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*****
*   PROGRAM TO CONSTRUCT MONTE CARLO DATA FOR DP MODEL   *
*****
*   TUITION COST INCLUDED                                   *
*****
*   VERSION WITH LAGGED SCHOOL AS STATE VARIABLE           *
*****

      INTEGER KSTATE(40,14000,4)
      INTEGER FSTATE(40,40,40,11,2)
      INTEGER KMAX(40)
      DIMENSION EMAX(40,14000),EMAX1(40,14000)
      DIMENSION BETA(2,6),A(4,4),RHO(4,4)
      DIMENSION SIGMA(4)
      DIMENSION EU1(5000,40),EU2(5000,40),C(5000,40),B(5000,40)
      DIMENSION RNN(4)
      DIMENSION PROB(40,4)
      DIMENSION PROB1(40,4)
      INTEGER X1,X2,E,T
      READ(9,1500) NPER,NPOP,DRAW,DRAW1,TAU
      WRITE(10,1500) NPER,NPOP,DRAW,DRAW1,TAU
1500  FORMAT(1X,i3,1X,i5,1X,f7.0,1X,f6.0,1X,f6.2)
C     GAMA= 0.577
      WNA=-9.99
      do 1 J=1,2
        READ(9,1501) (BETA(J,k),k=1,6)
        WRITE(10,1501) (BETA(J,k),k=1,6)
1501  FORMAT(6(1X,f10.6))
      1 continue
        READ(9,1502) CBAR1,CBAR2,CS,VHOME,DELTA
        WRITE(10,1502) CBAR1,CBAR2,CS,VHOME,DELTA
1502  FORMAT(5(1X,f10.5))
      do 2 J=1,4
        READ(9,1503) (RHO(J,K),K=1,J)
        WRITE(10,1503) (RHO(J,K),K=1,J)
1503  FORMAT(4(1X,f10.5))
      2 continue
        READ(9,1503) (SIGMA(J),J=1,4)
        WRITE(10,1503) (SIGMA(J),J=1,4)
*****
*   TRANSFORMATIONS   *
*****

      CBAR1 = CBAR1*1000.00
      CBAR2 = CBAR2*1000.00
      CS    = CS    *1000.00
      VHOME = VHOME*1000.00
      DO 1007 J=3,4
        SIGMA(J) = SIGMA(J)*1000.0
1007  CONTINUE
*****
*   TAKE THE CHOLESKY DECOMPOSITION OF RHO AND PUT IN A   *
*****

      DO 3 J=2,4
        DO 4 K=1,J-1
          RHO(K,J) = RHO(J,K)
4     CONTINUE
3     CONTINUE
      CALL LFCDS(4,RHO,4,A,4,COND)
      DO 5 J=2,4
        DO 6 K=1,J-1

