CAL(Computer Assisted Learning) in Economics programs for Windows95/98

USER GUIDE *)

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URL: http://www.res.otaru-uc.ac.jp/~uzawa/welcome.html
URL: http://www.res.otaru-uc.ac.jp/~uzawa/cal-ee.html

Ver. 1.00	August	23,	1988
Ver. 1.10	May	21,	1992
Ver. 1.15	August	18,	1992
Ver. 1.20	April	26,	1997
Ver. 1.25	October	17,	1998
Ver. 1.26	December	12,	1998
Ver. 1.27	December	16,	1998
Ver. 1.28	March	18,	1999
Ver. 1.29b	February	6,	2000
Ver. 1.29	February	19,	2000

Chapter 0   Getting started

Downloading and Installation of CAL(Computer Assisted Learning) in Economics Programs for Windows95/98

0. Please switch on your IBM PC/AT computer or DOS/V compatible machine and start Windows95/98 on.

1.   You have to access Uzawa's Internet Win-Econ page for downloading my CAL(Computer Assisted Learning) in Economics Programs for Windows95/98. You can use Internet Explorer or Netscape Navigator as Internet browser. The internet address is as follows:
URL: http://www.res.otaru-uc.ac.jp/~uzawa/cal-economics/cal-ee.html

2.   You can see the following page and download the win-econ.zip file from my page by clicking the red colored and underlined part of *[2281KB] WinZip file of CAL in Economics Programs for Windows95/98 is here.*
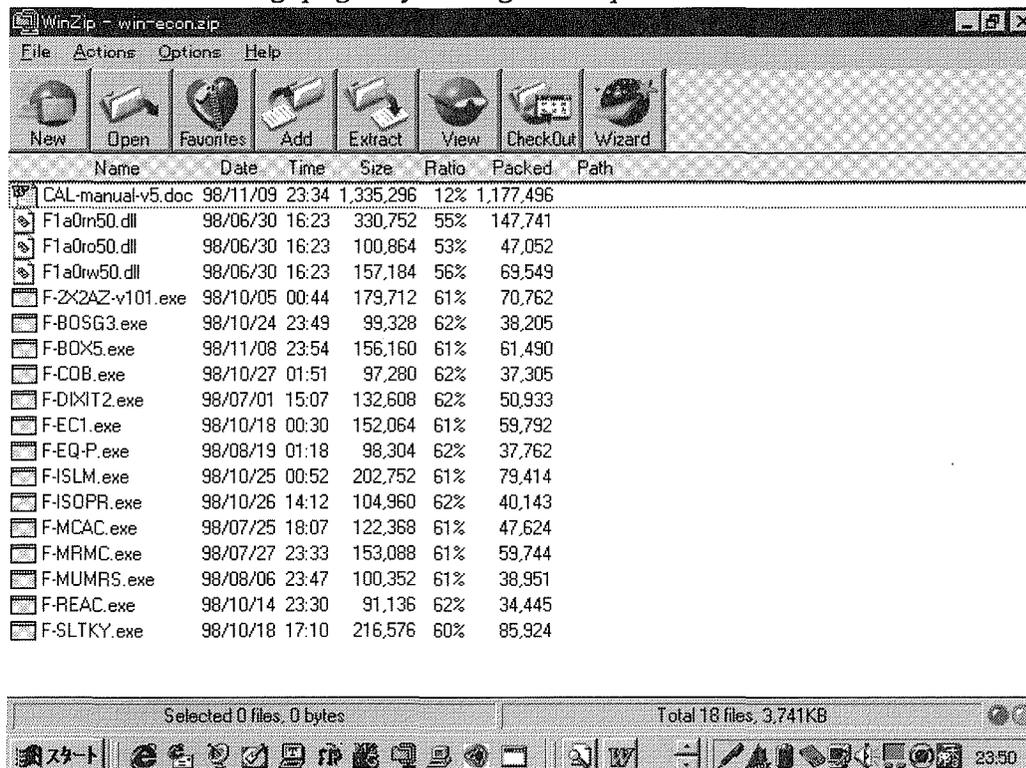*You can download my CAL in Economics Programs into your favorite holder.*
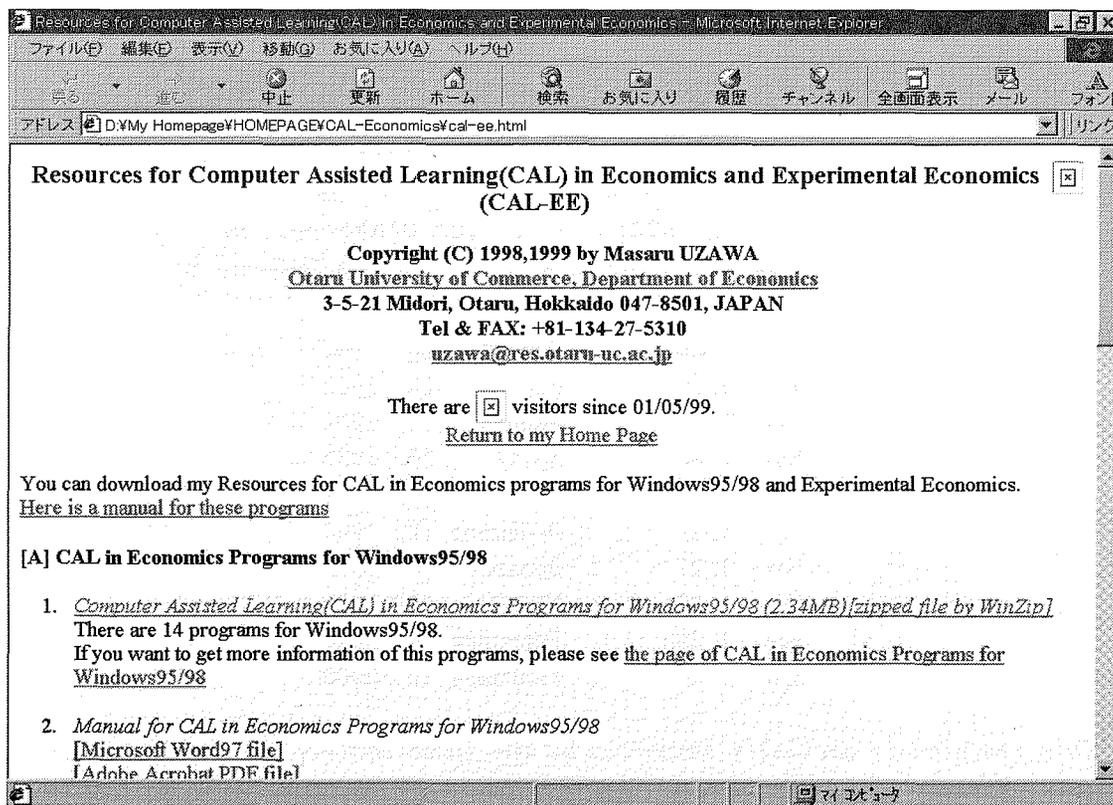
(Because I use Japanese version of Windows95/98, some of expression are Japanese. Please do not care about Japanese.)

*3.   Please decompress(Extract for WinZip) the win-econ.zip into your*

favorite holder,   say, [F-econ exe] by using WinZip(ShareWare) or the like.
See the following page by using WinZip.

Name	Date	Time	Size	Ratio	Packed	Path
CAL-manual-v5.doc	98/11/09	23:34	1,335,296	12%	1,177,496	
F1a0m50.dll	98/06/30	16:23	330,752	55%	147,741	
F1a0ro50.dll	98/06/30	16:23	100,864	53%	47,052	
F1a0rw50.dll	98/06/30	16:23	157,184	56%	69,549	
F-2X2AZ-v101.exe	98/10/05	00:44	179,712	61%	70,762	
F-BOSG3.exe	98/10/24	23:49	99,328	62%	38,205	
F-BOX5.exe	98/11/08	23:54	156,160	61%	61,490	
F-COB.exe	98/10/27	01:51	97,280	62%	37,305	
F-DIXIT2.exe	98/07/01	15:07	132,608	62%	50,933	
F-EC1.exe	98/10/18	00:30	152,064	61%	59,792	
F-EQ-P.exe	98/08/19	01:18	98,304	62%	37,762	
F-ISLM.exe	98/10/25	00:52	202,752	61%	79,414	
F-ISOPR.exe	98/10/26	14:12	104,960	62%	40,143	
F-MCAC.exe	98/07/25	18:07	122,368	61%	47,624	
F-MRMC.exe	98/07/27	23:33	153,088	61%	59,744	
F-MUMRS.exe	98/08/06	23:47	100,352	61%	38,951	
F-REAC.exe	98/10/14	23:30	91,136	62%	34,445	
F-SLTKY.exe	98/10/18	17:10	216,576	60%	85,924	

Selected 0 files, 0 bytes   Total 18 files, 3,741KB

4. To start my CAL in Economics programs, please click [Start(S)] button,[Program(P)] button ,and program name [MS(Microsoft) Explorer].

5. You can enter in the Windows screen of Microsoft Explorer and choose Drive and holder, say, [F-econ exe] that contains CAL in Economics Programs for Windows95/98 which you chose.

6.   You can find the file names in the Windows screen of Microsoft Explorer as follows.
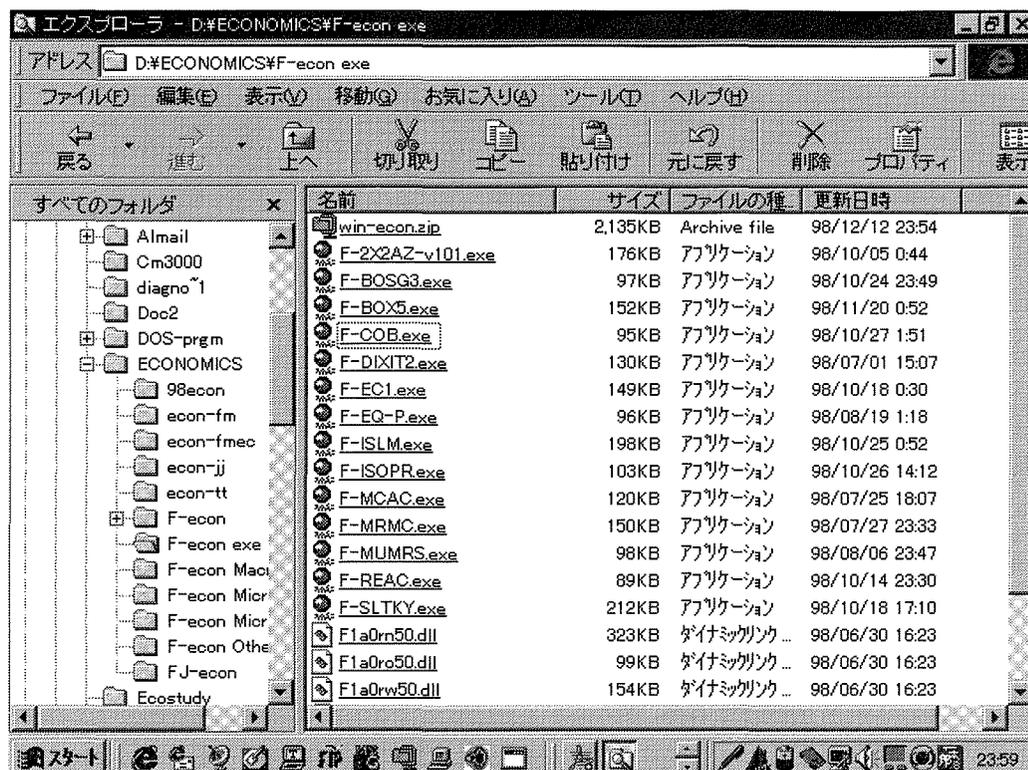
*If you want to use F-EC1.exe(*consumer equilibrium(income-consumption curve, price-consumption curve and demand curve)*, then please click or double click the name of F-EC1.exe.*

Then the program will start quickly.

7. If you wish to exit of or restart of CAL in Economics program, you must only come back the MS Explorer Windows in step 4.
This can be done if you can choose "0"(zero) which defines "exit" in any program you have exerted.

I hope you can succeed in exerting my CAL in Economics programs for Windows95/98 on your computer. You may use them for Windows2000.
If you have any questions or comments, please do not hesitate to ask me by E-mail.
My E-mail address is as follows:
                    uzawa@res.otaru-uc.ac.jp

Menu of the CAL in Economics programs for Windows95/98

There are 14 programs in CAL in Economics programs.
For your convenience, I list here all names of the CAL programs and their headlines.

F-MUMRS.exe   diminishing marginal utility and marginal rate of substitution
F-EC1.exe   income-consumption , price-consumption, and demand curves
F-SLTKY.exe   Slutsky's decomposition

F-MCAC.exe   MC, AC, and supply curve
F-MRMC.exe   monopoly equilibrium(MR=MC)

F-EQ-P.exe   groping process for the equilibrium price
F-COB.exe   cobweb theory

F-REAC.exe   Cournot's equilibrium
F-BOX5.exe   Pareto efficiency in the Edgeworth's box diagram
F-2X2AZ-v101.exe   equilibrium and Pareto efficient allocation in 2x2 exchange
              economy
F-MULT.exe   multiplier theory in income determination [No exe file]
F-ISLM.exe   IS-LM analysis
F-INVST.exe   marginal efficiency of investment [No exe file]
F-MONY.exe   money creation process [No exe file]

F-DIXIT2.exe Entry Deterrence due to Prof. Dixit(1979)
F-ISOPR.exe   Cournot equilibrium, Stackelberg equilibrium and iso-profit
              curves
F-BOSG3.exe   Attainable set for the two person game including the battle-
              of-the-sexes game

Summary Contents of CAL in Economics programs for Windows95/98

Chapter 1 *Marginal Utility and Marginal Rate of Substitution*
\<F-MUMRS.exe\>

This program shows you the diminishing law of marginal utility and diminishing law of marginal rate of substitution.

   The utility function is a CES type.   When you choose parameters for the utility function, you can see the indifference curves to be described.   The level of the utility are displayed on the screen.
   So you can confirm that both the marginal utility and the marginal rate of substitution are decreasing according to increase of good 1.
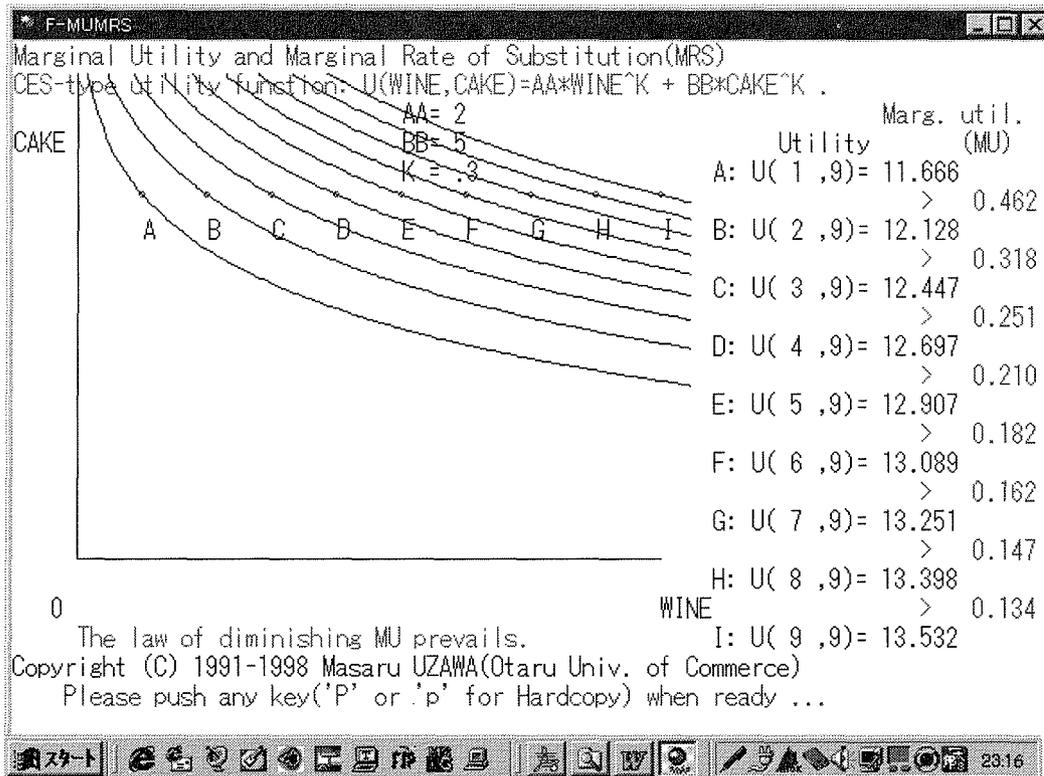Please see Figures 1.1 & 1.2 as follows:

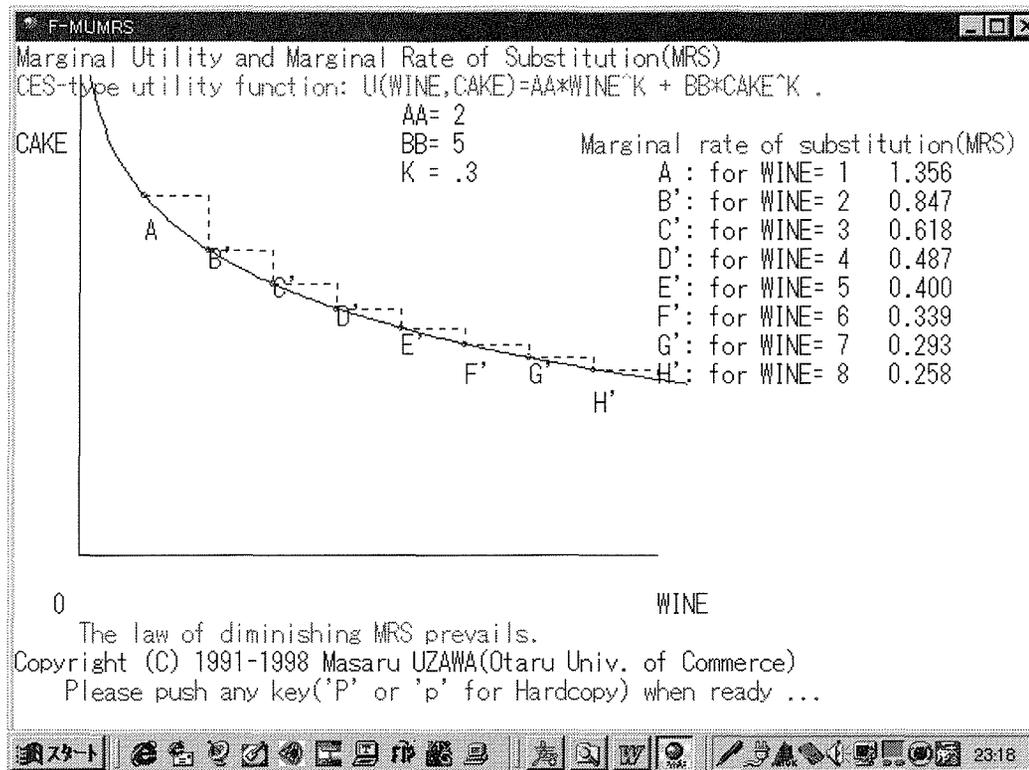Figure 1.1 The law of diminishing marginal utility(MU) prevails.

Figure 1.2 The law of diminishing marginal rate of substitution(MRS) prevails.

Collection of graphs will be gathered in another brochure for your reference.
You can see the same type of graphics on the screen step by step.

Chapter 2 *Income-consumption curve, price-consumption curve and demand curve* <F-EC1.exe>

This program is the IBM version 1.00 which has been written by M. UZAWA (Otaru Univ. of Commerce). (Cobb-Douglas case was partly programmed by Takashi SUZUKI who was a former student in my seminar).
It was revised and enlarged by M. UZAWA on July 6, 1988 for NEC's PC9800 series).
This version is for Windows95/98 transferred by M. UZAWA.

Consumer equilibrium points are displayed on the screen for the following 3 cases:
1. income-consumption curve,
2. price-consumption curve (Offer curve), and
3. demand curve.

You can choose one of the following **four** type of utility functions:

1. Cobb-Douglas case $u(x,y) = x^A * y^B$

2. Giffen's good case $u(x,y) = (x - A)/(B - y)^2$

3. CES case $u(x,y) = A*x^K + B*y^K$
   (Constant Elasticity of Substitution)

4. Rational function case $u(x,y) = x*y/(x*y + A*x + B*y)$

If you choose a number (1, 2, 3 or 4), then program lets you enter values of parameters of the utility function.

In the first phase, you can see the income-consumption curve.

In the case of Giffen good case, the income-consumption curve is downward sloping (inferior good case), while in cases of Cobb-Douglas, CES and Rational function, each income-consumption curve is upward sloping (normal or superior good case).
Please see Figures 2.1.1 - 2.1.4.
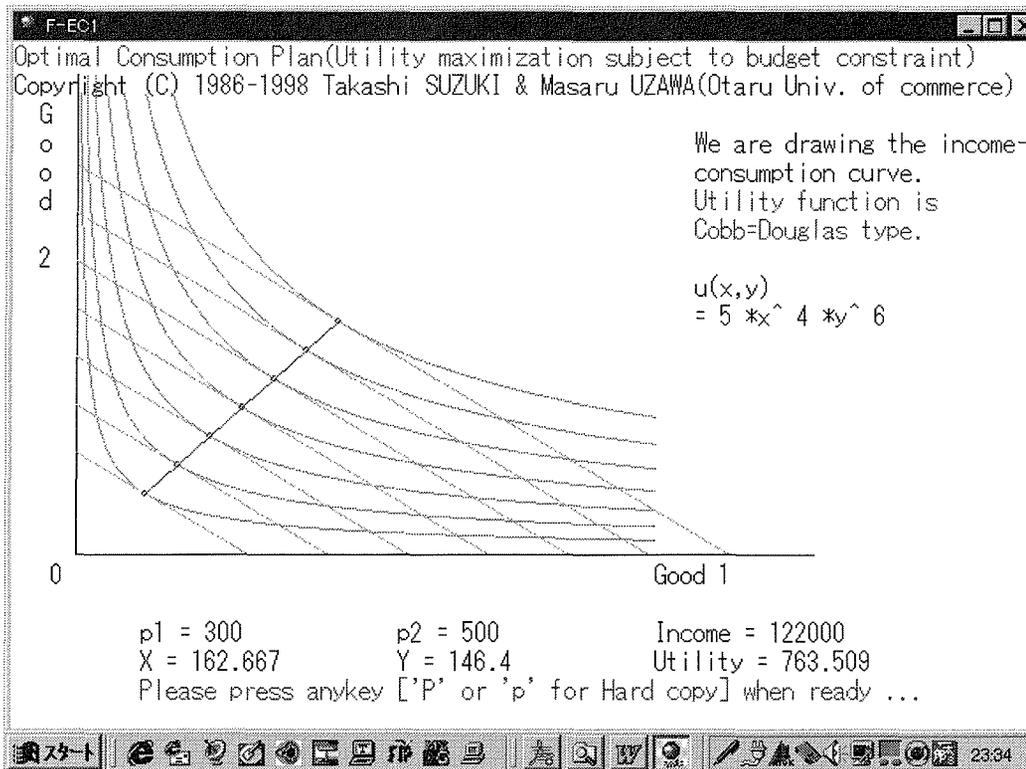
Figure 2.1.1 Income-consumption curve for Cobb=Douglas type of utility function.

