$TITLE: M4-3b.GMS: modeling health insurance
* with moral hazard, adverse selection modeled as an MCP
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$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   actuarially fairness  1 = actuarially 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
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
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;

EQUATIONS

UTILITY1 expected utility type 1
INSURANCE1 the amount of insurance purchased
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
FOCALK1 first-order condition for alpha1

UTILITY2 expected utility type 2
INSURANCE2 the amount of insurance purchased
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
FOCALK2 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;
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;
* can the insurance companies make money by offering actuarially 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;