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        A(J,K) = A(K,J)
6  CONTINUE
5  CONTINUE
    DO 7 J=1,4
        WRITE(10,1503) (RHO(J,K),K=1,4)
7  CONTINUE
    DO 8 J=1,4
        DO 1008 K=1,4
            A(J,K)=A(J,K)*SIGMA(J)
1008  CONTINUE
        WRITE(10,1503) (A(J,K),K=1,4)
8  CONTINUE
*****
*   CREATE THE STATE INDEX   *
*****
    DO 10 T=1,NPER
        K=0
        DO 20 E=10,20
            IF(E.GT.10+T-1) GOTO 20
        DO 21 X1=0,T-1
        DO 22 X2=0,T-1
            IF(X1+X2+E-10.LT.T) THEN
                DO 23 LS=0,1
                    IF((LS.eq.0).and.((E-T).eq.9)) goto 23
                    IF((LS.eq.1).and.(E.eq.10).and.(T.gt.1)) goto 23
                    K=K+1
                    KSTATE(T,K,1)=X1
                    KSTATE(T,K,2)=X2
                    KSTATE(T,K,3)=E
                    KSTATE(T,K,4)=LS
                    FSTATE(T,X1+1,X2+1,E-9,LS+1)=K
23                CONTINUE
            ENDIF
        22 CONTINUE
        21 CONTINUE
        20 CONTINUE
        KMAX(T)=K
10  CONTINUE
    do 24 t=1,nper
        write(10,2001) t,kmax(t)
2001  format(' t=',i2,' kmax(t)=' ,i6)
    24 continue
*****
*   DRAW RANDOM VARIABLES   *
*****
    CALL RNSET(1111111111)
C    DO 30 T=1,NPER
        DO 31 J=1,DRAW
            DO 30 T=1,NPER
                CALL RNNOR(4,RNN)
                EU1(J,T) = exp(A(1,1)*RNN(1))
                EU2(J,T) = exp(A(2,1)*RNN(1)+A(2,2)*RNN(2))
                C(J,T)   = A(3,1)*RNN(1)+A(3,2)*RNN(2)+A(3,3)*RNN(3)
                B(J,T)   = A(4,1)*RNN(1)+A(4,2)*RNN(2)+A(4,3)*RNN(3)
                *         +A(4,4)*RNN(4)
30  CONTINUE
31  CONTINUE
C 30 CONTINUE
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*   CONSTRUCT THE EXPECTED MAX OF THE TIME NPER VALUE FUNCTIONS   *
*****
      DO 40 K=1,KMAX(NPER)
        EMAX(NPER,K)=0.
C      EMAX1(NPER,K)=0.
40 CONTINUE
      DO 41 K=1,KMAX(NPER)
        X1=KSTATE(NPER,K,1)
        X2=KSTATE(NPER,K,2)
        E=KSTATE(NPER,K,3)
        LS=KSTATE(NPER,K,4)
        W1=exp(BETA(1,1)+BETA(1,2)*E+BETA(1,3)*X1+BETA(1,4)*X1**2
*          +BETA(1,5)*X2+BETA(1,6)*X2**2)
        W2=exp(BETA(2,1)+BETA(2,2)*E+BETA(2,3)*X1+BETA(2,4)*X1**2
*          +BETA(2,5)*X2+BETA(2,6)*X2**2)
        IF(E.GE.12) THEN
          CBAR = CBAR1 - CBAR2
        ELSE
          CBAR = CBAR1
        ENDIF
        IF(LS.eq.0) CBAR = CBAR - CS
      DO 42 J=1,DRAW
        V1 = W1*EU1(J,NPER)
        V2 = W2*EU2(J,NPER)
        IF(E.LE.19) THEN
          V3 = CBAR+C(J,NPER)
        ELSE
          V3 = CBAR - 40000.0
        ENDIF
        V4 = VHOME+B(J,NPER)
C      write(10,2002) j,eu1(nper,j),eu2(nper,j),c(nper,j)
C 2002 format(' j=',i2,' eu1=',f10.3,' eu2=',f10.3,' c=',f10.3)
C      SUMV=EXP((V1-VMAX)/TAU)+EXP((V2-VMAX)/TAU)
C      *      +EXP((V3-VMAX)/TAU)+EXP((V4-VMAX)/TAU)
        VMAX=AMAX1(V1,V2,V3,V4)
        EMAX(NPER,K)=EMAX(NPER,K)+VMAX
C      EMAX1(NPER,K)=EMAX1(NPER,K)
C      *      +TAU*(GAMA+LOG(SUMV)+VMAX/TAU)
42 CONTINUE
      EMAX(NPER,K) = EMAX(NPER,K)/DRAW
41 CONTINUE
*****
*   CONSTRUCT THE EXPECTED MAX OF THE VALUE FUNCTIONS FOR   *
*   PERIODS 2 THROUGH NPER-1   *
*****
      DO 50 S=1,NPER-2
        T=NPER-S
      DO 51 K=1,KMAX(T)
        EMAX(T,K)=0.
C      EMAX1(T,K)=0.
51 CONTINUE
      DO 52 K=1,KMAX(T)
        X1=KSTATE(T,K,1)
        X2=KSTATE(T,K,2)
        E=KSTATE(T,K,3)
        LS=KSTATE(T,K,4)
        W1=exp(BETA(1,1)+BETA(1,2)*E+BETA(1,3)*X1+BETA(1,4)*X1**2
*          +BETA(1,5)*X2+BETA(1,6)*X2**2)
        W2=exp(BETA(2,1)+BETA(2,2)*E+BETA(2,3)*X1+BETA(2,4)*X1**2