Figure 2.1.2 Income-consumption curve for Giffen good's type of utility function
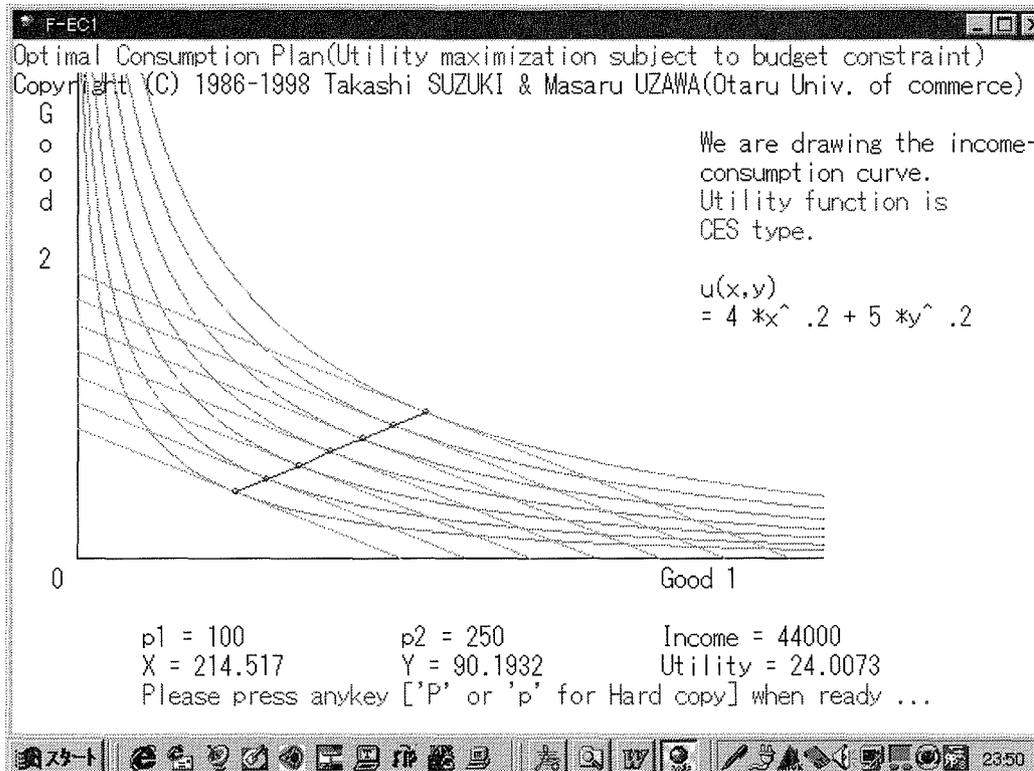
Figure 2.1.3   Income-consumption curve for CES type of utility function.
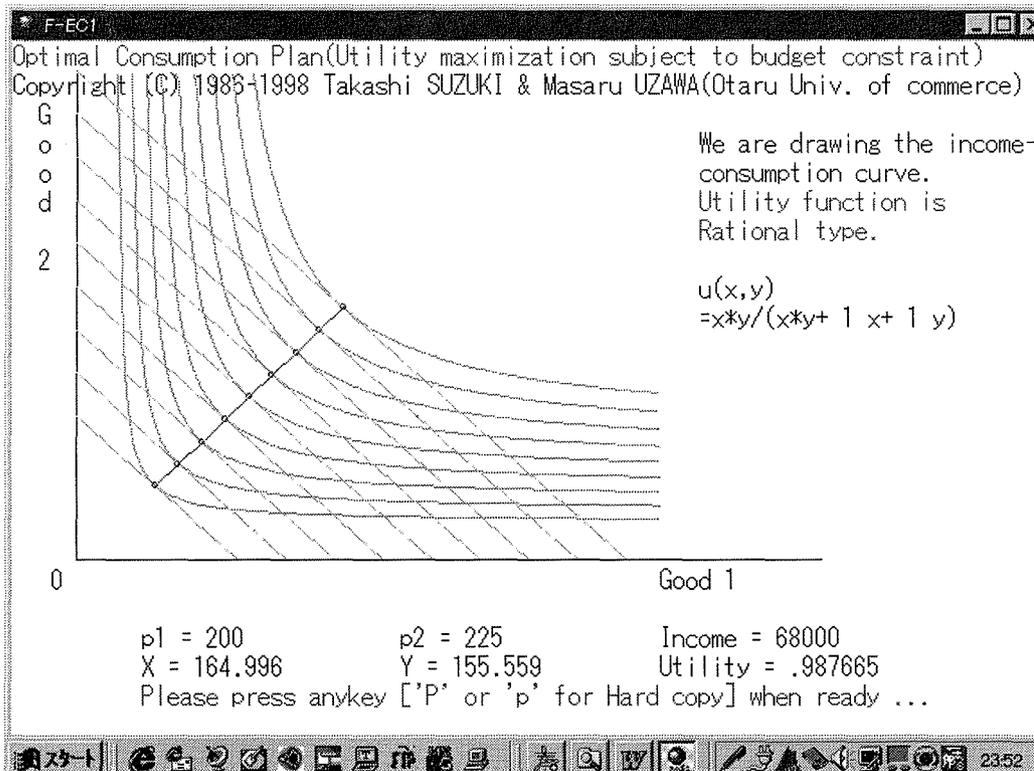
Figure 2.1.4   Income-consumption curve for Rational type of utility function.

In the second phase, you can see the price-consumption curve, namely, offer curve.

In the case of Cobb-Douglas, the equilibrium points are horizontal line. In the case of Giffen, notice that the price-consumption curve is rightward down-sloping when price of good 1 increases. Namely, when the price rises, then the demand for good increases ! In the case of CES, the offer curve is leftward down-sloping, while in the case of Rational function, the offer curve is leftward up-sloping. *Please see Figures 2.2.1 - 2.2.4.*
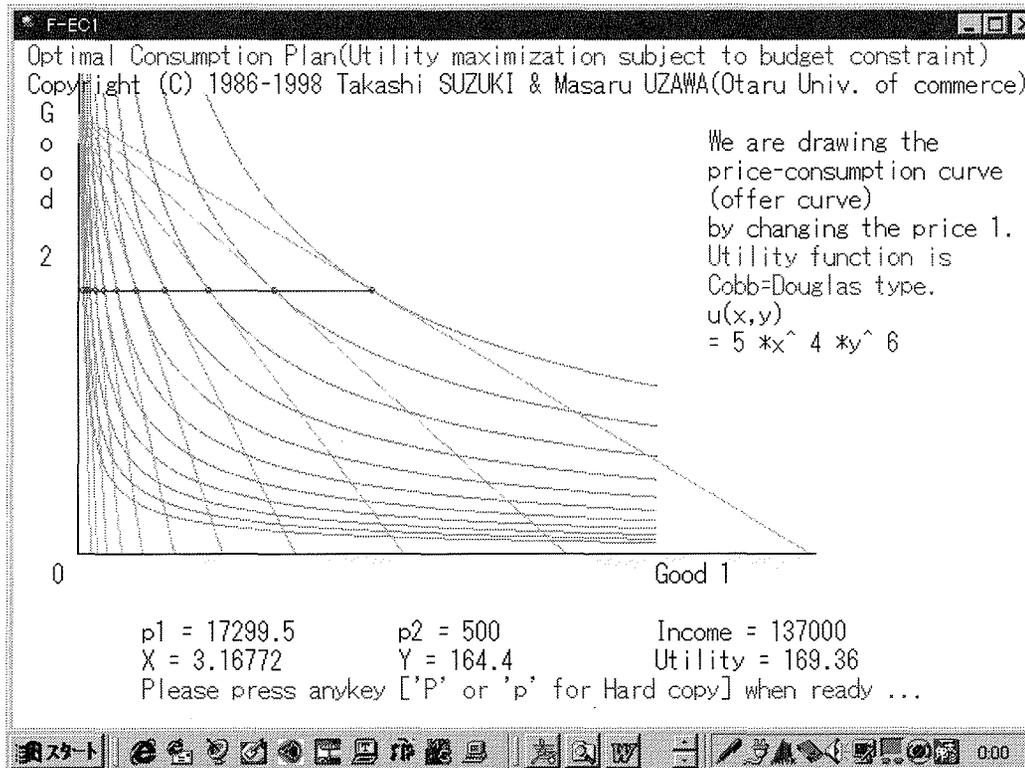
Figure 2.2.1 Price-consumption curve for Cobb=Douglas type of utility function.

```
F-EC1                                                              _□×
Optimal Consumption Plan(Utility maximization subject to budget constraint)
Copyright (C) 1986-1998 Takashi SUZUKI & Masaru UZAWA(Otaru Univ. of commerce)
G
o                                                    We are drawing the
o                                                    price-consumption curve
d                                                    (offer curve)
                                                     by changing the price 1.
2                                                    Utility function is
60                                                   Giffen good type.
                                                     u(x,y)
                                                     =(x- 40 )/(y- 60 )^2


0                                               Good 1
     p1 = 442.609      p2 = 306.333      Income = 27374
     X = 59.6796       Y = 3.13141       Utility = 6.08515E-03
     Please press anykey ['P' or 'p' for Hard copy] when ready ...
```
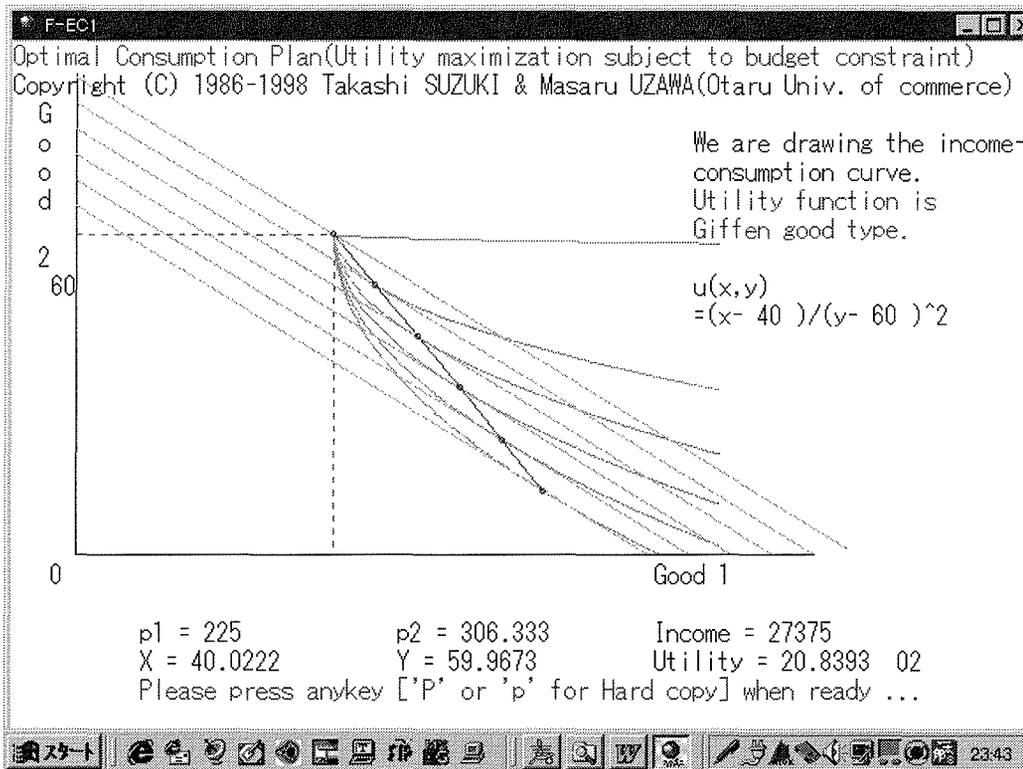
Figure 2.2.2   Price-consumption curve for Giffen good's type of utility function.


```
F-EC1                                                              _□×
Optimal Consumption Plan(Utility maximization subject to budget constraint)
Copyright (C) 1986-1998 Takashi SUZUKI & Masaru UZAWA(Otaru Univ. of commerce)
G
o                                                    We are drawing the
o                                                    price-consumption curve
d                                                    (offer curve)
                                                     by changing the price 1.
2                                                    Utility function is
                                                     CES type.
                                                     u(x,y)
                                                     = 4 *x^ .2 + 5 *y^ .2


0                                               Good 1
     p1 = 2329.81      p2 = 250         Income = 48000
     X = 6.22563       Y = 133.982      Utility = 19.0825
     Please press anykey ['P' or 'p' for Hard copy] when ready ...
```
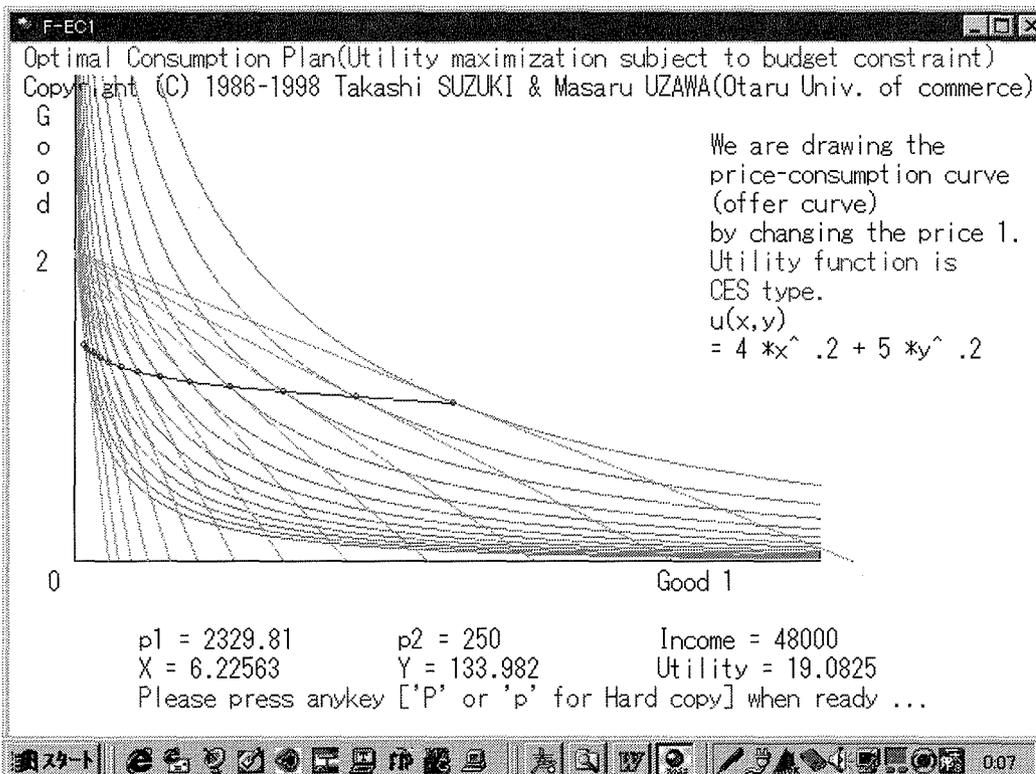
Figure 2.2.3   Price-consumption curve for CES type of utility function.

```
┌─────────────────────────────────────────────────────────────────────┐
│ F-EC1                                                       _ □ X     │
│ Optimal Consumption Plan(Utility maximization subject to budget constraint) │
│ Copyright (C) 1986-1998 Takashi SUZUKI & Masaru UZAWA(Otaru Univ. of commerce) │
│ G                                                                     │
│ o                          We are drawing the                         │
│ o                          price-consumption curve                    │
│ d                          (offer curve)                              │
│                            by changing the price 1.                   │
│ 2                          Utility function is                        │
│                            Rational type.                             │
│                            u(x,y)                                     │
│                            =x*y/(x*y+ 1 x+ 1 y)                        │
│                                                                       │
│ 0                                            Good 1                    │
│       p1 = 6057.5       p2 = 225          Income = 61333.3             │
│       X = 8.4891        Y = 44.0471       Utility = .876808            │
│       Please press anykey ['P' or 'p' for Hard copy] when ready ...    │
└─────────────────────────────────────────────────────────────────────┘
```

Figure 2.2.4 Price-consumption curve for Rational type of utility function.

In the final phase, you can see the demand curve.

In the case of Giffen, the demand curve is upward sloping, while in the cases of Cobb-Douglas, CES and Rational function, each demand curve is downward sloping(the law of demand prevails).
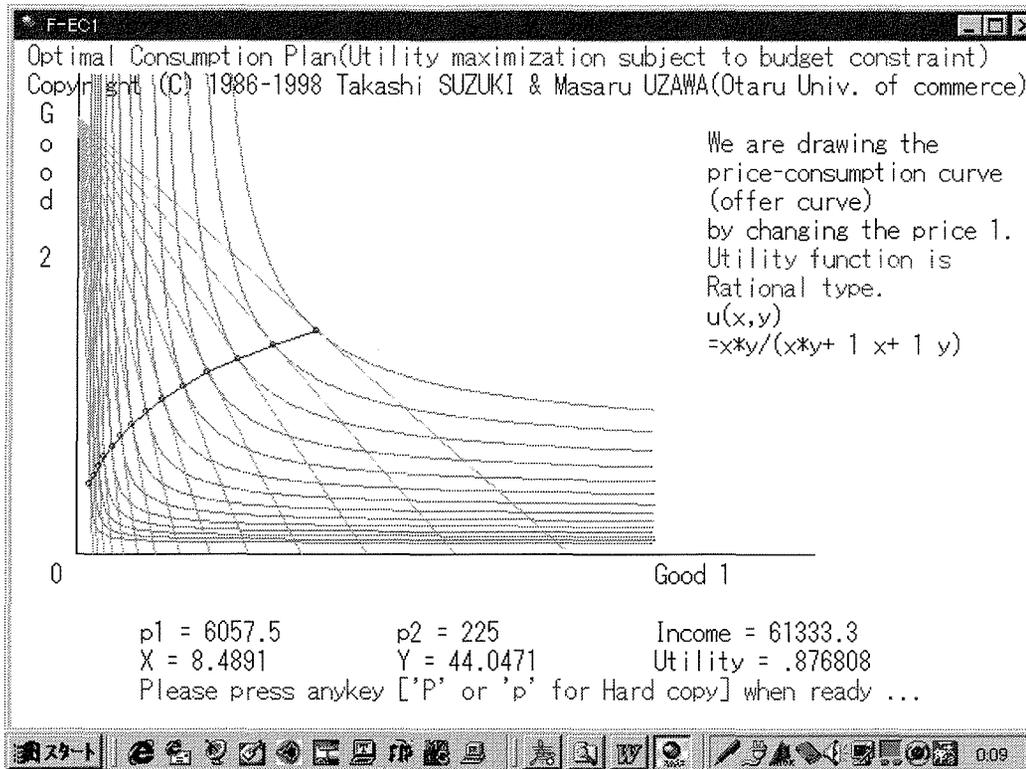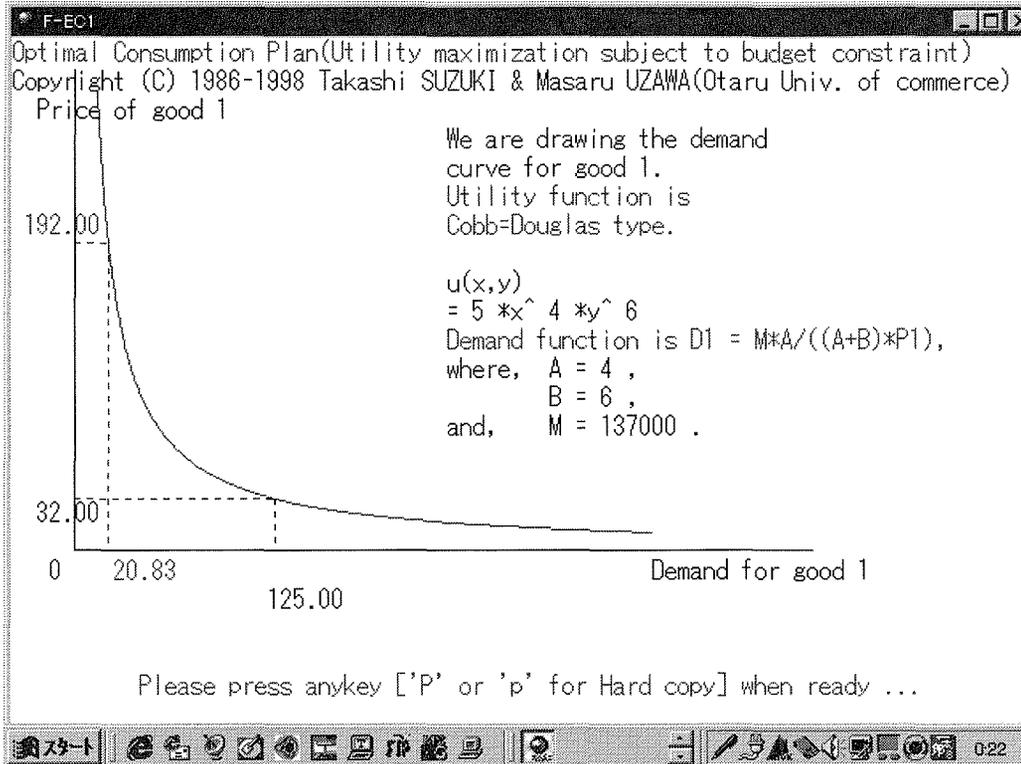*Please see Figures 2.3.1 - 2.3.4.*

F-EC1

Optimal Consumption Plan(Utility maximization subject to budget constraint)
Copyright (C) 1986-1998 Takashi SUZUKI & Masaru UZAWA(Otaru Univ. of commerce)
  Price of good 1

We are drawing the demand
curve for good 1.
Utility function is
Cobb=Douglas type.

