3,2)+x3*(-82.2881-0.00899799*x4)+71.423*x4+0.00394789*power(x4,2)=g=2500;
ppl..   940607+32.3151*x3-23.0116*x4=g=5000;
pm1..   860297+0.322829*power(x3,2)+x3*(2639.69+0.0085293*x4)+20.9689*x4-0.224095*power(x4,2)=g=22000;
pm2..   532442-0.00166713*power(x3,2)+x3*(24.4997-0.527486*x4)+2745.44*x4+0.444251*power(x4,2)=g=22000;
Gov..   (-x3)*(2664.19+0.642325*x3-0.518957*x4)+(-x4)*(2766.41-0.518957*x3+0.440311*x4)=g=-2000;
teta..   59.5089+0.45652*x3-0.376117*x4=g=0;
t5..     14.0083-0.000285555*x3+ 0.0112606*x4=g=0;
t6..     14.6968+0.0113672*x3-0.000392209*x4=g=0;
p3..     1211.14+0.0419288*x3-0.0323953*x4=g=0;
p4..     1195.82-0.0295358*x3+0.0264828*x4=g=0;
q1..     1921.56+0.433497*x3-0.353033*x4=g=0;
q2..     742.633+0.208828*x3-0.165924*x4=g=0;
q3..     584.953-0.173508*x3+0.149074*x4=g=0;
q4..     2181.45-0.345449*x3+0.291237*x4=g=0;
model fuzzyfirstsen /all/;
option optcr=0,optca=0;
option nlp=conopt;
solve  fuzzyfirstsen using nlp minimizing z1;
display z1.l,x3.l,x4.l;
```

S2.gms

```
parameters
alpha1 /0.1/
alpha2 /0.3/
sigma /0.4/
gamma /0.3/;
variables
z1
x3
x4
;
equations
h1
pr1
pr2
ppl
pm1
pm2
```

```
Gov
t5
t6
teta
p3
p4
q1
q2
q3
q4
;
h1..    z1=e=(-x3)*(2664.19+0.642325*x3-0.518957*x4)+(-x4)*(2766.41-0.518957*x3+0.440311*x4);
pr1..   488857+0.0087559*power(x3,2)+x3*(132.235-0.013722*x4)-104.751*x4+0.00537515*power(x4,2)=g=1000;
pr2..   421168+0.00512469*power(x3,2)+x3*(-82.2881-0.00899799*x4)+71.423*x4+0.00394789*power(x4,2)=g=2500;
ppl..   940607+32.3151*x3-23.0116*x4=g=5000;
pm1..   860297+0.322829*power(x3,2)+x3*(2639.69+0.0085293*x4)+20.9689*x4-0.224095*power(x4,2)=g=22000;
pm2..   532442-0.00166713*power(x3,2)+x3*(24.4997-0.527486*x4)+2745.44*x4+0.444251*power(x4,2)=g=22000;
Gov..   alpha1*(2664.19+0.642325*x3-0.518957*x4)+alpha2*(2766.41-0.518957*x3+0.440311*x4)
          +gamma*(4103.01+0.0880475*x3-0.0617957*x4)
          +sigma*gamma*(1327.59+0.03532*x3-0.0168504*x4)=l=10000;
teta..    59.5089+0.45652*x3-0.376117*x4=g=0;
t5..     14.0083-0.000285555*x3+ 0.0112606*x4=g=0;
t6..     14.6968+0.0113672*x3-0.000392209*x4=g=0;
p3..     1211.14+0.0419288*x3-0.0323953*x4=g=0;
p4..     1195.82-0.0295358*x3+0.0264828*x4=g=0;
q1..     1921.56+0.433497*x3-0.353033*x4=g=0;
q2..     742.633+0.208828*x3-0.165924*x4=g=0;
q3..     584.953-0.173508*x3+0.149074*x4=g=0;
q4..     2181.45-0.345449*x3+0.291237*x4=g=0;
model fuzzysecondsen /all/;
option optcr=0,optca=0;
option nlp=conopt;
solve  fuzzysecondsen using nlp maximizing z1;
display z1.l,x3.l,x4.l;
```

GAMS Code for decentralized model

S1.gms

