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$TITLE: M4-3b.GMS: modeling health insurance
*    with moral hazzard, adverse selection modeled as an MCP
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$ONTEXT
MODELING DEMAND FOR HEALTH INSURANCE
                                                        |---Sick
          |--Do not buy Insurance--choose effort --|
          |                                             |---Healthy
Income---|
+ Type    |                                             |---Sick
          |--   Buy Insurance    --choose effort---|
                                                        |---Healthy
$OFFTEXT
```

PARAMETERS

M0	income in the first time period
MH	income in the second time period when healthy
MS	income in the second time period when sick (before insurance)
ACUF	acutuarially fairness 1 = actuarily fair ACUF < 1 unfair
BETA	needed to make the consumption concave(diminishing returns)
TYPE1	low-risk type: probability of good health at effort = 0
TYPE2	high-risk type: probability of good health at effort = 0
RISKAV	average riskiness at effort = 0
EFFT1	effort of type 1

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 EFFT2    effort of type 2

 PROFIT1  profit from insuring type 1
 PROFIT2  profit from insuring type 2
 PROFIT   profit for insurance company from insuring person 1 and 2;


ACUF=1.0;
BETA = 0.5;
M0 = 10;
MH = 10;
MS = 4;
TYPE1 = 0.5; TYPE2 = 0.5;
RISKAV = ((1-TYPE1)+(1-TYPE2))/2;
*PROFIT = 0;

POSITIVE VARIABLES

 U1        expected utility type 1
 INS1      insurance purchased
 PNS1      payoff from insurance if sick
 ALPHA1    probability of good health
 EFFORT1   effort spent to insure good health: diet exercise and such
 LAMINS1   Lagrangean multiplier on constraint equation INSURANCE1
 LAMEFF1   Lagrangean multiplier on constraint equation MORALHAZ1
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 U2         expected utility type 2
 INS2       insurance purchased
 PNS2       compensation from purchasing insurance if sick
 ALPHA2     probability of good health
 EFFORT2    effort spent to insure good health: diet exercise and such
 LAMINS2    Lagrangean multiplier on constraint equation INSURANCE2
 LAMEFF2    Lagrangean multiplier on constraint equation MORALHAZ2;
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EQUATIONS

```
 UTILITY1    expected utility type 1
 INSURANCE1  the amount of insurance puchased
 MORALHAZ1   good health depends on effort but effort reduces U
 FOCINS1     first-order condition for insurance purchased
 FOCPNS1     first-order condition for payoff when sick
 FOCEFF1     first-order condition for effort1
 FOCALP1     first-order condition for alpha1

 UTILITY2    expected utility type 2
 INSURANCE2  the amount of insurance puchased
 MORALHAZ2   good health depends on effort but effort reduces U
 FOCINS2     first-order condition for insurance purchased
 FOCPNS2     first-order condition for payoff when sick
 FOCEFF2     first-order condition for effort2
 FOCALP2     first-order condition for alpha2;
```

```
UTILITY1..    U1 =E= (M0-INS1)**BETA
                     + ALPHA1*MH**BETA + (1-ALPHA1)*(MS+PNS1)**BETA
                     - 0.06*(EFFORT1 + EFFORT1**2);

INSURANCE1..  INS1*ACUF =E= PNS1*RISKAV;

MORALHAZ1..   TYPE1 + 0.15*EFFORT1 =G= ALPHA1;

FOCINS1..     BETA*(M0-INS1)**(BETA-1) =G= LAMINS1*ACUF;

FOCPNS1..     LAMINS1*RISKAV =G= (1-ALPHA1)*BETA*(MS+PNS1)**(BETA-1);

FOCEFF1..     0.06 + 0.12*EFFORT1 =G= 0.15*LAMEFF1;

FOCALP1..     LAMEFF1 =G= MH**BETA - (MS+PNS1)**BETA;



UTILITY2..    U2 =E= (M0-INS2)**BETA
                     + ALPHA2*MH**BETA + (1-ALPHA2)*(MS+PNS2)**BETA
                     - 0.06*(EFFORT2 + EFFORT2**2);

INSURANCE2..  INS2*ACUF =E= PNS2*RISKAV;
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```
MORALHAZ2..   TYPE2 + 0.15*EFFORT2 =G= ALPHA2;

FOCINS2..     BETA*(M0-INS2)**(BETA-1) =G= LAMINS2*ACUF;

FOCPNS2..     LAMINS2*RISKAV =G= (1-ALPHA2)*BETA*(MS+PNS2)**(BETA-1);

FOCEFF2..     0.06 + 0.12*EFFORT2 =G= 0.15*LAMEFF2;

FOCALP2..     LAMEFF2 =G= MH**BETA - (MS+PNS2)**BETA;


MODEL INSURE /UTILITY1.U1, INSURANCE1.LAMINS1, MORALHAZ1.LAMEFF1
      FOCINS1.INS1, FOCPNS1.PNS1, FOCEFF1.EFFORT1, FOCALP1.ALPHA1
      UTILITY2.U2, INSURANCE2.LAMINS2, MORALHAZ2.LAMEFF2
      FOCINS2.INS2, FOCPNS2.PNS2, FOCEFF2.EFFORT2, FOCALP2.ALPHA2/;

U1.L = 1;
INS1.L =2;
PNS1.L = 4;
ALPHA1.L = 0.5;
EFFORT1.L = 0;
U2.L = 1;
INS2.L =2;
PNS2.L = 4;
ALPHA2.L = 0.5;
EFFORT2.L = 0;
```

```
SOLVE INSURE USING MCP;

PROFIT1 = INS1.L - (1 - ALPHA1.L)*PNS1.L;
PROFIT2 = INS2.L - (1 - ALPHA2.L)*PNS2.L;
PROFIT = PROFIT1 + PROFIT2;
EFFT1 = EFFORT1.L;
EFFT2 = EFFORT2.L;
DISPLAY TYPE1, TYPE2, EFFT1, EFFT2, PROFIT1, PROFIT2, PROFIT;

* counterfactual: two risk types

TYPE1 = 0.55;
TYPE2 = 0.45;
RISKAV = ((1-TYPE1)+(1-TYPE2))/2;

SOLVE INSURE USING MCP;

PROFIT1 = INS1.L - (1 - ALPHA1.L)*PNS1.L;
PROFIT2 = INS2.L - (1 - ALPHA2.L)*PNS2.L;
PROFIT = PROFIT1 + PROFIT2;
EFFT1 = EFFORT1.L;
EFFT2 = EFFORT2.L;
DISPLAY TYPE1, TYPE2, EFFT1, EFFT2, PROFIT1, PROFIT2, PROFIT;
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* can the insurance companies make money by offering actuarily
* unfair insurance?

ACUF = 0.9;

SOLVE INSURE USING MCP;

PROFIT1 = INS1.L - (1 - ALPHA1.L)*PNS1.L;
PROFIT2 = INS2.L - (1 - ALPHA2.L)*PNS2.L;
PROFIT = PROFIT1 + PROFIT2;
EFFT1 = EFFORT1.L;
EFFT2 = EFFORT2.L;
DISPLAY TYPE1, TYPE2, EFFT1, EFFT2, PROFIT1, PROFIT2, PROFIT;
```