192.00

u(x,y)
= 5 *x^ 4 *y^ 6
Demand function is D1 = M*A/((A+B)*P1),
where,   A = 4 ,
         B = 6 ,
and,   M = 137000 .

32.00

0   20.83   Demand for good 1
          125.00

Please press anykey ['P' or 'p' for Hard copy] when ready ...

Figure 2.3.1 Demand curve for Cobb=Douglas type of utility function.

F-EC1

Optimal Consumption Plan(Utility maximization subject to budget constraint)
Copyright (C) 1986-1998 Takashi SUZUKI & Masaru UZAWA(Otaru Univ. of commerce)
  Price of good 1

We are drawing the demand
curve for good 1.
Utility function is
Giffen good type.

374.75

u(x,y)
Demand curve is p1 =(M - B*P2)/(2*A - D1),and
Demand function is D1 =2*A - (M - B*P2)/P1,
where,   A = 40 ,
         B = 60 ,
         M = 27374 ,
and,   P2= 306.333 .

224.85

0   40   Demand for good 1
          56.00

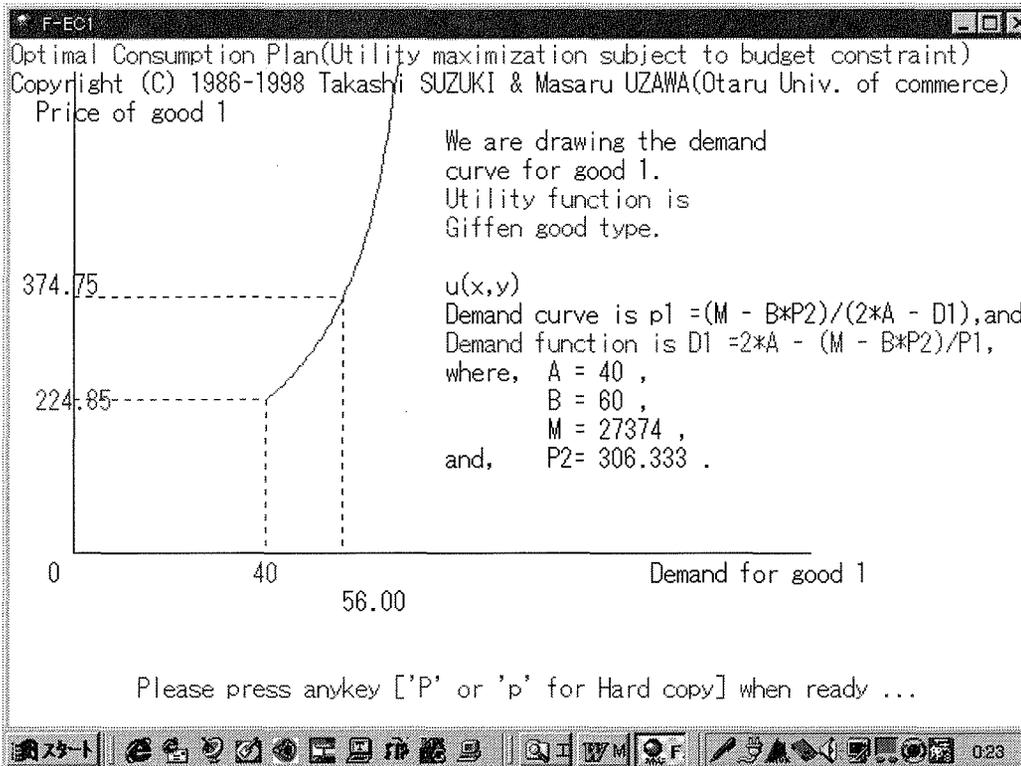Please press anykey ['P' or 'p' for Hard copy] when ready ...

Figure 2.3.2 Demand curve for Giffen good's type of utility function.
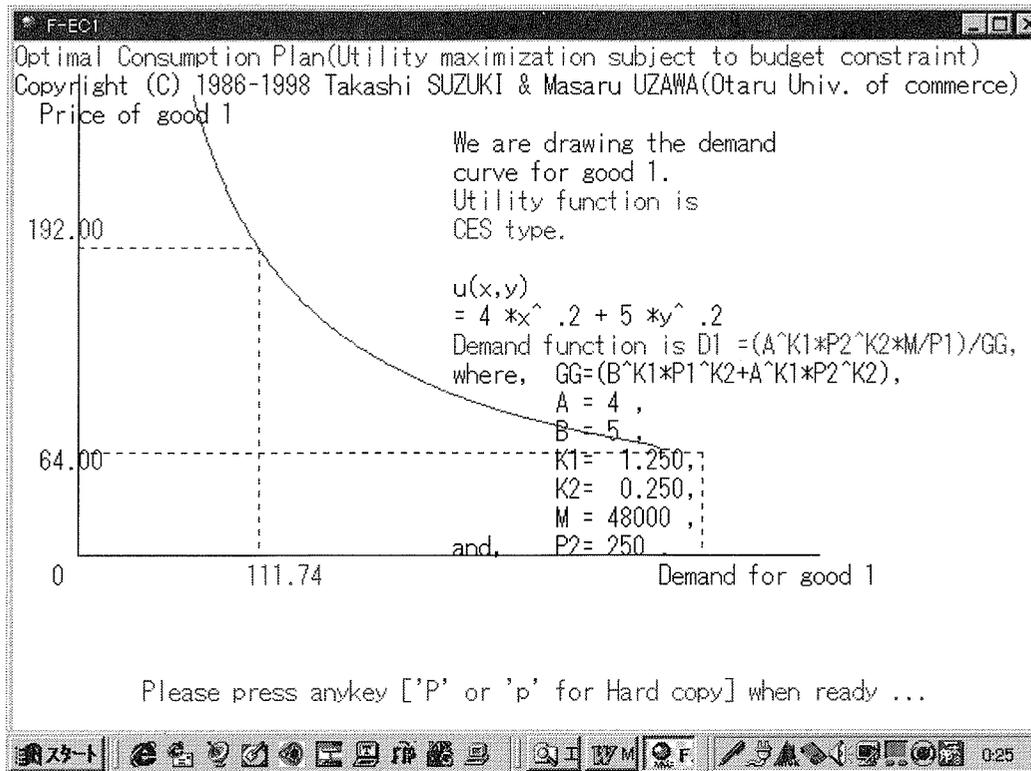
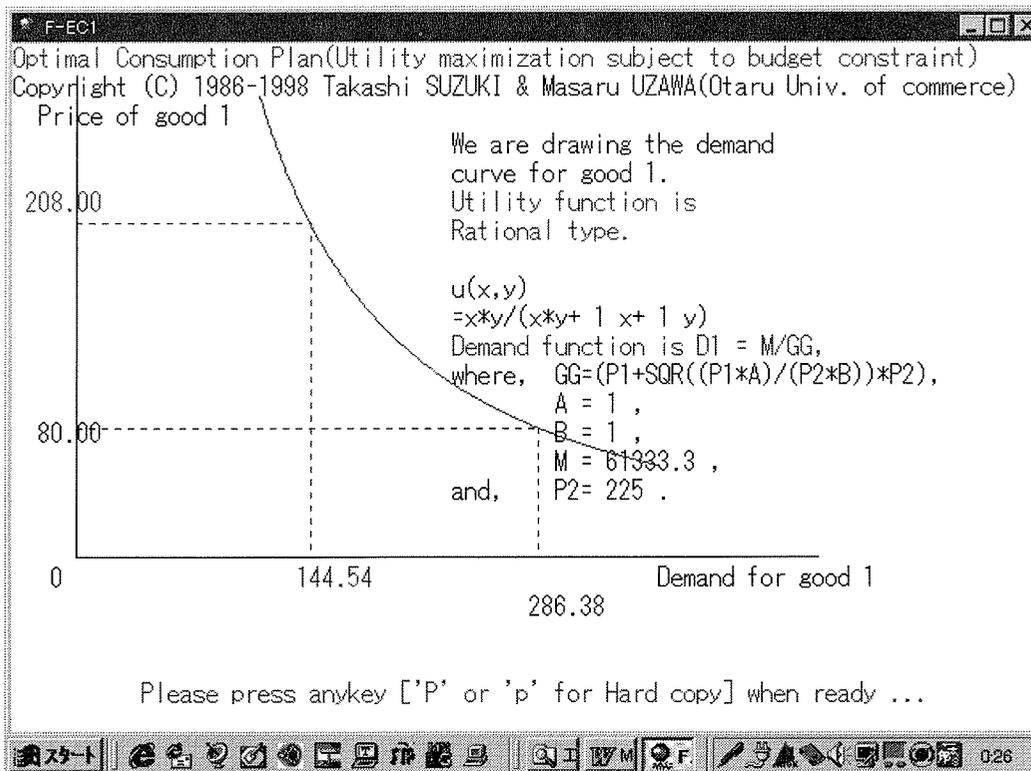Figure 2.3.3 Demand curve for CES type of utility function.

Figure 2.3.4 Demand curve for Rational type of utility function.

Collection of graphs will be gathered in another brochure for your reference. You can see the same type of graphics on the screen step by step.

Chapter 3   Slutsky decomposition of the price effects into sum of the Substitution effect and the Income effect
<F-SLTKY.exe>

This program was programmed by Masaru UZAWA(Otaru Univ. of commerce) at May 31, 1988.
It is a English Version of SLUTSKY.BAS(Japanese message).
This version is for Windows95/98 transferred by M. Uzawa.

We offer a graphics demonstration for Slutsky's decomposition. This program helps you understanding the Slutsky's decomposition of price effect into sum of substitution effect and income effect.

You can choose
   1. auto demonstration,
   2. manual demonstration, and
   0. exit of program.

If you choose number 1 or 2 then you can choose the utility function.
Please input numbers for parameters that characterize the utility function when you choose 2.
Three types of indifference curves are displayed for different parameters.
You can guess the relation of the shapes of indifference curve and parameters.
Next, please input numbers for prices and income when you choose 2.
The constraint and the budget line are displayed.
The process for obtaining the equilibrium is displayed. Marginal rate of substitution (MRS_{12}), relative price, and equilibrium E are displayed.
Next, please input a new price of good 1, p1' when you choose 2.
The New equilibrium E' and the compensated equilibrium E'' are displayed. The move from E to E' is the price effect. The price effect is decomposed into sum of the substitution effect (E to E'') and the income effect (E'' to E').

This decomposition is well known to the Slutsky's decomposition.

Please choose one of the following six types of utility functions:

1. Cobb-Douglas type $u(x1, x2) = x1^A * x2^B$
   (Cobb, Douglas)

2. Giffen's good type $u(x1, x2) = (x1 - A)/(B - x2)^2$
   (Wold, Jureen)

3. CES type $u(x1, x2) = A*x1^K + B*x2^K$
   (Arrow, Chenery, Minhas, Solow)

4. Rational function type $u(x1, x2) = x1*x2/(x1*x2+A*x1+B*x2)$

5. Sum of Rational functions type $u(x1, x2) = - A/X1 - B/X2$

6. LES   type $u(x1, x2) = A*LOG(X1-K)+B*LOG(X2-L)$
   (Klein, Rubin, Stone, Geary)

I can show you some of screen graphics are gathered here.
Please see Figures 3.1.1 – 3.2.4.
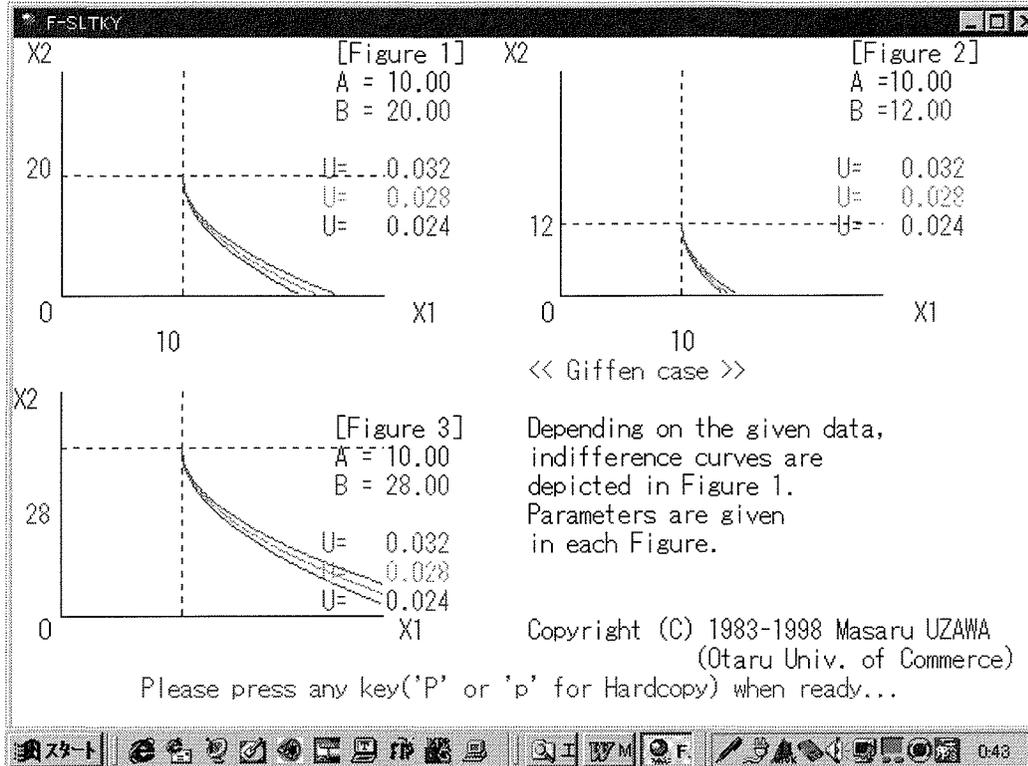

Figure 3.1.1 Three indifference curves for the Giffen good's case.
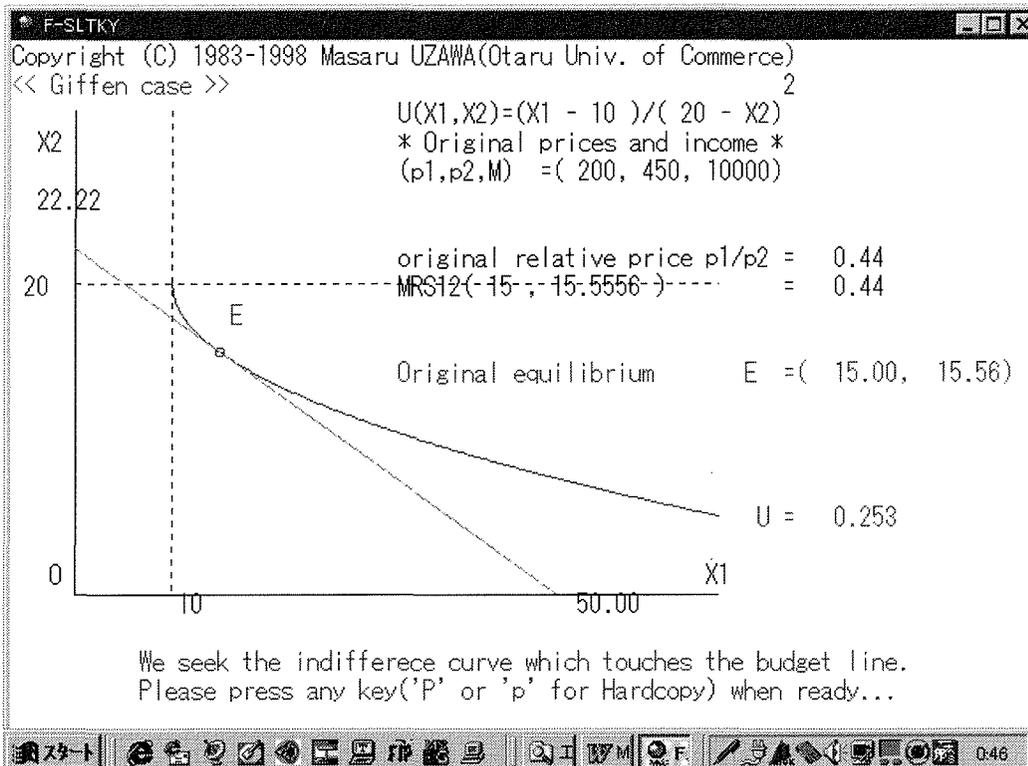

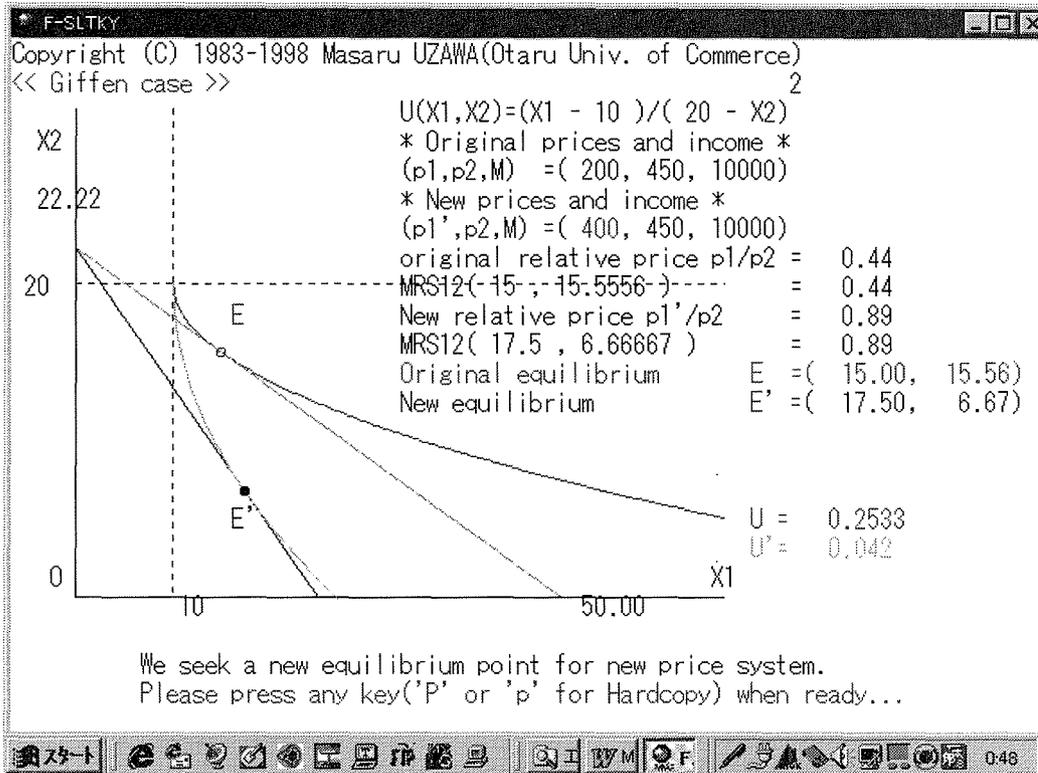Figure 3.1.2 Consumer equilibrium in the Giffen good's case.

F-SLTKY

Copyright (C) 1983-1998 Masaru UZAWA(Otaru Univ. of Commerce)
<< Giffen case >>   2

X2
                              U(X1,X2)=(X1 - 10)/(20 - X2)
22.22   * Original prices and income *
                              (p1,p2,M) =(200, 450, 10000)
                              * New prices and income *
20   (p1',p2,M) =(400, 450, 10000)
                              original relative price p1/p2 =   0.44
                              MRS12(-15-,-15.5556-)----   =   0.44
                         E   New relative price p1'/p2   =   0.89
                              MRS12(17.5 , 6.66667)   =   0.89
                              Original equilibrium   E =(15.00, 15.56)
                              New equilibrium   E' =(17.50,   6.67)

                       E'   U =   0.2533
                                             U' = 0.042
0
                                        X1
        10   50.00

    We seek a new equilibrium point for new price system.
    Please press any key('P' or 'p' for Hardcopy) when ready...

Figure 3.1.3 New consumer equilibrium in the Giffen good's case.