```
parameters
alpha1 /0.1/
alpha2 /0.3/
sigma /0.4/
gamma /0.3/;
variables
z1
x1
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;
equations
h1
pr1
pr2
ppl
pm1
pm2
Gov
t1
t3
teta
p1
p2
q1
q2
q3
q4
;
h1..    z1=e=alpha1*(2645.39 + 0.569258*x1- 0.00035951*x2)+alpha2*(2845.36 - 0.464602*x1+ 0.0000161173*x2)
          +gamma*(3657.13 + 0.0730779*x1- 0.000130597*x2)
          +sigma*gamma*(1833.63 + 0.0315779*x1- 0.000212796*x2);
pr1..   454637+0.00723626*power(x1,2)+x1*(111.356-0.00000914577*x2)-0.0587744*x2+0.00000000288979*power(x2,2)=g=1000;
pr2..   409685+0.00482622*power(x1,2)+x1*(-71.1258+0.00000713266*x2)-0.0502353*x2+0.00000000263533*power(x2,2)=g=2500;
ppl..   1023646+29.3578*x1-0.0589657*x2=g=5000;
pm1..   971746+0.284484*power(x1,2)+x1*(2645.38-0.000359505*x2)-0.0123645*x2+0.00000000281636*power(x2,2)=g=22000;
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pm2..    667579+0.0048233*power(x1,2)+x1*(40.8459-0.464602*x2)+2845.36*x2+0.0000115893*power(x2,2)=g=22000;
Gov..    (-x1)*(2645.39+0.569258*x1-0.00035951*x2)+(-x2)*(2845.36-0.464602*x1+0.0000161173*x2)=g=-2000;
teta..   29.4685+0.430584*x1-0.00000674638*x2=g=0;
t1..     14.6686-0.00000461752*x1-0.000000182503*x2=g=0;
t3..     14.7162-0.000235853*x1-0.00029359*x2=g=0;
p1..     1122.42+0.0420112*x1- 0.0000265486*x2=g=0;
p2..     1107.78-0.0343093*x1-0.0000253528*x2=g=0;
q1..   1673.06 + 0.397012*x1- 0.000250661*x2=g=0;
q2..   972.33 + 0.172246*x1 - 0.000108849*x2=g=0;
q3..   861.301 - 0.140668*x1- 0.000103946*x2=g=0;
q4..   1984.06 - 0.323934*x1+ 0.000120064*x2=g=0;
*e17..   703.746 - 0.0166186 *x1 - 0.25907*x2=g=663.831 - 0.0112083*x1 - 0.500283*x2;
*e18..   696.09 - 0.0112083 *x1- 0.500283*x2=g=663.831 - 0.0112083 *x1 - 0.500283*x2;
model fuzzyfirstsen /all/;
option optcr=0,optca=0;
option nlp=conopt;
solve  fuzzyfirstsen using nlp minimizing z1;
display z1.l,x1.l,x2.l;
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S2.gms

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h1..    z1=e=(-x1)*(2645.39+0.569258*x1-0.00035951*x2)+(-x2)*(2845.36-0.464602*x1+0.0000161173*x2);
pr1..   454637+0.00723626*power(x1,2)+x1*(111.356-0.00000914577*x2)-0.0587744*x2+0.00000000288979*power(x2,2)=g=1000;
pr2..   409685+0.00482622*power(x1,2)+x1*(-71.1258+0.00000713266*x2)-0.0502353*x2+0.00000000263533*power(x2,2)=g=2500;
ppl..   1023646+29.3578*x1-0.0589657*x2=g=5000;
pm1..   971746+0.284484*power(x1,2)+x1*(2645.38-0.000359505*x2)-0.0123645*x2+0.00000000281636*power(x2,2)=g=22000;
pm2..   667579+0.0048233*power(x1,2)+x1*(40.8459-0.464602*x2)+2845.36*x2+0.0000115893*power(x2,2)=g=22000;
Gov..   alpha1*(2645.39 + 0.569258*x1- 0.00035951*x2)+alpha2*(2845.36 - 0.464602*x1+ 0.0000161173*x2)
          +gamma*(3657.13 + 0.0730779*x1- 0.000130597*x2)
          +sigma*gamma*(1833.63 + 0.0315779*x1- 0.000212796*x2)=l=10000;
teta..   29.4685+0.430584*x1-0.00000674638*x2=g=0;
t1..     14.6686-0.00000461752*x1-0.000000182503*x2=g=0;
t3..     14.7162-0.000235853*x1-0.00029359*x2=g=0;
p1..     1122.42+0.0420112*x1- 0.0000265486*x2=g=0;
p2..     1107.78-0.0343093*x1-0.0000253528*x2=g=0;
q1..   1673.06 + 0.397012*x1- 0.000250661*x2=g=0;
q2..   972.33 + 0.172246*x1 - 0.000108849*x2=g=0;
q3..   861.301 - 0.140668*x1- 0.000103946*x2=g=0;
q4..   1984.06 - 0.323934*x1+ 0.000120064*x2=g=0;
*e17..   703.746 - 0.0166186 *x1 - 0.25907*x2=g=663.831 - 0.0112083*x1 - 0.500283*x2;
*e18..   696.09 - 0.0112083 *x1- 0.500283*x2=g=663.831 - 0.0112083 *x1 - 0.500283*x2;
model fuzzysecondsen /all/;
option optcr=0,optca=0;
option nlp=conopt;
solve  fuzzysecondsen using nlp maximizing z1;
display z1.l,x1.l,x2.l;
```