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*      +BETA(2,5)*X2+BETA(2,6)*X2**2)
IF(E.GE.12) THEN
  CBAR = CBAR1 - CBAR2
ELSE
  CBAR = CBAR1
ENDIF
IF(LS.eq.0) CBAR = CBAR - CS
DO 53 J=1,DRAW
  V1=W1*EU1(J,T)      + DELTA*EMAX(T+1,FSTATE(T+1,X1+2,X2+1,E-9,1))
  V2=W2*EU2(J,T)      + DELTA*EMAX(T+1,FSTATE(T+1,X1+1,X2+2,E-9,1))
  IF(E.LE.19) then
    V3=CBAR+C(J,T)    + DELTA*EMAX(T+1,FSTATE(T+1,X1+1,X2+1,E-8,2))
  else
    V3=CBAR - 40000.0
  ENDIF
  V4=VHOME+B(J,T)      + DELTA*EMAX(T+1,FSTATE(T+1,X1+1,X2+1,E-9,1))
C      SUMV=EXP((V1-VMAX)/TAU)+EXP((V2-VMAX)/TAU)
C      *      +EXP((V3-VMAX)/TAU)+EXP((V4-VMAX)/TAU)
  VMAX=AMAX1(V1,V2,V3,V4)
  EMAX(T,K)=EMAX(T,K)+VMAX
C      EMAX1(T,k)=EMAX1(T,K)
C      *      +TAU*(GAMA+LOG(SUMV+VMAX/TAU))
53 CONTINUE
  EMAX(T,K) = EMAX(T,K)/DRAW
52 CONTINUE
50 CONTINUE
C      DO 54 T=2,NPER
C      DO 55 K=1,KMAX(T)
C          WRITE(10,2000) T,K,KSTATE(T,K,1),KSTATE(T,K,2),
C          *      KSTATE(T,K,3),EMAX(T,K)
C 2000    FORMAT(' T=',I2,' K=',I4,' X1=',I2,' X2=',I2,
C          *      ' E=',I2,' EMAX=',F16.3)
C      55 CONTINUE
C      54 CONTINUE
C      GOTO 999
*****
*      CONSTRUCT MONTE-CARLO DATA FOR PERIODS 1 THROUGH NPER      *
*****
      do 58 t=1,nper
      do 59 j=1,4
        prob(t,j)=0.0
        prob1(t,j)=0.0
59 continue
58 continue
      wealth = 0.0
      DO 60 L=1,NPOP
        X1=0
        X2=0
        E=10
        LS1=1
      DO 61 T=1,NPER-1
        LS = LS1
        W1=exp(BETA(1,1)+BETA(1,2)*E+BETA(1,3)*X1+BETA(1,4)*X1**2
        *      +BETA(1,5)*X2+BETA(1,6)*X2**2)
        W2=exp(BETA(2,1)+BETA(2,2)*E+BETA(2,3)*X1+BETA(2,4)*X1**2
        *      +BETA(2,5)*X2+BETA(2,6)*X2**2)
        WAGE1=W1*EU1(L,T)
        WAGE2=W2*EU2(L,T)
        V1=WAGE1 + DELTA*EMAX(T+1,FSTATE(T+1,X1+2,X2+1,E-9,1))

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V2=WAGE2 + DELTA*EMAX(T+1,FSTATE(T+1,X1+1,X2+2,E-9,1))
IF(E.GE.12) THEN
  CBAR = CBAR1 - CBAR2
ELSE
  CBAR = CBAR1
ENDIF
IF(LS.eq.0) CBAR = CBAR - CS
IF(E.LE.19) then
  V3=CBAR+C(L,T) + DELTA*EMAX(T+1,FSTATE(T+1,X1+1,X2+1,E-8,2))
  WAGE3=CBAR+C(L,T)
ELSE
  V3=CBAR - 40000.0
  WAGE3=CBAR-40000.0
ENDIF
V4=VHOME+B(L,T) + DELTA*EMAX(T+1,FSTATE(T+1,X1+1,X2+1,E-9,1))
WAGE4=VHOME+B(L,T)
VMAX=AMAX1(V1,V2,V3,V4)
SUMV=EXP((V1-VMAX)/TAU)+EXP((V2-VMAX)/TAU)
*   +EXP((V3-VMAX)/TAU)+EXP((V4-VMAX)/TAU)
prob(t,1)=prob(t,1)+( EXP((v1-vmax)/tau) /sumv ) /npop
prob(t,2)=prob(t,2)+( EXP((v2-vmax)/tau) /sumv ) /npop
prob(t,3)=prob(t,3)+( EXP((v3-vmax)/tau) /sumv ) /npop
prob(t,4)=prob(t,4)+( EXP((v4-vmax)/tau) /sumv ) /npop
IF (VMAX .EQ. V1) THEN
  K=1
  LS1=0
ENDIF
IF (VMAX .EQ. V2) THEN
  K=2
  LS1=0
ENDIF
IF (VMAX .EQ. V3) THEN
  K=3
  LS1=1
ENDIF
IF (VMAX .EQ. V4) THEN
  K=4
  LS1=0
ENDIF
prob1(t,k)=prob1(t,k)+1.0/npop
IF(K.EQ.1) THEN
  WRITE(11,1000) L,NPER,K,WAGE1,X1,X2,E,LS
  X1=X1+1
  wealth = wealth + WAGE1*(DELTA**T)
ENDIF
IF(K.EQ.2) THEN
  WRITE(11,1000) L,NPER,K,WAGE2,X1,X2,E,LS
  X2=X2+1
  wealth = wealth + WAGE2*(DELTA**T)
ENDIF
IF(K.EQ.3) THEN
  WRITE(11,1000) L,NPER,K,WAGE3,X1,X2,E,LS
  E=E+1
  wealth = wealth + WAGE3*(DELTA**T)
ENDIF
IF(K.EQ.4) THEN
  WRITE(11,1000) L,NPER,K,WAGE4,X1,X2,E,LS
  wealth = wealth + WAGE4*(DELTA**T)
ENDIF