F-SLTKY

Copyright (C) 1983-1998 Masaru UZAWA(Otaru Univ. of Commerce)
<< Giffen case >>   2

X2
                              U(X1,X2)=(X1 - 10)/(20 - X2)
22.22   * Original prices and income *
                              (p1,p2,M) =(200, 450, 10000)
                              * New prices and income *
20   (p1',p2,M) =(400, 450, 10000)
                              original relative price p1/p2 =   0.44
                              MRS12(-15-,-15.5556-)----   =   0.44
                         E   New relative price p1'/p2   =   0.89
                              MRS12(17.5 , 6.66667)   =   0.89
                              Original equilibrium   E =(15.00, 15.56)
                              New equilibrium   E' =(17.50,   6.67)
                              Hicksian compensated point E''=(11.25, 17.78)

                       E'   U =   0.2533
                                             U' = 0.042
0
                                        X1
        10   50.00

    We seek the Hicksian compensated equilibrium point E"
    and show the Slutsky's decomposition.
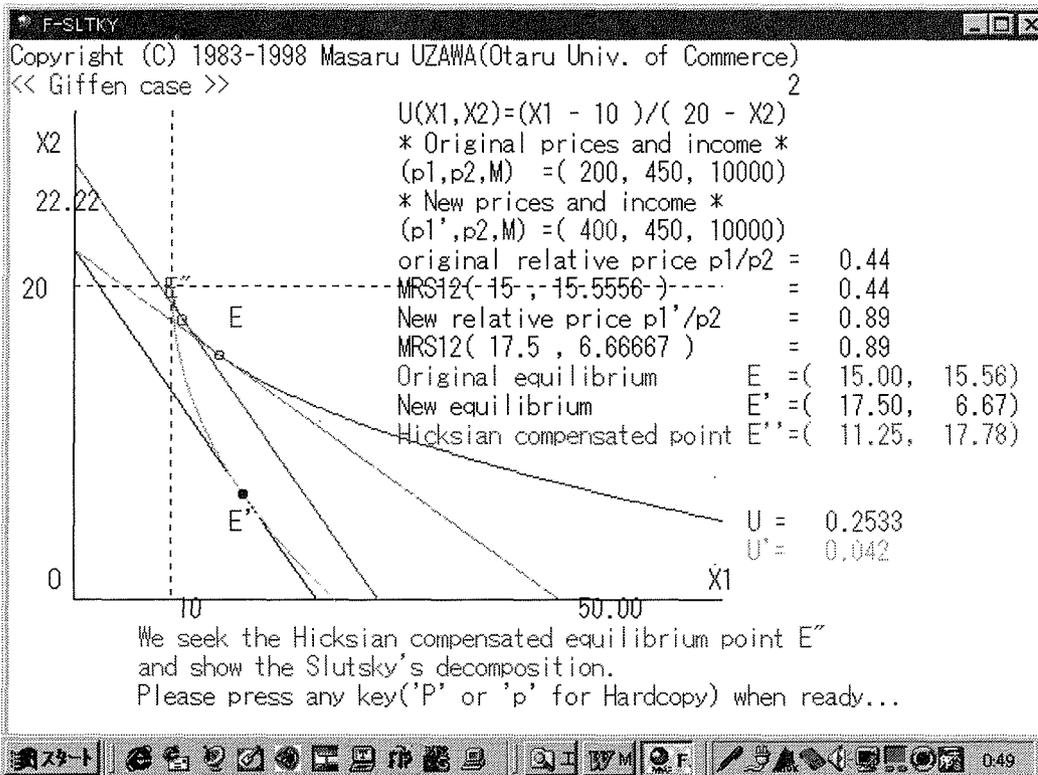   Please press any key('P' or 'p' for Hardcopy) when ready...

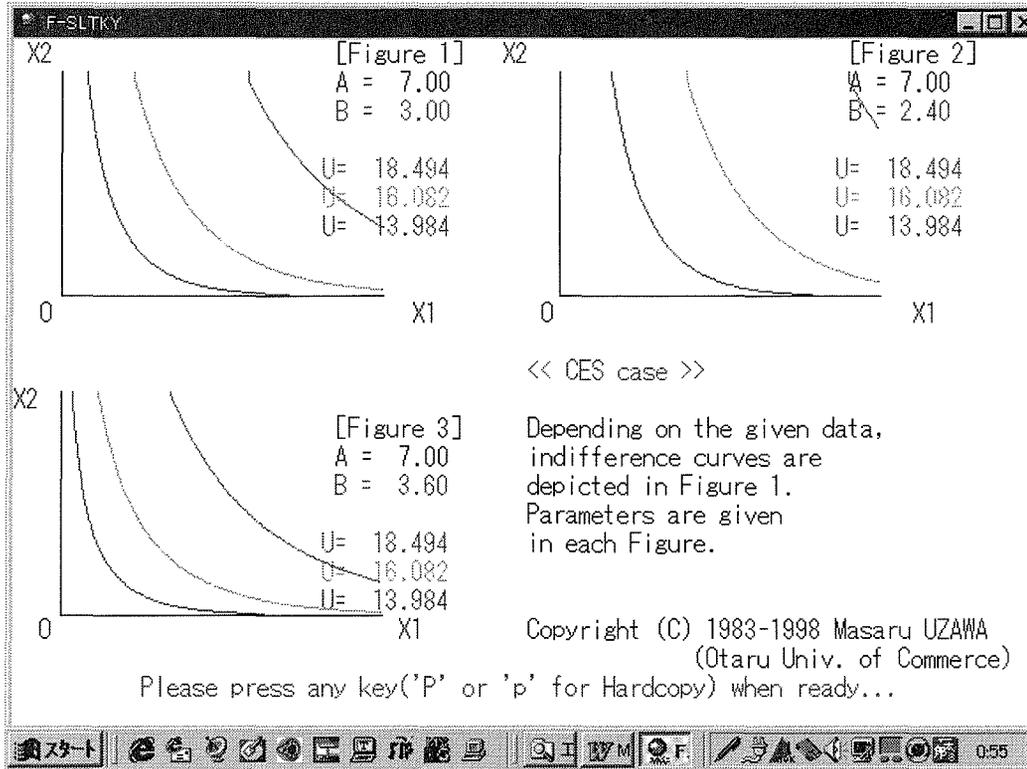Figure 3.1.4 Slutsky decomposition in the Giffen good's case.

Figure 3.2.1 Three indifference curves for the CES case.
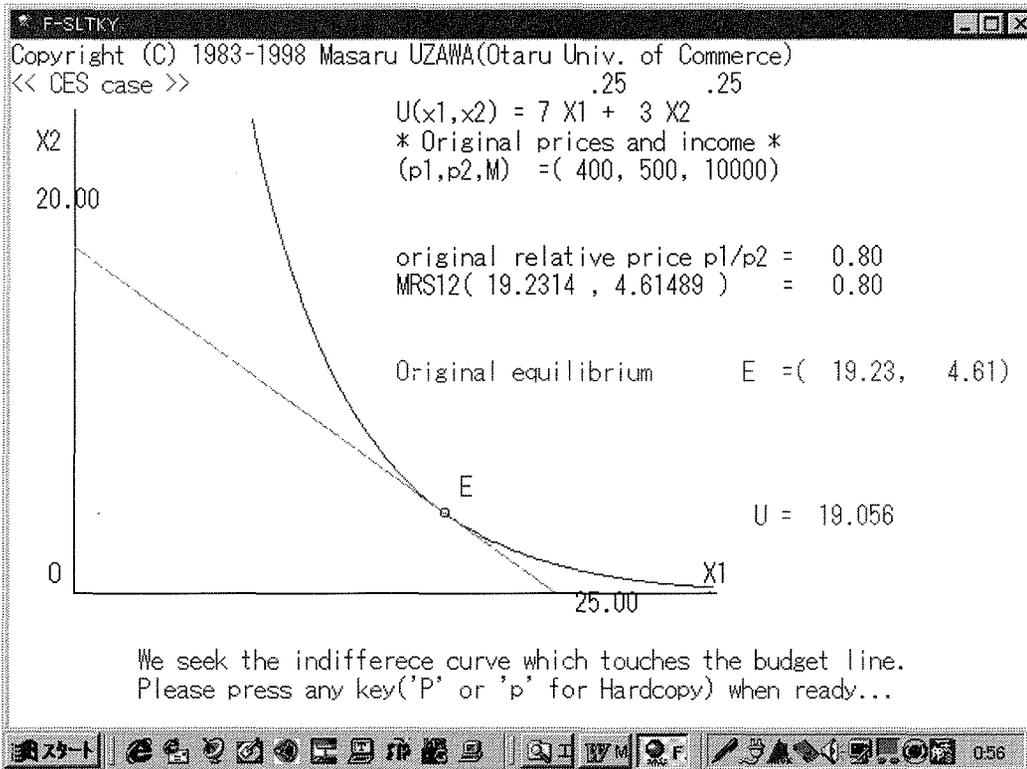

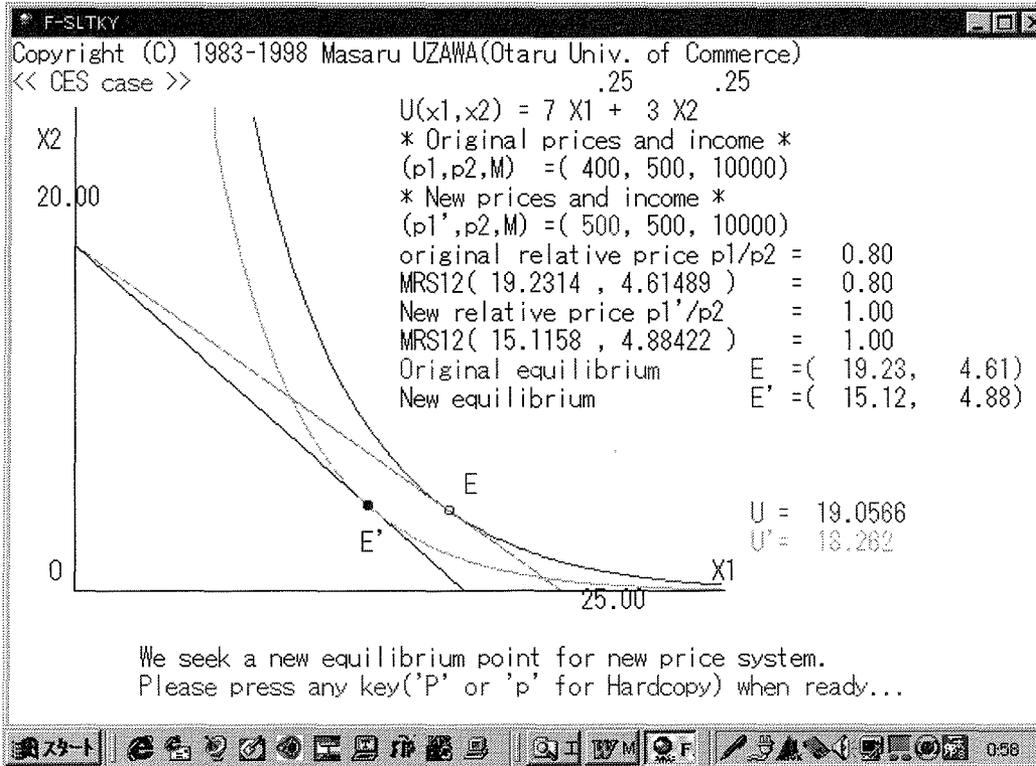Figure 3.2.2 Consumer equilibrium in the CES case.

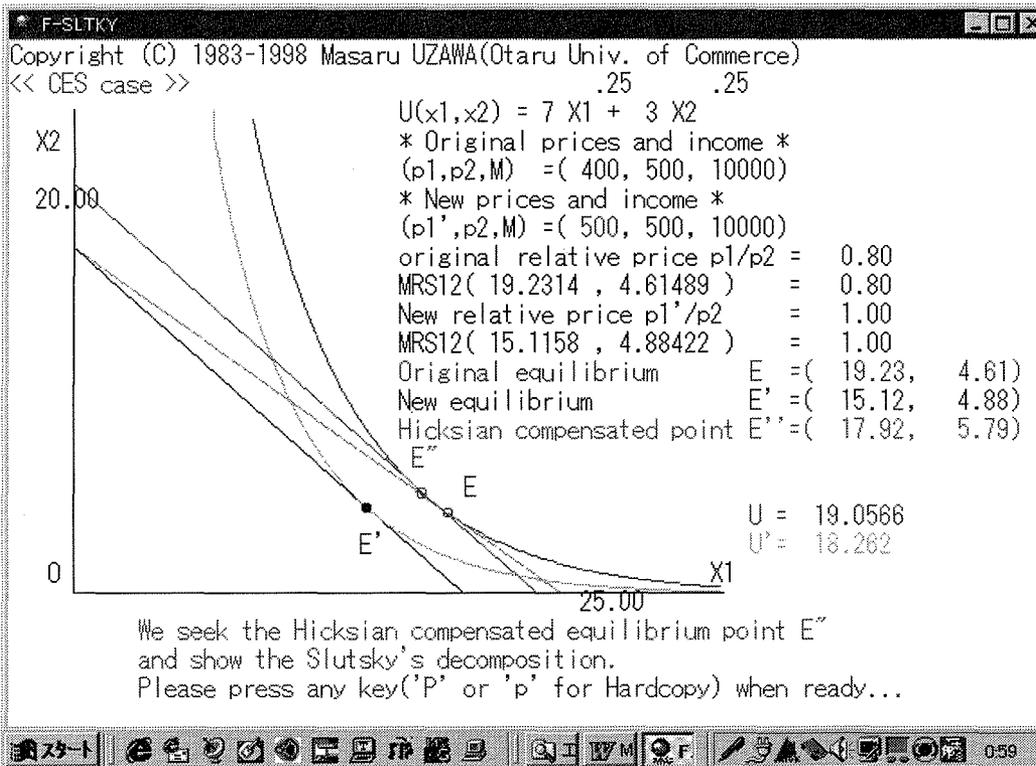Figure 3.2.3   New consumer equilibrium in the CES case.

Figure 3.2.4   Slutsky decomposition in the CES case.

Collection of graphs will be gathered in another brochure for your reference.
You can see the same type of graphics on the screen step by step.

Chapter 4 Profit maximization by Competitive firm
(Marginal cost, Average cost and Supply curve)
<F-MCAC.exe>

This program shows you the simulation of profit maximization of competitive firm.
Marginal cost (MC), Average cost (AC) and supply curves are depicted on the screen.

    This program was programmed by Masaru UZAWA (Otaru Univ. of Commerce) on November
7, 1989 for NEC's PC-9801 series (Japanese version). It was translated in English
version on July 5, 1991 for Toshiba's DynaBook (J-3100SS) and on May 6, 1992 for IBM
PC/AT.
This version is for Windows95/98.

    For the Newton method, I refer to J. Hylebohn (ed.), 'BASIC program for numerical
calculus,' (McGraw-Hill, 1981). Translated by Tatemasa Oya, McGraw-Hill Kogakusha,
1982, pp. 44-45.

Program begins with the following message:

    Let cost function be $C(q)=C3*q^3+C2*q^2+C1*q+C0$.

1. Demonstration (1) $C(q) = 0.05*q^3 - 4*q^2 + 500*q + 2500$
2. Demonstration (2) $C(q) = q^3 - 30*q^2 + 353*q + 1000$
3. Demonstration (3) $C(q) = 100*q^3 - 300*q^2 + 500*q + 300$
4. Demonstration (4) $C(q) = 5*q^3 - 90*q^2 + 600*q + 200$
5. Demonstration (5) $C(q) = 0.001*q^3 - 0.1*q^2 + 10*q + 100$
6. Manual demonstration (you can choose parameters)

    Please press a number (1, 2, 3, 4, 5, or 6).

In phase 1, you can see the cost curve when you choose 1, 2, 3, 4 or 5.
If you choose 6, then you are invited to input parameters of cost function and you
can see the associate cost curve.

Next, you can see the profit maximizing output, profit, and fixed cost multiplied by
(-1) in the tabular form.

In phase 2, you can see the associate average cost curve (AC), average variable cost
curve (AVC), and marginal cost curve (MC).

You can confirm that MC crosses the minimum of AC and that of AVC, respectively.
Under the given price, competitive firm can produce the output that maximizes the
profit.

Depending on the market price, the profit can be positive or negative.

Let market price be p, the minimum of average cost be AC.min, the minimum of average
variable cost be AVC.min, and the minimum of marginal cost be MC.min.

Following 5 cases can occur:

1. When **p > AC.min,** the maximum profit is positive.
   In phase 2, rectangle area painted by green shows the maximum profit.

2. When **p = AC.min,** the maximum profit is zero.
   In phase 2, the profit cannot be exactly zero because of calculated roundness.

3. When **AVC.min < p < AC.min,** the maximum profit is negative.
   In phase 2, rectangle area painted by red shows the maximum profit.

4. When **p = AVC.min,** the maximum profit = − fixed cost.

5. When **MC.min < p < AVC.min,** the tentative maximum profit is negative.
   In phase 2, rectangle area painted by purple shows the tentative maximum profit.
   Because the absolute value of tentative negative profit is larger than fixed
   cost, zero output produces the true maximum profit in this case.

On the next screen you can choose the case in the following menu:

********* M   E   N   U *********
1. Come back the initial phase
   you can choose another parameters
2. Keeping parameters constant,
   you can see the table of profit
3. Keeping parameters constant,
   you can come back the phase
0. Quit from the program

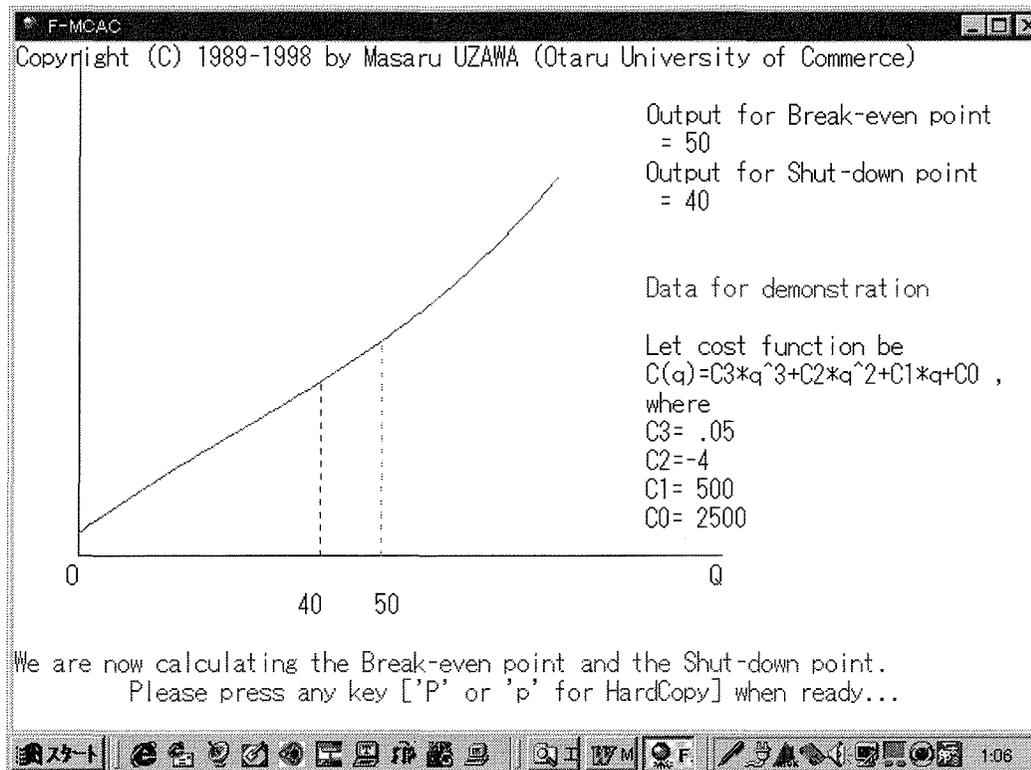   Please press a number (1, 2, 3, or 0).

Figure 4.1.1 Cost curve for case (1).

Figure 4.1.2 Price, Output, Profit and negative value of Fixed cost in case (1)

```
 F-MCAC                                                           _ □ ×
                       Price      Output    Profit   -Fixed cost
Break-even point      475.000    50.000      -0.0    -2500.0
                      472.250    49.604     -137.0    -2500.0
                      469.500    49.201     -272.8    -2500.0
                      466.750    48.790     -407.6    -2500.0
                      464.000    48.372     -541.2    -2500.0
                      461.250    47.945     -673.6    -2500.0
                      458.500    47.510     -804.8    -2500.0
                      455.750    47.065     -934.9    -2500.0
                      453.000    46.611    -1063.7    -2500.0
                      450.250    46.146    -1191.2    -2500.0
                      447.500    45.670    -1317.5    -2500.0
                      444.750    45.181    -1442.4    -2500.0
                      442.000    44.679    -1566.0    -2500.0
                      439.250    44.163    -1688.1    -2500.0
                      436.500    43.631    -1808.9    -2500.0
                      433.750    43.081    -1928.1    -2500.0
                      431.000    42.513    -2045.8    -2500.0
                      428.250    41.924    -2161.9    -2500.0
                      425.500    41.311    -2276.3    -2500.0
                      422.750    40.671    -2389.1    -2500.0
Shut-down point       420.000    40.000    -2500.0    -2500.0
        Please press any key ['P' or 'p' for HardCopy] when ready...
 スタート                                                            1:10
```

Figure 4.1.3 Price, Output, Profit and negative value of Fixed cost in case (1).

```
 F-MCAC                                                           _ □ ×
                       Price      Output    Profit   -Fixed cost
Shut-down point       420.000    40.000    -2500.0    -2500.0
                      418.667    39.662    -2553.1    -2500.0
                      417.334    39.316    -2605.7    -2500.0
                      416.001    38.960    -2657.9    -2500.0
                      414.667    38.593    -2709.6    -2500.0
                      413.334    38.214    -2760.8    -2500.0
                      412.001    37.822    -2811.5    -2500.0
                      410.668    37.417    -2861.7    -2500.0
                      409.335    36.995    -2911.3    -2500.0
                      408.002    36.556    -2960.3    -2500.0
                      406.669    36.095    -3008.7    -2500.0
                      405.336    35.612    -3056.5    -2500.0
                      404.002    35.100    -3103.7    -2500.0
                      402.669    34.556    -3150.1    -2500.0
                      401.336    33.971    -3195.8    -2500.0
                      400.003    33.335    -3240.6    -2500.0
                      398.670    32.631    -3284.6    -2500.0
                      397.337    31.833    -3327.6    -2500.0
                      396.004    30.886    -3369.4    -2500.0
                      394.671    29.652    -3409.8    -2500.0
                      393.337    26.831    -3448.0    -2500.0
        Please press any key ['P' or 'p' for HardCopy] when ready...
 スタート                                                            1:12
```

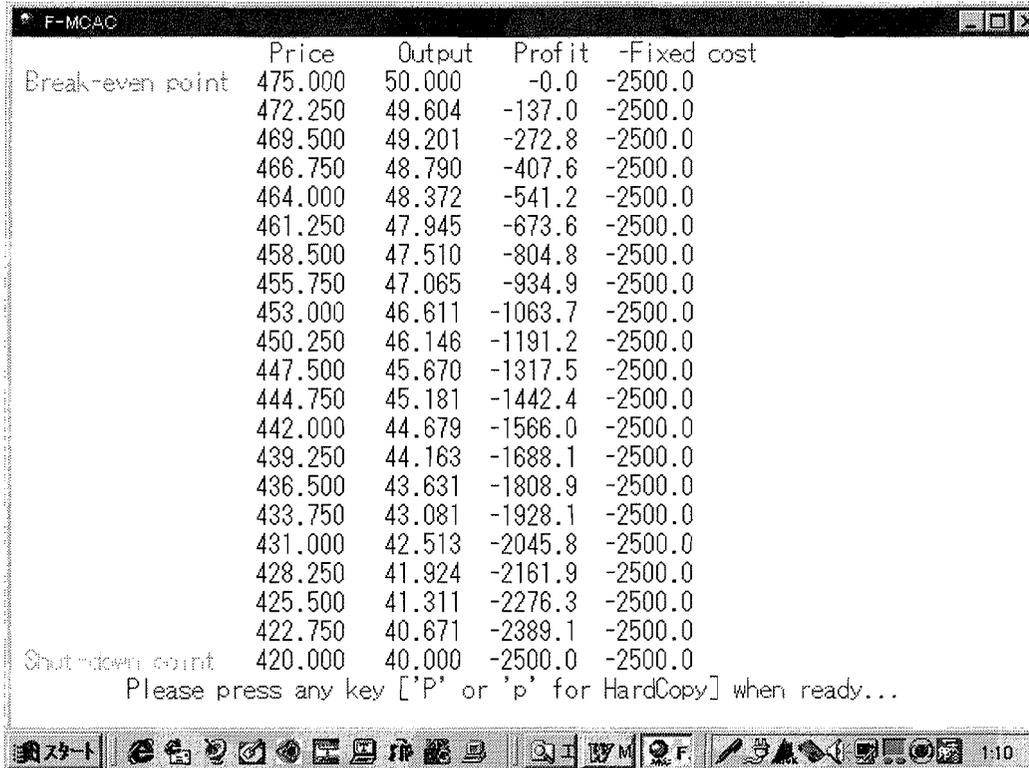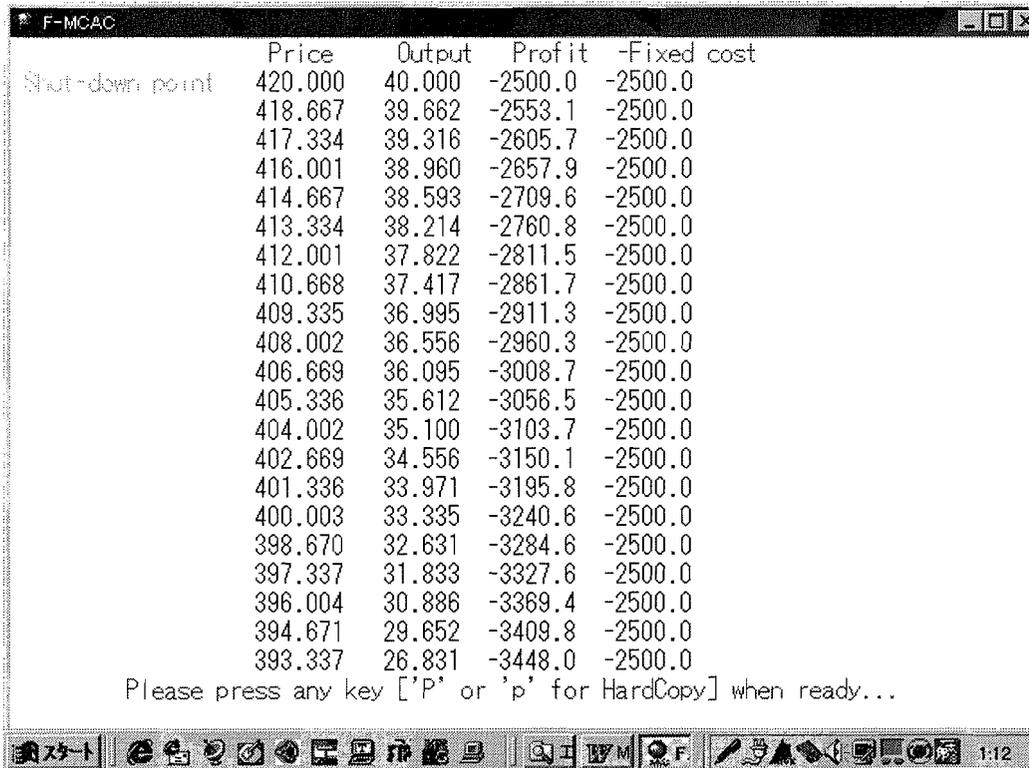Figure 4.1.4 Price, Output, Profit and negative value of Fixed cost in case (1).
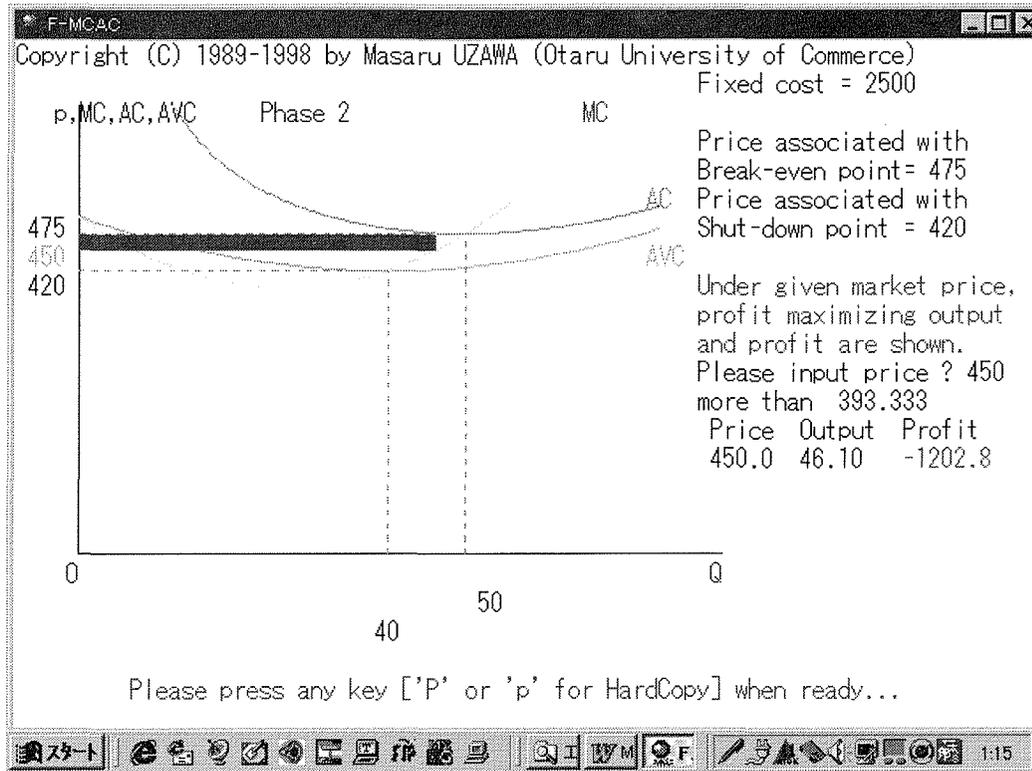
Figure 4.1.5 Producer equilibrium and maximum profit in case (1).

Collection of graphs will be gathered in another brochure for your reference.
You can see the same type of graphics on the screen step by step.

Chapter 5 Profit maximization by Monopoly firm
(Marginal revenue and Marginal cost)
<F-MRMC.exe>

This program shows you the simulation of profit maximization of monopoly firm. Marginal cost (MC), Average cost (AC) and Marginal revenue (MR) curves are depicted in the screen.

This program was programmed by Masaru UZAWA (Otaru University of Commerce) on January 8, 1990 for Fujitsu's FM R-60&70 series. It was translated in English on July 4, 1991 for Toshiba's DynaBook(J-3100SS). It also was transferred in English on April 30, 1992 for IBM PC/AT while I was in University of Rochester, U.S.A. as visiting scholar.

For the Newton method, I refer to J. Hylebohn(ed.),'BASIC program for numerical calculation,' (McGraw-Hill, 1981). Translated by Tatemasa Oya, McGraw-Hill Kogakusha, 1982, pp. 44-45.

Program begins with the following menu screen:

Phase 1   <<< M E N U >>>

        Let demand curve be   p = AA - BB*D ,
        and cost function be C(Q)=C3*Q^3+C2*Q^2+C1*Q+C0 .

  1. Demonstration (1)
     p = 1000 - 10*D,   C(Q)=0.05*Q^3-4*Q^2+500*Q+2500
  2. Demonstration (2)
     p = 500 - 20*D,   C(Q)=Q^3-30*Q^2+353*Q+1000
  3. Demonstration (3)
     p = 800 -250*D,   C(Q)=100*Q^3-300*Q^2+500*Q+259.316
  4. Demonstration (4)
     p = 700 - 40*D,   C(Q)=5*Q^3-90*Q^2+600*Q+2000
  5. Demonstration (5)
     p = 350 - 22*D,   C(Q)=5*Q^3-90*Q^2+600*Q+200
  6. Manual demonstration (you can choose parameters.)

  0. Quit from the program

     Please press a number (1,2,3,4,5,6, or 0).

To execute of Demonstration, you must choose a number 1,2,3,4 or 5.
If you choose a number 6, then you are requested to input parameters.
If you choose a number zero(0), the program ends.

    In phase 1, you can choose five demonstrations or you can choose yourself parameters of demand and cost functions.
    In phase 2, you can see the revenue, cost, and profit curves which are determined by the parameters in phase 1.

Following 3 cases are possible:
(A) The revenue curve crosses the cost curve and the maximum profit is positive (demonstration (1) and demonstration (2))
(B) The revenue curve contacts with the cost curve and the maximum profit is zero (demonstration (3)),

and,

(C) The revenue curve cannot intersect with the cost curve and the maximum profit is negative (demonstration (4) and demonstration (5))

In phase 3, you can see the procedure to solve maximum profit and associated price under given data in phase 1.

For your reference, value of fixed cost multiplied by (-1) is given.

In phase 4, you can see demand curve (DD), marginal revenue curve (MR), average cost curve (AC), average variable cost curve (AVC), and marginal cost curve (MC).

In addition, you can also see the profit maximizing price, output, and, profit in the diagram.

You can see the following menu message:

＊＊＊＊＊ M E N U ＊＊＊＊＊

1. Going back to the initial phase 1, you can choose another parameters.
2. Keeping parameters constant, you can come back phase 2 in which revenue, cost and profit curves are depicted.
3. Keeping parameters constant, you can come back phase 3 in which procedure for profit maximization is described.
4. Keeping parameters constant, you can come back phase 4 in which MR, MC, AC and AVC curves are described.

0. Quit from the program.

Please press a number (1, 2, 3, 4, or 0).

You can choose any of above number.
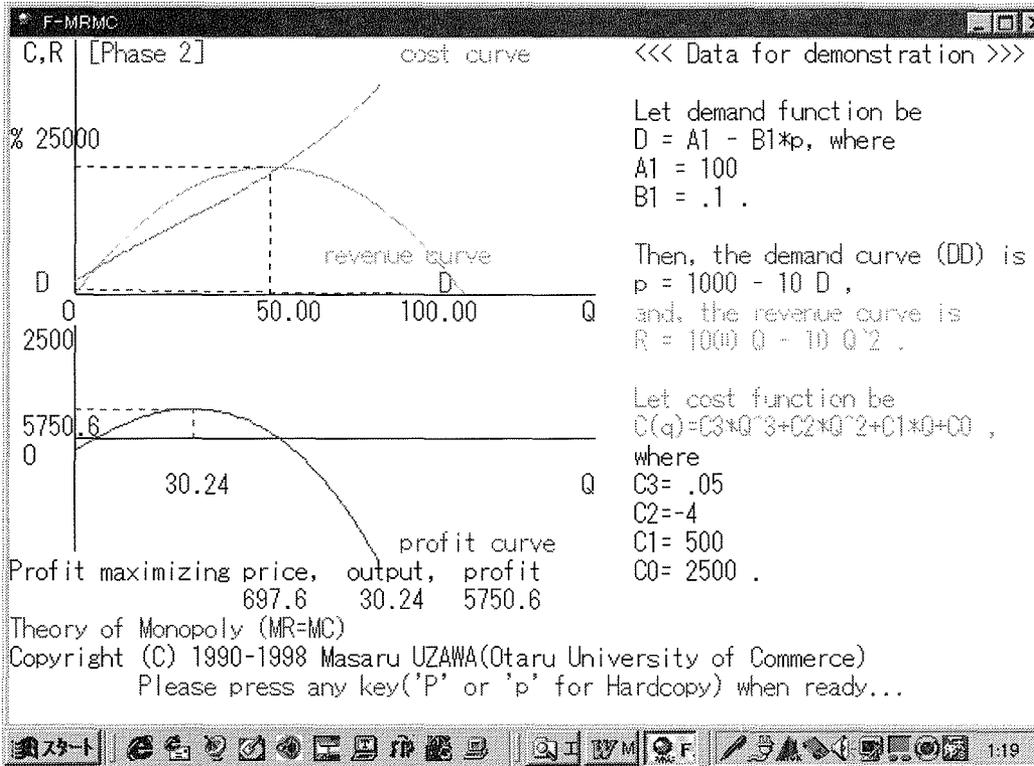
Figure 5.1.1 Revenue, Cost, and Profit in case (1).
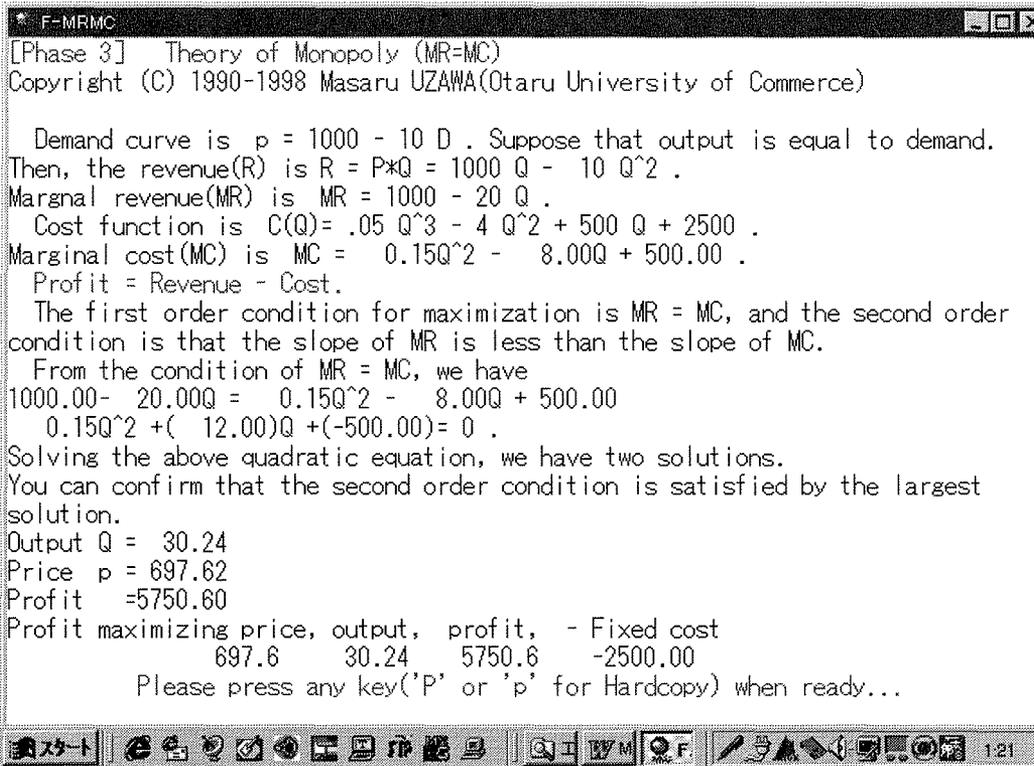
Figure 5.1.2 Derivation of monopoly equilibrium in case (1).

```
F-MRMC                                                    _ □ X
p,MC,AC,AVC,MR  [Phase 4]                      MC

 D

 697.62

                                                         AC
                                                         AVC
 507.44

                                                      D

  0        30.24      50.00      100.00   Q
                      MR
Theory of Monopoly (MR=MC)
Copyright (C) 1990-1998 Masaru UZAWA(Otaru University of Commerce)
      Please press any key('P' or 'p' for Hardcopy) when ready...
```

Under the given demand
and cost functions, we have
monopoly price, output,
and maximal profit.

price = 697.62
output= 30.24
profit=5750.60

For your reference,
we give (- Fixed cost).

Average cost(AC) = 507.44
- Fixed cost   =-2500.00

Figure 5.1.3 Monopoly equilibrium in case (1).

Collection of graphs will be gathered in another brochure for your reference.
You can see the same type of graphics on the screen step by step.

Chapter 6   Simulated Groping process for the equilibrium price
<F-EQ-P.exe>

This program was programmed by Masaru UZAWA (Otaru Univ. of Commerce) on May 24, 1988.

This version is for Windows95/98.

This program simulates the equilibrium price formation. When the price simulation begins, please input the price data. If the price is in the neighborhood of the equilibrium price in the [n]th trial, you can find the equilibrium price after [n]th groping.

Approximation is checked by the parameter epsilon. Given number of epsilon is 0.001. You can change the approximation condition, if necessary.


```
 F-EQ-P                                                          _ □ x
p │ 98/10/21  01:29:17  [ 5 ]      *:demand  *:supply     ED :Excess Demand
  │ Copyright (C) 1988-1998 Masaru UZAWA                   ES :Excess Supply
  │ Neighborhood= .001 *equilibrium price            [ 1]price=? 200      ES
  │                                                  [ 2]price=? 50       ED
118│                                                 [ 3]price=? 80       ED
  │                                                  [ 4]price=? 81       ES
  │                                                  [ 5]price=? 80.5     ES
  │                                                  [ 6]price=? 80.2     ED
80.3│                                                [ 7]price=? 80.3     ED
  │
  │
  │
  │       Demand curve is  p =  118 - 25 D
14.0│      Supply curve is  p =  14 + 44 S
  0        where p = price, D = demand, and S = supply.  D,S
             1.5                              4.7
You win and find the equilibrium price   80.32 after [ 7 ]th trials.

Please press any key ['P' or 'p' for HardCopy] when ready ...
```
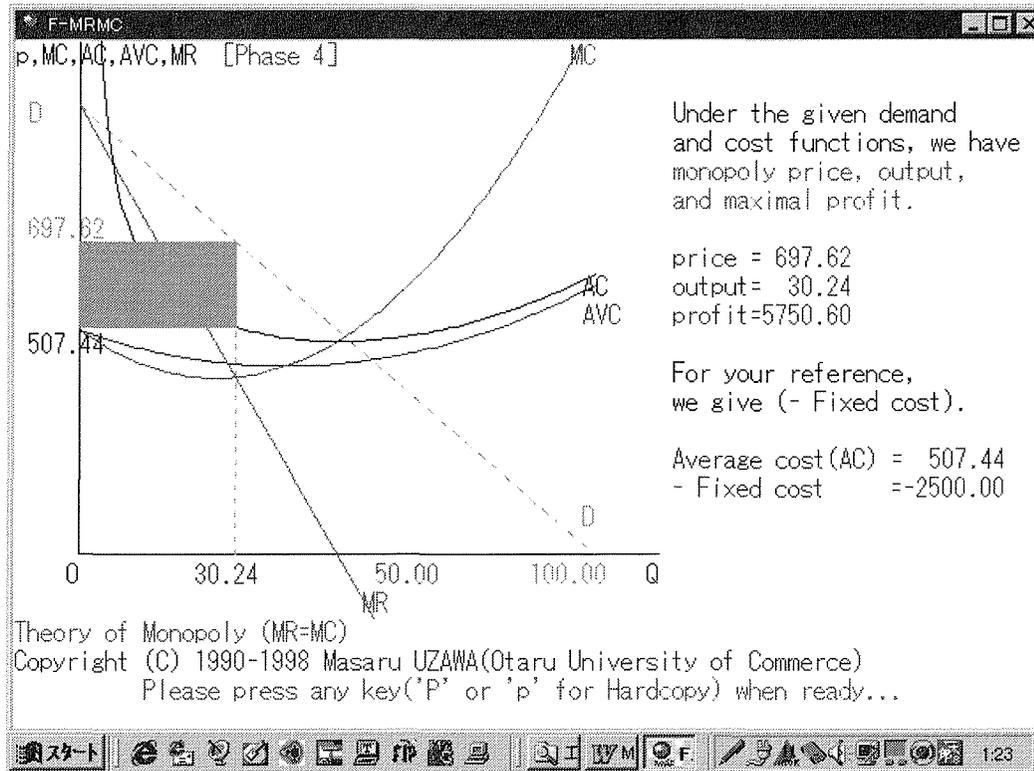
Figure 6.1   Search for market equilibrium price (Example 1).

```
F-EQ-P                                                          _ □ X
p   98/10/25  16:03:36  [ 2 ]      *:demand  *:supply     ED :Excess Demand
    Copyright (C) 1988-1998 Masaru UZAWA             ES :Excess Supply
    Neighborhood= .001  *equilibrium price           [ 1]price=? 500    ES
                                                     [ 2]price=? 100    ED
                                                     [ 3]price=? 110    ES
                                                     [ 4]price=? 104    ED
                                                     [ 5]price=? 105    ES
                                         ( 1.2 , 141.4)  [ 6]price=? 104.5   ED

104.5

24    Demand curve is  p =  35 /D
      Supply curve is  p =  24 + 99 S
      where p = price, D = demand, and S = supply.  D,S
                              0.8
You win and find the equilibrium price  104.51 after [ 6 ]th trials.

Please press any key ['P' or 'p' for HardCopy] when ready ...
```
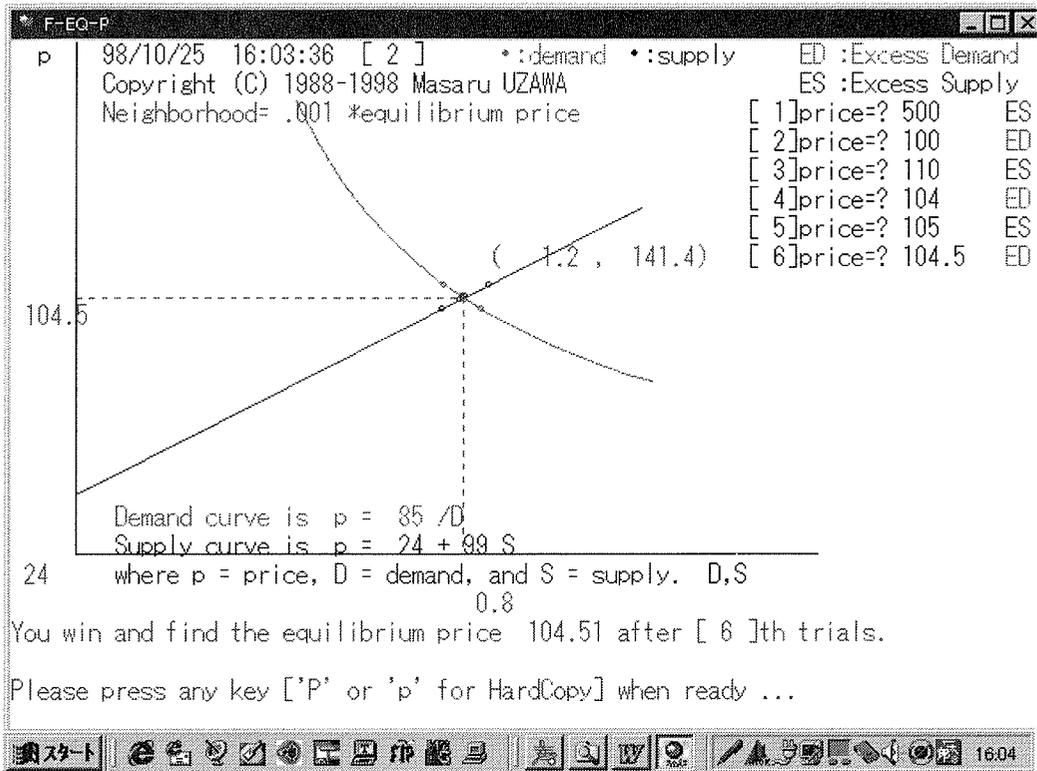
Figure 6.2   Search for market equilibrium price (Example 2).