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61 CONTINUE
  T = NPER
  LS = LS1
  W1=exp(BETA(1,1)+BETA(1,2)*E+BETA(1,3)*X1+BETA(1,4)*X1**2
*   +BETA(1,5)*X2+BETA(1,6)*X2**2)
  W2=exp(BETA(2,1)+BETA(2,2)*E+BETA(2,3)*X1+BETA(2,4)*X1**2
*   +BETA(2,5)*X2+BETA(2,6)*X2**2)
  V1=W1*EU1(L,T)
  V2=W2*EU2(L,T)
  IF(E.GE.12) THEN
    CBAR = CBAR1 - CBAR2
  ELSE
    CBAR = CBAR1
  ENDIF
  IF(LS.EQ.0) CBAR = CBAR - CS
  IF(E.LE.19) then
    V3=CBAR+C(L,T)
  ELSE
    V3=CBAR - 40000.0
  ENDIF
  V4=VHOME+B(L,T)
  VMAX=AMAX1(V1,V2,V3,V4)
  SUMV=EXP((V1-VMAX)/TAU)+EXP((V2-VMAX)/TAU)
*   +EXP((V3-VMAX)/TAU)+EXP((V4-VMAX)/TAU)
  prob(t,1)=prob(t,1)+( EXP((v1-vmax)/tau) /sumv ) /npop
  prob(t,2)=prob(t,2)+( EXP((v2-vmax)/tau) /sumv ) /npop
  prob(t,3)=prob(t,3)+( EXP((v3-vmax)/tau) /sumv ) /npop
  prob(t,4)=prob(t,4)+( EXP((v4-vmax)/tau) /sumv ) /npop
  IF (VMAX .EQ. V1) THEN
    K=1
  ENDIF
  IF (VMAX .EQ. V2) THEN
    K=2
  ENDIF
  IF (VMAX .EQ. V3) THEN
    K=3
  ENDIF
  IF (VMAX .EQ. V4) THEN
    K=4
  ENDIF
  prob1(t,k)=prob1(t,k)+1.0/npop
  IF(K.EQ.1) THEN
    WRITE(11,1000) L,NPER,K,V1,X1,X2,E,LS
    wealth = wealth + WAGE1*(DELTA**T)
  ENDIF
  IF(K.EQ.2) THEN
    WRITE(11,1000) L,NPER,K,V2,X1,X2,E,LS
    wealth = wealth + WAGE2*(DELTA**T)
  ENDIF
  IF(K.EQ.3) THEN
    WRITE(11,1000) L,NPER,K,V3,X1,X2,E,LS
    wealth = wealth + WAGE3*(DELTA**T)
  ENDIF
  IF(K.EQ.4) THEN
    WRITE(11,1000) L,NPER,K,V4,X1,X2,E,LS
    wealth = wealth + WAGE4*(DELTA**T)
  ENDIF
60 CONTINUE
  wealth = wealth/npop

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        write(10,1060) wealth
1060 format(' discounted wealth = ',f16.2)
        do 70 t=1,nper
            write(10,3000) t,(prob(t,j),j=1,4)
3000    format(' t=',i3,' prob=',4f16.12)
        70 continue
        do 71 t=1,nper
            write(10,3001) t,(prob1(t,j),j=1,4)
3001    format(' t=',i3,' prob1=',4f16.12)
        71 continue
1000 FORMAT(1X,I5,1X,I3,1X,I1,1X,F10.2,4(1X,I3))
C 999 CONTINUE
        STOP
        END

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