Collection of graphs will be gathered in another brochure for your reference.
You can see the same type of graphics on the screen step by step.

Chapter 7 Simulation in cobweb theory
<F-COB. exe>

This program was programmed by Masaru UZAWA (Otaru Univ. of Commerce) on June 16, 1988.
This version is for Windows95/98.
It helps you understanding the cobweb theory.

Program begins as follows:

Cobweb Theory
Copyright(C) 1988-1998 Masaru UZAWA (Otaru University of Commerce)

         M E N U

1. Manual demonstration of the cobweb theory
     (Case of randomly given parameters for the demand and supply curves)
2. Manual demonstration of the cobweb theory
     (You can choose the parameters for the demand and supply curves)
3. Auto demonstration (Converging cobweb case)
4. Auto demonstration (Diverging cobweb case)
5. Auto demonstration (Persistent oscillations case)

0. Quit from the program

Please press a number (1, 2, 3, 4, 5 or 0).

If you choose number 3, then convergent case is displayed on the screen.
If you choose number 4, then divergent case is displayed on the screen.
If you choose number 5, then cyclical case is displayed on the screen.
If you choose number 1 or 2, then you have to input a number for initial price level.
Depending on the parameters, you will see the convergent case, the divergent case, or persistent oscillation case.
Please see the Figures 7.1-7.5.
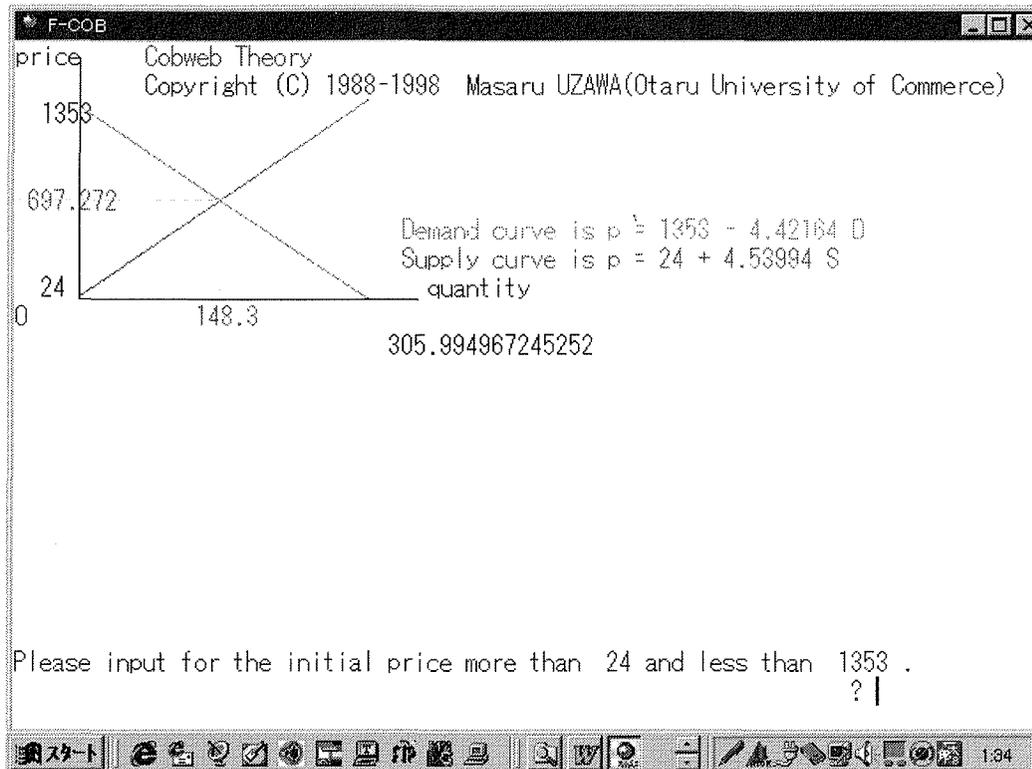
Figure 7.1   You can choose initial price of Cobweb Theory.
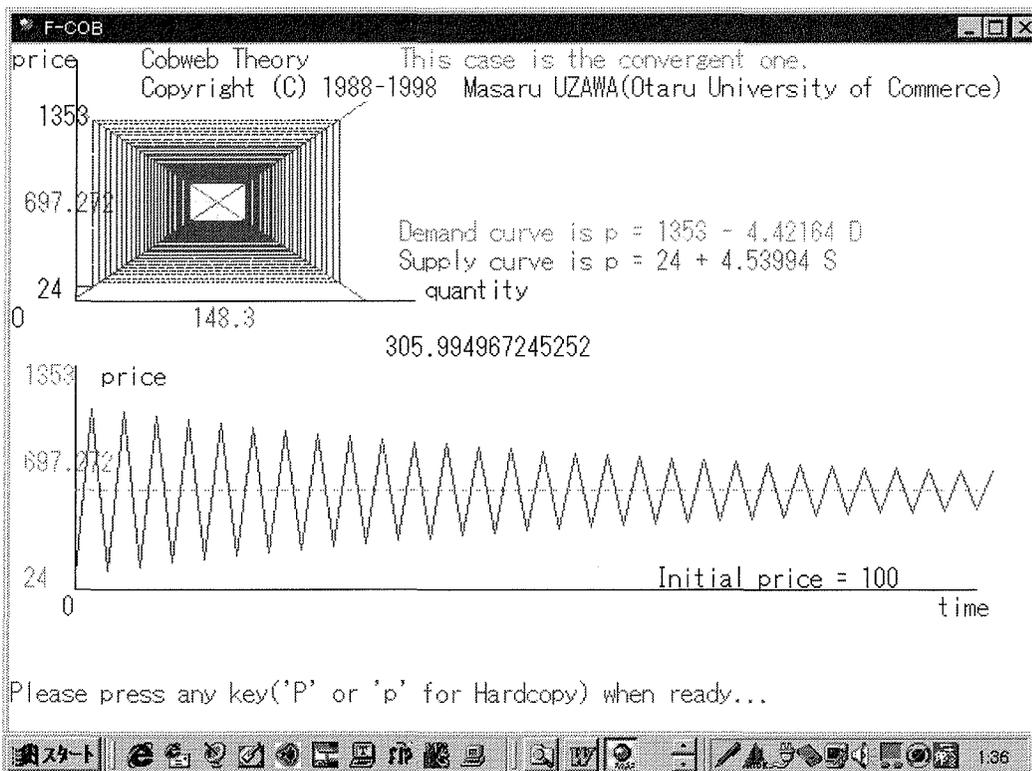

Figure 7.2   The convergent processes in price movement of Cobweb Theory.
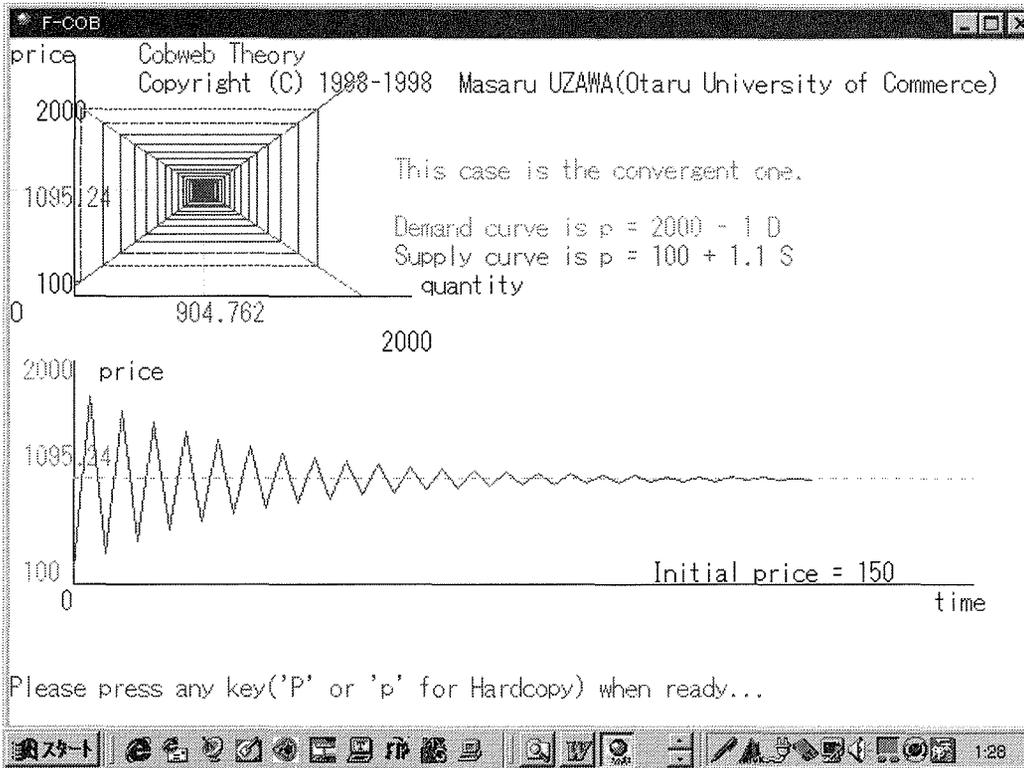
Figure 7.3   The convergent case of Cobweb Theory.
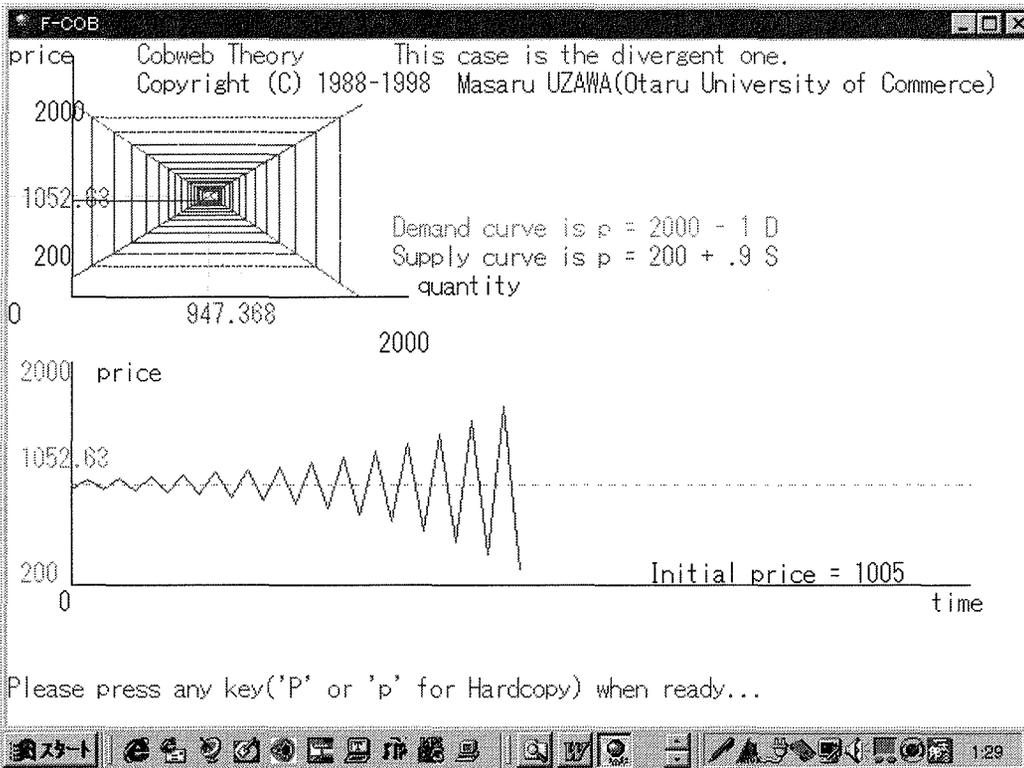
Figure 7.4   The divergent case of Cobweb Theory.
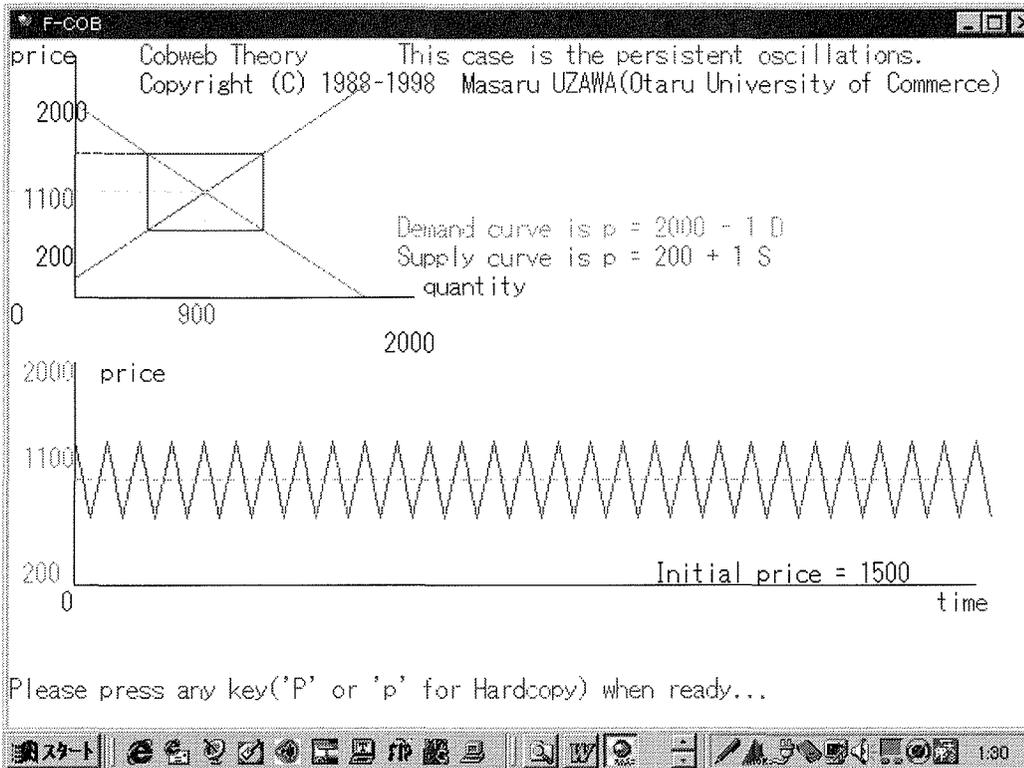
Figure 7.5   The persistent oscillations case of Cobweb Theory.

Collection of graphs will be gathered in another brochure for your reference.
You can see the same type of graphics on the screen step by step.

Chapter 8 Cournot equilibrium by using the reaction curve
<F-REAC. exe>

This program was programmed by Masaru UZAWA (Otaru Univ. of Commerce) on July 5,
1988. It shows the demonstration of Cournot's reaction function equilibrium.

Following is the menu screen:

> M E N U

1. Demonstration of Cournot's Reaction Function Equilibrium
2. Auto Demonstration of Cournot's Reaction Function Equilibrium
   (Convergent case)
3. Auto Demonstration of Cournot's Reaction Function Equilibrium
   (Divergent case)

0. Exit of program.

   Please press a number (1, 2, 3 or 0).

If you choose number 2, then convergent case is displayed on the screen.
If you choose number 3, then divergent case is displayed on the screen.
If you choose number 1, then you must input a number for initial output level.
Depending on the parameters, you will see the convergent case or the divergent case.

Figure 8.1 Divergent case in the Cournot equilibrium.
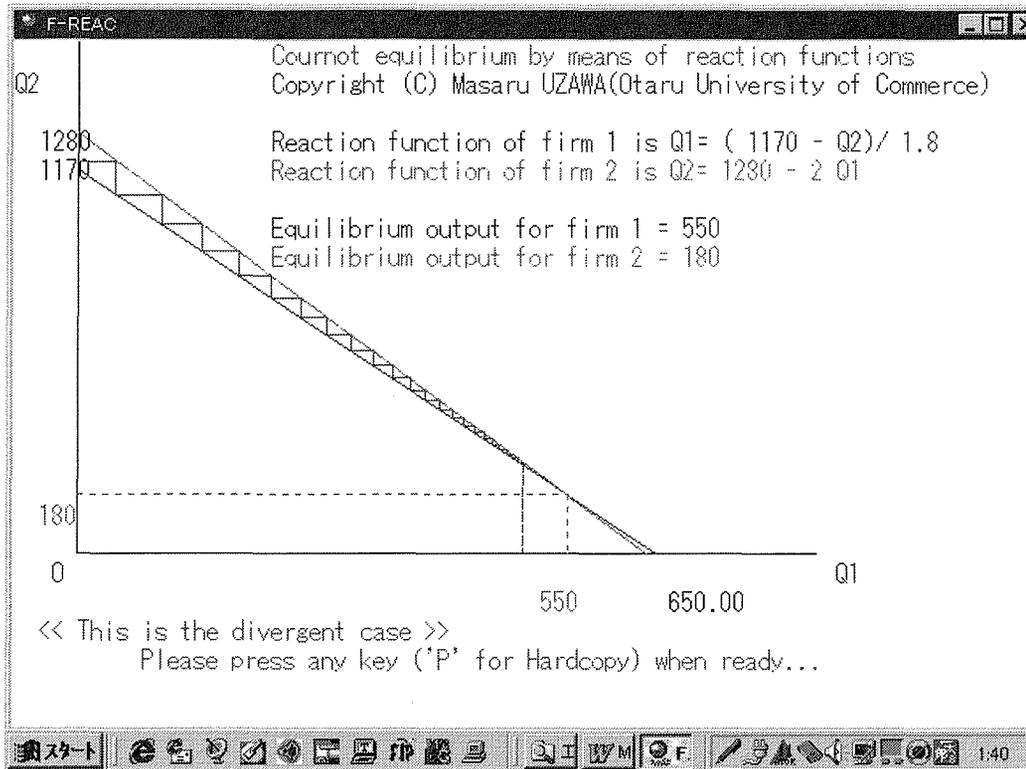
Figure 8.2   Convergent case in the Cournot equilibrium.
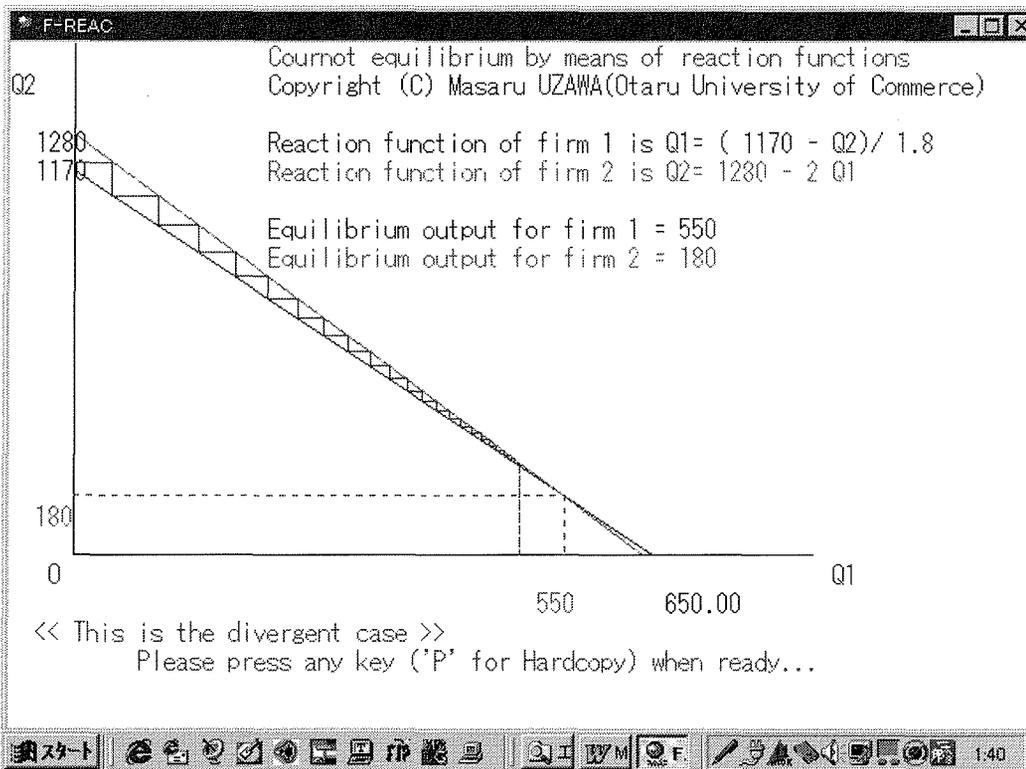
Figure 8.3   Divergent case of the Cournot equilibrium.

Collection of graphs will be gathered in another brochure for your reference.
You can see the same type of graphics on the screen step by step.

Chapter 9 Pareto efficiency in the Edgeworth's box diagram
<F-BOX5.exe>

This program shows you the Edgeworth's Box diagram which exhibits the Pareto efficient points and advantageous allocations for both agents.

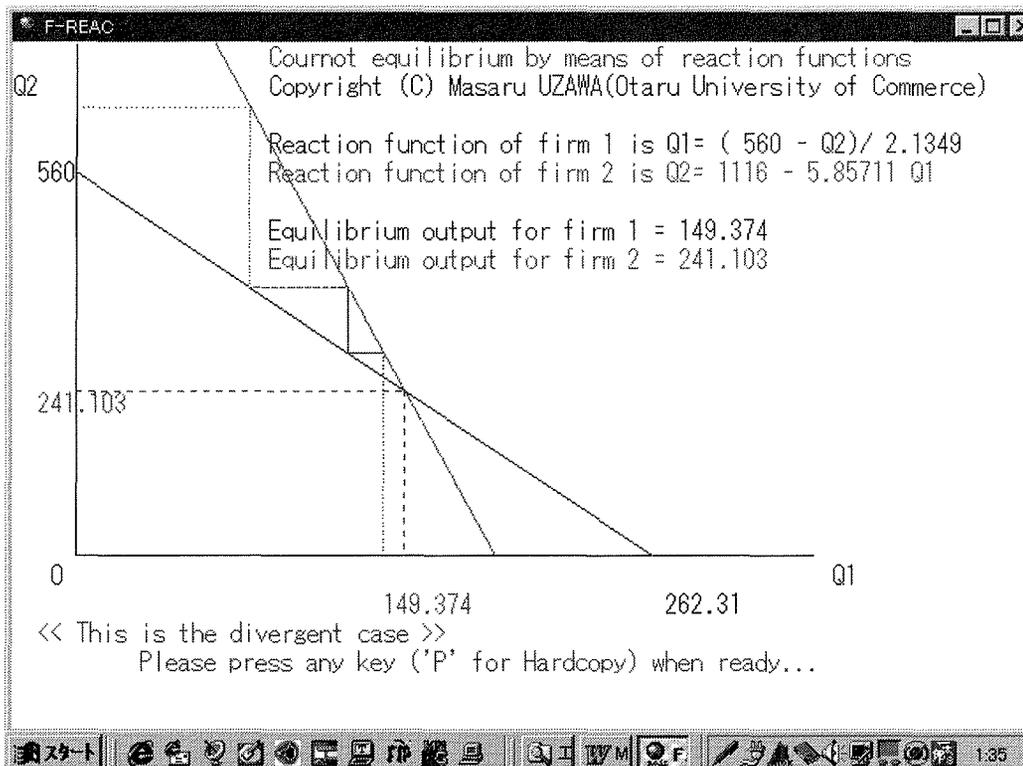　　　This program was programmed on February 9, 1992 by Masaru Uzawa (Otaru University of Commerce) for FM R60&70. It was transferred in English on May 6, 1992 for IBM PC/AT. This version is for Windows95/98.

　　　Program begins with the following message:

*********************** M　E　N　U　****************************
1. demo(locus of the Pareto efficient points is convex from below)
2. demo(locus of the Pareto efficient points is a line)
3. demo(locus of the Pareto efficient points is convex from above)
4. demo(locus of the Pareto efficient points is convex from below)
5. execution(you can choose parameters)
6. See the explanation of the program

0. Exit from the program

Please press a number(1, 2, 3, 4, 5, 6 or 0).

　　　If you want to see demonstrations, please press 1, 2, 3, or 4.

　　　We can say that an allocation E is the Pareto efficient allocation if the following conditions are satisfied, i.e.,
(1) an allocation E is feasible(i.e., in the Edgeworth's box diagram),
　　and
(2) no other feasible allocation exists in which any person's utility are not worse off and at least one person's utility can be well off.

　　　When you press '1', '2', '3', or '4', then the Edgeworth's box diagram appears in the screen in which allocations between two agents are displayed.

　　　Origin of agent X is ox. Good 1 is measured to right horizontal, and good 2 is measured to upper vertical.
　　　Origin of agent Y is Oy. Good 1 is measured to left horizontal, and good 2 is measured to down vertical.
　　　We can show data for 2 agents' initial endowments, parameters of utility functions, and initial endowments in the economy on the right screen.

　　　First, we can draw two indifference curves through each agent's initial endowment. You can see the message from us on the screen.

　　　Next, we want to know the advantageous allocations for both agents. We can draw an indifference curve which contacts with other agent's indifference through the initial endowment.

An allocation in the shaded area is a preferred allocation to initial endowment for both agents.

Therefore, two agents(X and Y) can exchange one good for another to increase utilities in the shaded area.

You can see agent Y's indifference curve which contacts with agent X's indifference curve, step by step. On the screen, you also see the message 'We are now seeking the Pareto efficient points. Please wait a minute.'

You can confirm that the curve from Ox to Oy shows the Pareto efficient points. This curve is called, in usual, 'contract curve.'

The contract curve defined by Edgeworth is the portion of contract curve in the shaded area and now is called 'Core (of the allocation).'

When you choose '1', then the locus of the Pareto efficient points is convex from below.

When you choose '2', then the locus of the Pareto efficient points is a line.

When you choose '3', then the locus of the Pareto efficient points is convex from above.

When you choose '4', then the locus of the Pareto efficient points is convex from below.

When you choose '5', then you can see data of demonstrations on the screen. Please input numbers for the following economic data.

Let us define agent X's initial endowment to be (W.X1,W.X2).

W.X1 is a positive number.

W.X2 is a positive number.

Let us define agent X's utility function to be

$UX(X1,X2)=SX*X1\hat{}(AX)*X2\hat{}(BX)$.

SX is a positive number less than 10.

AX is a positive number less than 10.

BX is more than a given positive number and less than 10.

Let us define agent Y's initial endowment to be (W.Y1,W.Y2).

W.Y1 is a positive number.

W.Y2 is a positive number.

Let us define agent Y's utility function to be

$UY(Y1,Y2)=SY*Y1\hat{}(AY)*Y2\hat{}(BY)$.

SY is a positive number less than 10.

AY is a positive number less than 10.

BY is more than a given positive number and less than 10.

If you have finished to input data, the screen goes as same as the case of demonstration.

```
F-BOX5                                                    _ □ ×
The Pareto efficient points in the Edgeworth's box diagram    [1]
Copyright (C) 1990-1998  Masaru UZAWA(Otaru Univ. of Commerce)
1990-02-09  Ver. 1.00  for Fujitsu's FMR series(Japanese version)
11/05/98  Ver. 1.00  for Windows95/98


  We can say that an allocation E is the Pareto efficient allocation
if the following conditions are satisfied,i.e.,
(1)an allocation E is feasible(i.e.,in the Edgeworth's box diagram),
  and
(2)no other feasible allocation exists in which any person's utility
   are not worse off and at least one person's utility can be well off.



            Do you want to see an explanation of the program(Y/N)?

            If yes,then please press 'Y' or 'y'.

            If you want to execute the program soon,
            then please press any key other than 'Y' or 'y'.
```

Figure 9.1 Starting message

```
F-BOX5                                                    _ □ ×
The Pareto efficient points in the Edgeworth's box diagram    [i]
Copyright (C) 1990-1998  Masaru UZAWA(Otaru Univ. of Commerce)
1990-02-09  Ver. 1.00  for Fujitsu's FMR series(Japanese version)
11/05/98  Ver. 1.00  for Windows95/98

   ********************   M   E   N   U   ********************

   1. demo (locus of the Pareto efficient points is convex from below)

   2. demo (locus of the Pareto efficient points is a line)

   3. demo (locus of the Pareto efficient points is convex from above)

   4. demo (locus of the Pareto efficient points is convex from below)

   5. execution (you can choose parameters)

   6. See the explanation of this program


   0. Quit from the program

   Please a number(1,2,3,4,5,6 or 0).
```

Figure 9.2 Menu of the program

The Pareto efficient points in the Edgeworth's box diagram   [ii]
Copyright (C) 1990-1998 Masaru UZAWA(Otaru Univ. of Commerce)

You can choose the scale of the Edgeworth's box diagram:

1. Abscissa/ordinate ratio on the screen is 3/4 irrespective of
   the ratio of the initial endowment in the economy, or

2. Abscissa/ordinate ratio on the screen is accord with
   the ratio of the initial endowment of the economy.

3. Return to the previous menu phase [i]

Please press a number (1,2 or 3).

Figure 9.3 Choice of the size of the Edgeworth's box diagram

<< Data for demonstration >>   [1/1 mode]   [iii]
Because of AX/BX= .666667 > .428571 =AY/BY,   * Data for agent X *
contract curve is convex from below.   W_X1 = 20
                                              W_X2 = 50
                                              UX(X1,X2)
                                              =SX*X1^(AX)*X2^(BX)
                                              SX = 1
                                              AX = .4
                                              BX = .6
                                              * Data for agent Y *
                                              W_Y1 = 40
                                              W_Y2 = 20
                                              UY(Y1,Y2)
                                              =SY*Y1^(AY)*Y2^(BY)
                                              SY = 1
                                              AY = .3
                                              BY = .7
Copyright(C) 1990-1998 Masaru Uzawa   Y2   * Data for the economy *
        (Otaru Univ. of Commerce)   Endowment of good 1 = 60
                                              Endowment of good 2 = 70

We are now drawing the indifference curve through the initial endowment.
   Please press any key('P' or 'p' for Hardcopy) when ready...

Figure 9.4 Drawing the indifference curve through the initial endowment

F-BOX5

```
<< Data for demonstration >>                    [ 1/1 mode ]        [v]
Because of AX/BX= .666667 > .428571 =AY/BY,     * Data for agent X *
contract curve is convex from below.            W_X1 = 20
      X2        40              Oy              W_X2 = 50
 Y1                                             UX(X1,X2)
                                                =SX*X1^(AX)*X2^(BX)
 50        W              20                    SX = 1
                                                AX = .4
                                                BX = .6
                                                * Data for agent Y *
                                                W_Y1 = 40
                                                W_Y2 = 20
                                                UY(Y1,Y2)
                                                =SY*Y1^(AY)*Y2^(BY)
                                                SY = 1
                                                AY = .3
                                                BY = .7
 Ox        20                X1                 * Data for the economy *
Copyright(C) 1990-1998 Masaru Uzawa     Y2      Endowment of good 1 = 60
          (Otaru Univ. of Commerce)            Endowment of good 2 = 70
The painted      area shows advantageous allocation for both agents.
They can exchange one good for another when they are in painted area.
                Do you change the Edgeworth's box(Y/N)?
```

Figure 9.5 Advantageous allocation for both agents

F-BOX5

```
<< Data for demonstration >>                    [ 1/1 mode ]       [viii]
Because of AX/BX= .666667 > .428571 =AY/BY,     * Data for agent X *
contract curve is convex from below.            W_X1 = 20
      X2        40              Oy              W_X2 = 50
 Y1                                             UX(X1,X2)
                                                =SX*X1^(AX)*X2^(BX)
 50        W              20                    SX = 1
                                                AX = .4
                                                BX = .6
                                                * Data for agent Y *
                                                W_Y1 = 40
                                                W_Y2 = 20
                                                UY(Y1,Y2)
                                                =SY*Y1^(AY)*Y2^(BY)
                                                SY = 1
                                                AY = .3
                                                BY = .7
 Ox        20                X1                 * Data for the economy *
Copyright(C) 1990-1998 Masaru Uzawa     Y2      Endowment of good 1 = 60
          (Otaru Univ. of Commerce)            Endowment of good 2 = 70
The curve from Ox to Oy shows the Pareto efficient points(Contract curve).
The set of Pareto efficient points in the painted       area is the contract
curve defined by Edgeworth.   Do you change the Edgeworth's box(Y/N)?
```
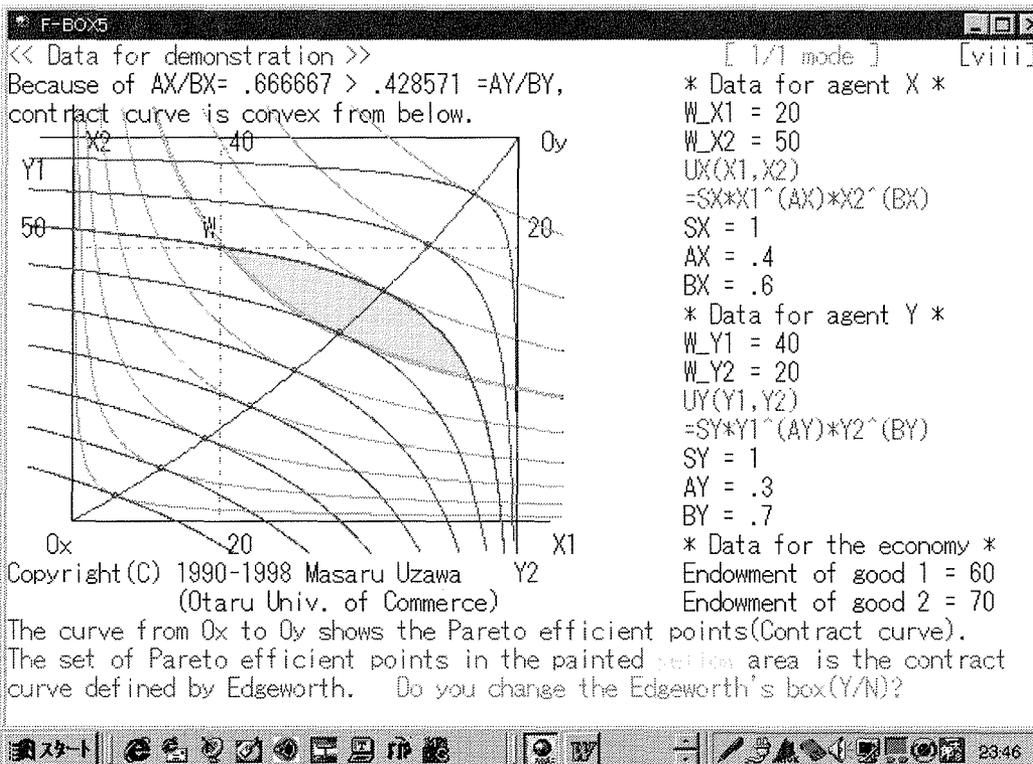
Figure 9.6 The Pareto efficient(or optimal) points

Collection of graphs will be gathered in another brochure for your reference.
You can see the same type of graphics on the screen step by step.

Chapter 10   Equilibrium and Pareto efficient allocation in 2x2
exchange economy
<F-2X2AZ-v101.exe″>

This program shows you the Edgeworth's box diagram in which you can see the equilibrium and Pareto efficiency in a 2x2 exchange economy.

   This program was programmed by Masaru Uzawa (Otaru University of Commerce) on February 14, 1990 for Fujitsu's FM R-60&70 series(Japanese version).
It was translated in English on June 13, 1991 for Toshiba's DynaBook (J-3100SS).
It was also transferred in English on April 28, 1992 for IBM PC/AT.
This version is for Windows95/98.

   Program begins with the following message screen:

 Do you want to get the explanation of the program (Y/N)?
 When you want to get the explanation of the program, please press Y or y.
 If you want to run the program, please press any key other than Y or y.

   If you can choose 'Y', then the explanation for the program begins otherwise you can see the following menu message:

 ****************** M   E   N   U ********************
 1. Demonstration (Pareto efficient locus is convex from below)
 2. Demonstration (Pareto efficient locus is the line)
 3. Demonstration (Pareto efficient locus is convex from above)
 4. Manual demonstration (You can choose parameters)
 0. Quit from the program

   Please press a number (1,2,3,4, or 0).

   If you see the demonstration, you may press a number such as 1,2, or 3. When you choose a number, then two panels appear for you.

   In the upper panel, you can see the indifference curve which passes through the consumer X's initial endowment(WX).   In the lower panel, you can see the indifference curve which passes through the consumer Y's initial endowment(WY).
   The shaded area shows allocations for which each consumer is better off.   In the right side of the panel, we show data for consumers X and Y.
   In the next phase, we give you the Box diagram to demonstrate the allocation processes of two consumers.
   The origin of consumer X is Ox, and good 1 is measured from Ox to the right, and good 2 is measured from Ox to the top.

   The origin of consumer Y is Oy, and good 1 is measured from Oy to the left, and good 2 is measured from Oy to the bottom.
   In the right side of the panel, we give data for two consumer's initial endowments, parameters of utility functions, and initial endowment in the economy.

First, we can depict the indifference curves that pass through the initial endowment of two consumers and you can see the message in the bottom.

Next, we can calculate the allocation for which two consumers are better off. The shaded area shows the favorable allocation for both consumers to the initial endowments. The shaded area also shows the region for which both consumers can exchange.

You can see the message 'Now we are calculating the equilibrium under the relative price in the economy.'

Now, we can first depict the line which has any given initial relative price and passes through the initial endowments.

Second, we can get the consumer X's indifference curve which contacts with the budget line.

Third, we can obtain the equilibrium for consumer X.

Fourth, we can depict the consumer Y's indifference curve which contacts with the same budget line.

Fifth, we can obtain the equilibrium for consumer Y.

In the lower-right panel, you can see the equilibrium of consumers X and Y and excess demands for good 1 and good 2.

The initial relative price is low, when the excess demand for good 1 is positive (Excess demand).

The initial relative price is high, when the excess demand for good 1 is negative (Excess supply).

You can see the message 'Now we are calculating the equilibrium relative price and the equilibrium'.

When you press any key, you can see the equilibrium relative price and the budget line which passes through the initial endowments. You can also see the consumer X's indifference curve which contacts with the budget line and the equilibrium for consumer X.

Next, you can see the consumer Y's indifference curve which contacts with the same budget line and the equilibrium for consumer Y. In the lower-right panel, you can see the equilibrium for consumers X and Y, and the excess demands for good 1 and good 2.

You can confirm that the excess demands for good 1 and good 2 are zero.

You can also confirm that both consumer X's indifference curve and consumer Y's indifference curve contact with the same budget line whose slope is the equilibrium relative price.

In other words, the equilibrium is the Pareto efficient point.

An allocation is called a Pareto efficient allocation if (and only if) there is no possible movement from it that could be make everyone better off.

In other words, you can see that the curve from Ox to Oy is the Pareto efficient allocations. Usually, this curve is called 'contract curve.'

The 'contract curve' defined by Edgeworth is the Pareto efficient allocation which is contained in the shaded area. We are now calling it the 'Core' of the resource allocation.

When you choose the number '1', the Pareto efficient locus is convex to the bottom.
When you choose the number '2', the Pareto efficient locus is the linear line.
When you choose the number '3', the Pareto efficient locus is convex to the top.

When you choose the number '4', data for demonstrations are shown.   And, you are requested for input numbers for parameters in the following way.

  Let consumer X's initial endowment be (W.X1, W.X2),
  W.X1 be positive,
  W.X2 be positive,
  consumer X's utility function be UX(X1, X2)=SX*X1^(AX)*X2^(BX),
  SX be positive and less than 10,
  AX be positive and less than 10,
  and,
  BX be more than some given positive number and less than 10.
  Let consumer Y's initial endowment be (W.Y1, W.Y2),
  W.Y1 be positive,
  W.Y2 be positive,
  consumer Y's utility function be UY(Y1, Y2)=SY*Y1^(AY)*Y2^(BY),
  SY be positive and less than 10,
  AY be positive and less than 10,
  and,
  BY be more than some given positive number and less than 10.

   When you input numbers, you can get the same graphics as for demonstration.

   Let Pareto efficient point be (X1, X2).
We have X2 = BX*AY*W.2*X1/(AX*BY*W.1 + (BX*AY − AX*BY)*X1)

   When AX/BX > AY/BY, the Pareto efficient locus is convex to the bottom.
   When AX/BX = AY/BY, the Pareto efficient locus is the linear line.
   When AX/BX < AY/BY, the Pareto efficient locus is convex to the top.

   Concerning the scale of the Edgeworth's box diagram, you can choose the following 2 cases.
  1. [relative mode]
     ordinate/abscissa ratio is 1/1 irrespective of the initial endowments ratio
  2. [real mode]
     ordinate/abscissa ratio is accord with the initial endowments ratio
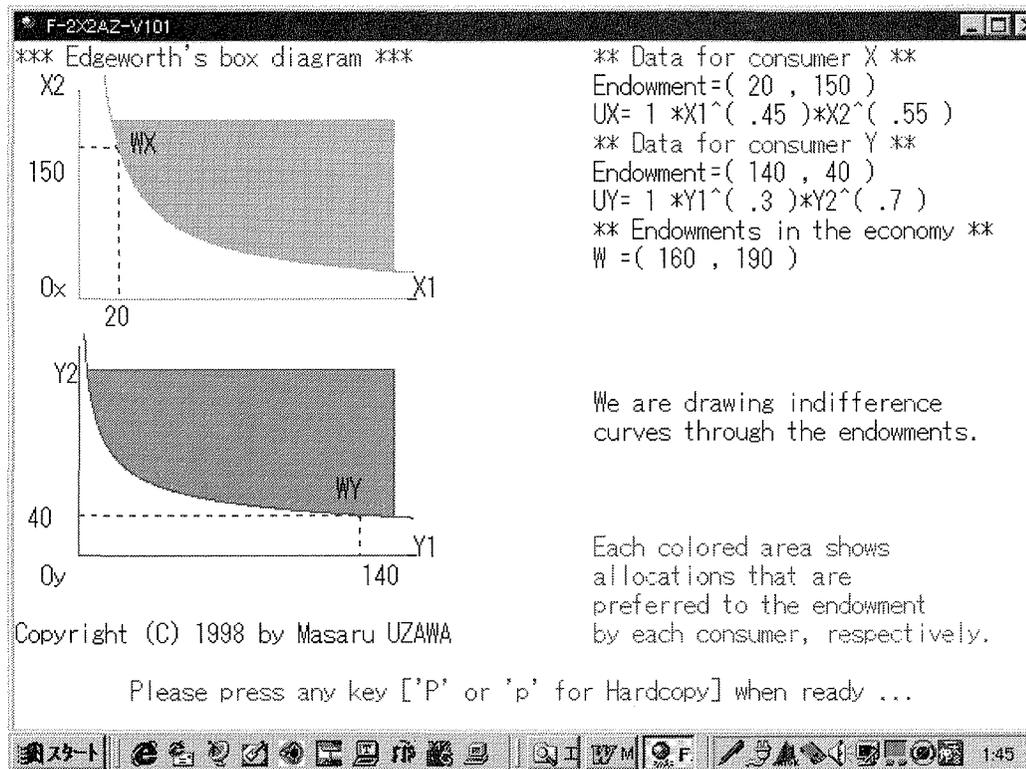
   Please press a number (1 or 2).

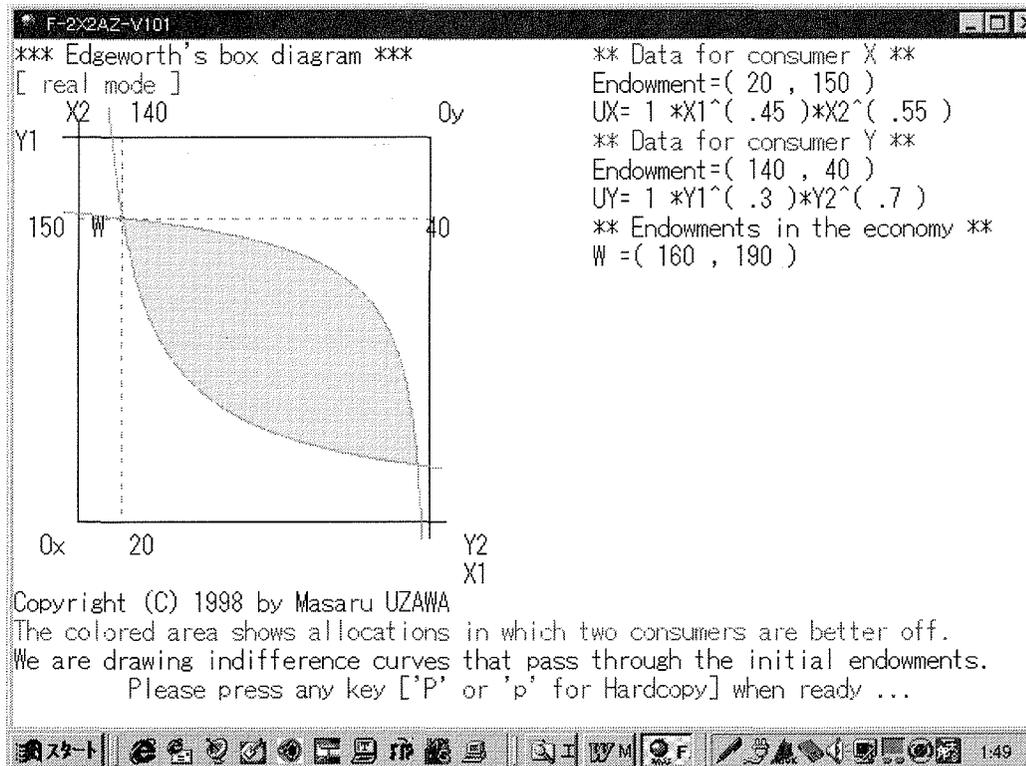Figure 10.1.1 Preferred sets to initial allocations.

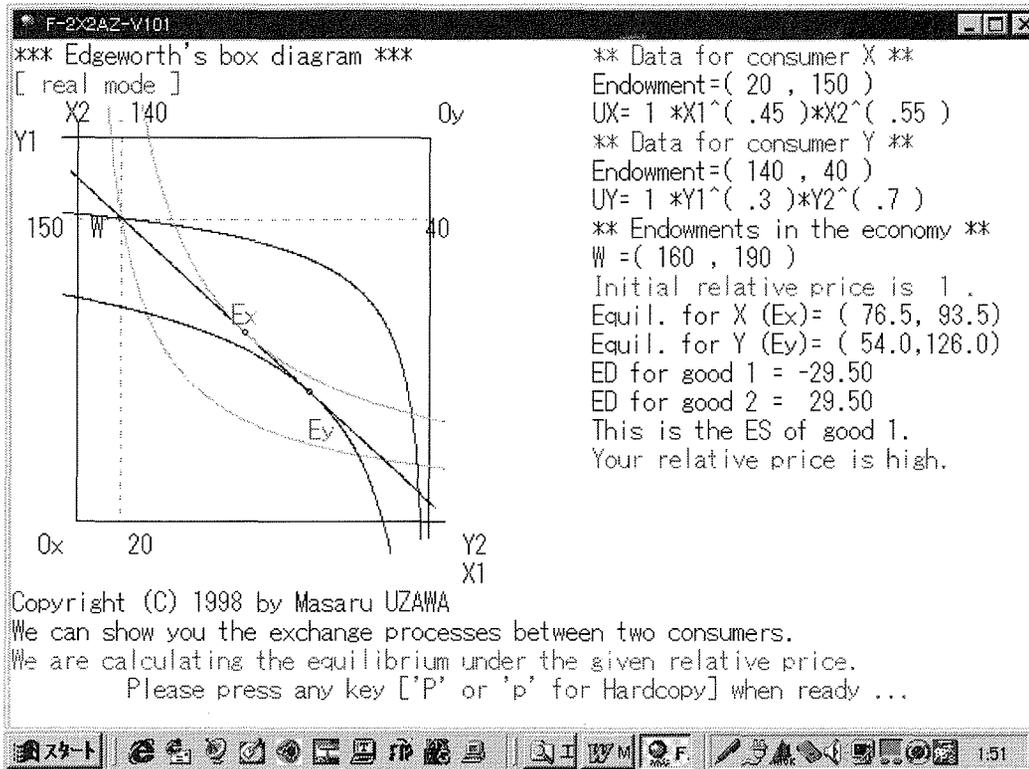Figure 10.1.2 Better off allocations for both consumers.

Figure 10.1.3 No exchange: mismatch of two consumers' equilibria.
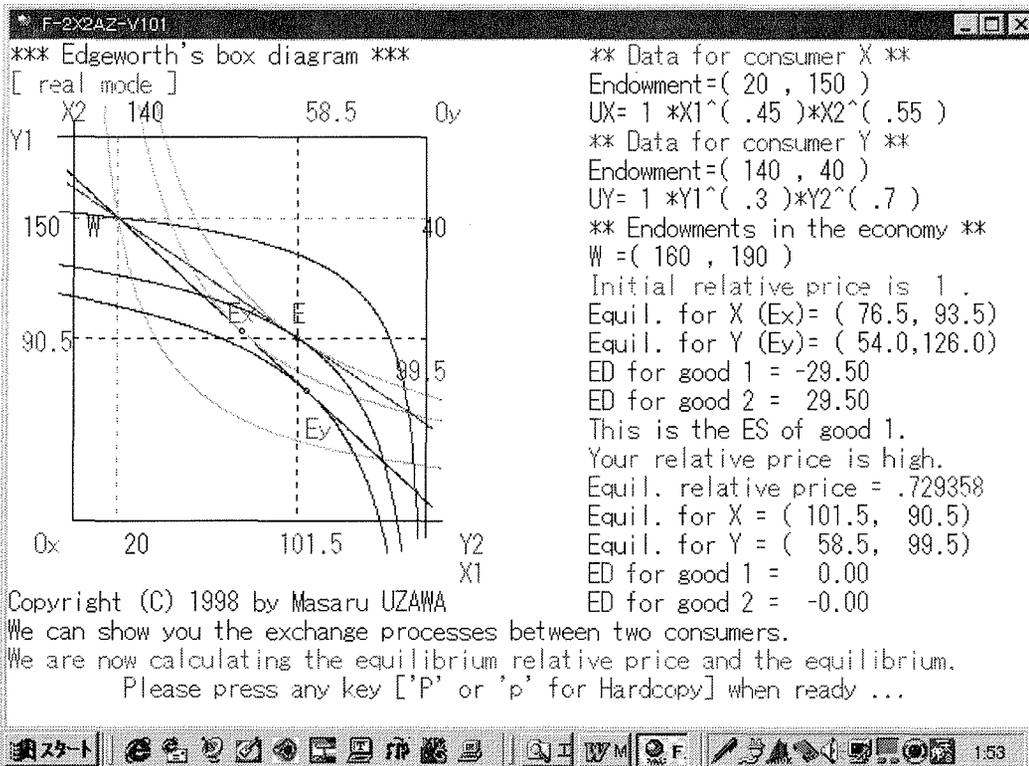
Figure 10.1.4 Exchange occurs: coincidence of two consumers' equilibria

```
** F-2X2AZ-V101                                              _ □ X

*** Edgeworth's box diagram ***        ** Data for consumer X **
[ real mode ]                          Endowment=( 20 , 150 )
      X2   140          58.5      Oy   UX= 1 *X1^( .45 )*X2^( .55 )
  Y1                                   ** Data for consumer Y **
                                       Endowment=( 140 , 40 )
                                       UY= 1 *Y1^( .3 )*Y2^( .7 )
  150   W                    40        ** Endowments in the economy **
                                       W =( 160 , 190 )
                                       Initial relative price is 1 .
                                       Equil. for X (Ex)= ( 76.5, 93.5)
  90.5          E                      Equil. for Y (Ey)= ( 54.0,126.0)
                            99.5       ED for good 1 = -29.50
                                       ED for good 2 =  29.50
                   Ey                  This is the ES of good 1.
                                       Your relative price is high.
                                       Equil. relative price = .729358
                                       Equil. for X = ( 101.5,  90.5)
   0x    20         101.5      Y2      Equil. for Y = (  58.5,  99.5)
                              X1       ED for good 1 =   0.00
  Copyright (C) 1998 by Masaru UZAWA   ED for good 2 =  -0.00
  The curve from Ox to Oy is the locus of the Pareto efficient point.
  This is the so-called contract curve.
        Please press any key ['P' or 'p' for Hardcopy] when ready ...

                                                                    1:55
```
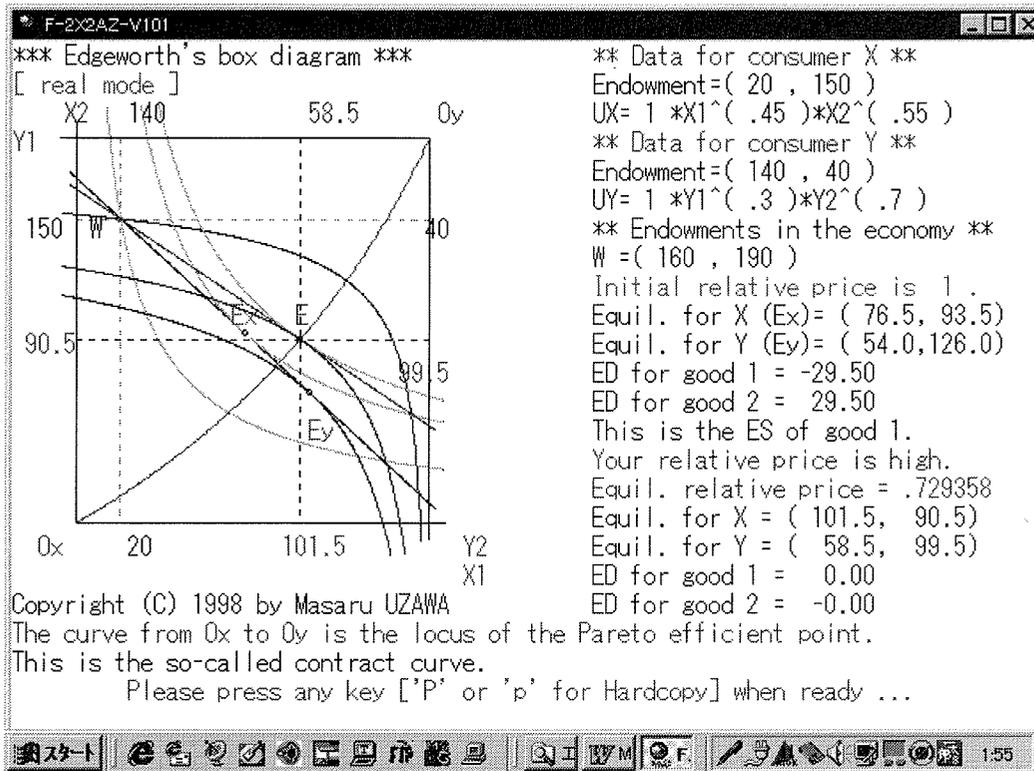
Figure 10.1.5 Pareto efficient allocations.

Collection of graphs will be gathered in another brochure for your reference.
You can see the same type of graphics on the screen step by step.

Chapter 11   Multiplier theory in income determination
No exe file
<F-MULT.exe>

This program was programmed by Masaru UZAWA (Otaru Univ. of Commerce) on July 15, 1988.

This program shows you a multiplier effect in the income determination. Program begins the following menu screen:

    M E N U
1. Display of Multiplier Effect
2. Comparison of Two Multiplier Effects

Please press a number (1 or 2)

If you choose number 1, then you must input a number for marginal propensity to consume(MPC), say 0.8. Values of temporary and cumulative spill-over effects are calculated and showed.
Then, you can see the temporary and cumulative spill-over effects in the chart.
If you choose number 2, you must input two different MPCs.
The same process proceeds as given in case 1. You can see the difference in multiplier effects for different MPCs.

Chapter 12 IS-LM analysis in income determination and interest
<F-ISLM. exe>

This program was programmed by Masaru UZAWA (Otaru Univ. of Commerce) on July 18, 1988. This version is for Windows95/98.

     This program helps you understanding the derivation of IS 15 and LM curves. Also you can get comparative statics in IS-LM analysis.

     The program begins the following message:

<   M E N U >
1. Auto demonstration of IS,LM curves and IS-LM analysis
2. Manual demonstration of IS,LM curves and IS-LM analysis

Please press a number(1 or 2).

     You can choose either auto demonstration or manual demonstration. If you press number 2 then you are required to input several parameters.

     The next menu screen begins as follows:

 *** M E N U ***:
 1. Derivation of IS curve
 2. Derivation of LM curve
 3. IS-LM Analysis (Shift in IS curve)
 4. IS-LM Analysis (Shift in LM curve)

Please press a number (1,2,3 or 4).

     If you choose number 1, then IS curve is derived on the screen from investment curve, saving curve and auxiliary I=S line. Next, you can see the effect of increase in government expenditure on IS curve, i. e., shift in IS curve.
     If you choose number 2, then LM curve is derived on the screen from transaction demand for money, speculative demand for money and money supply. Next, you can see the effect of increase in money supply on LM curve, i. e., shift in LM curve.
     If you choose number 3, then you can see the comparative statics in the case of shift in IS curve.
     If you choose number 4, then you can see the comparative statics in the case of shift in LM curve.
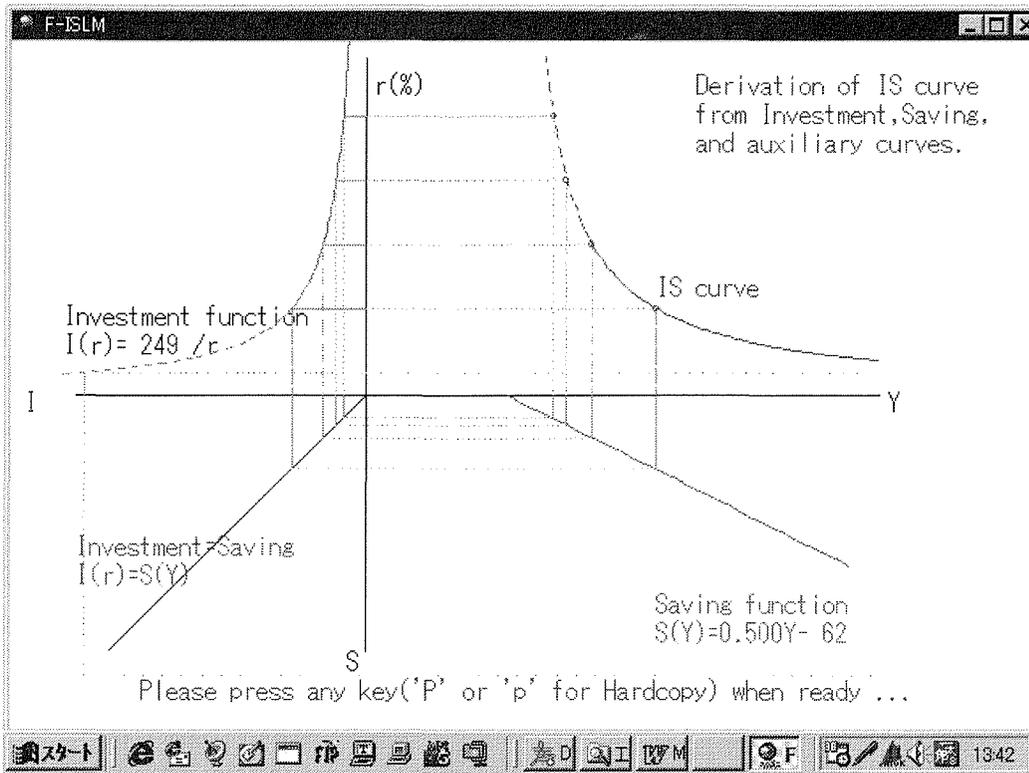
Figure 12.1.1 Derivation of IS curve.
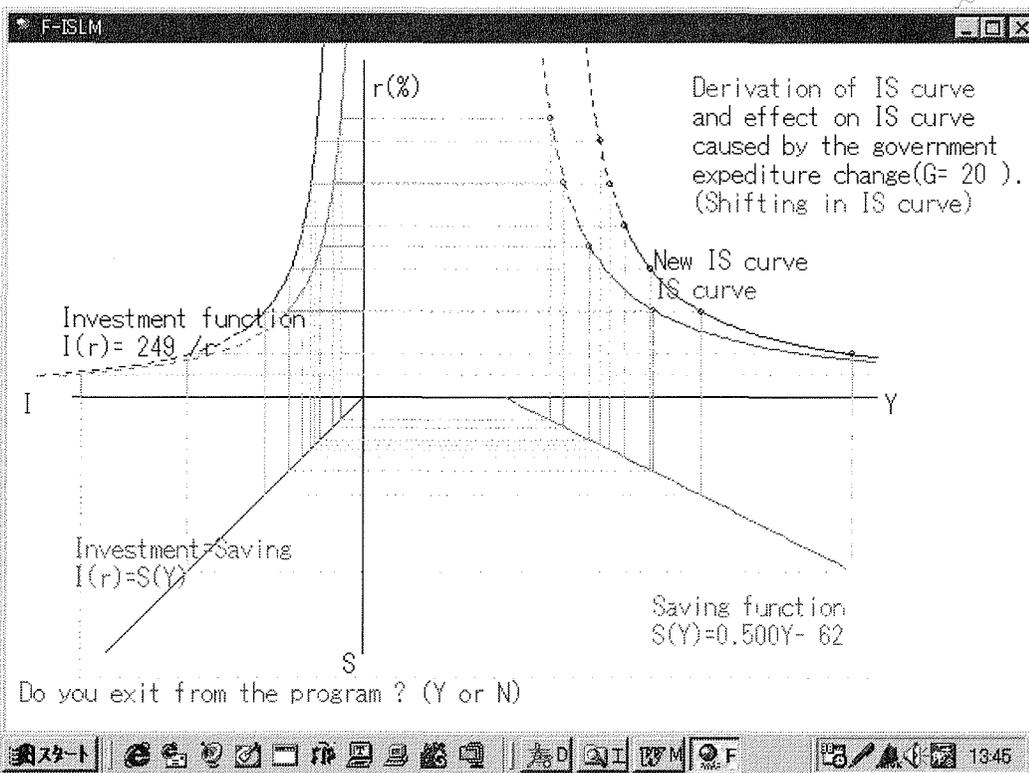
Figure 12.1.2 Derivation of New IS curve due to increase of investment.
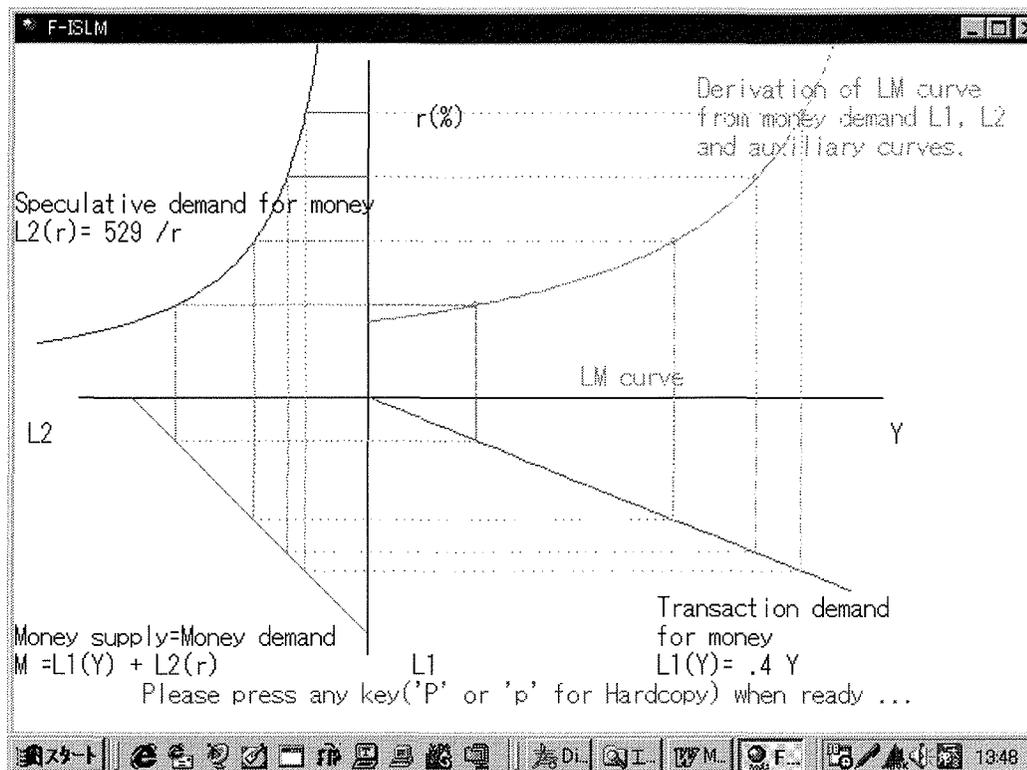
Figure 12.2.1 Derivation of LM curve.
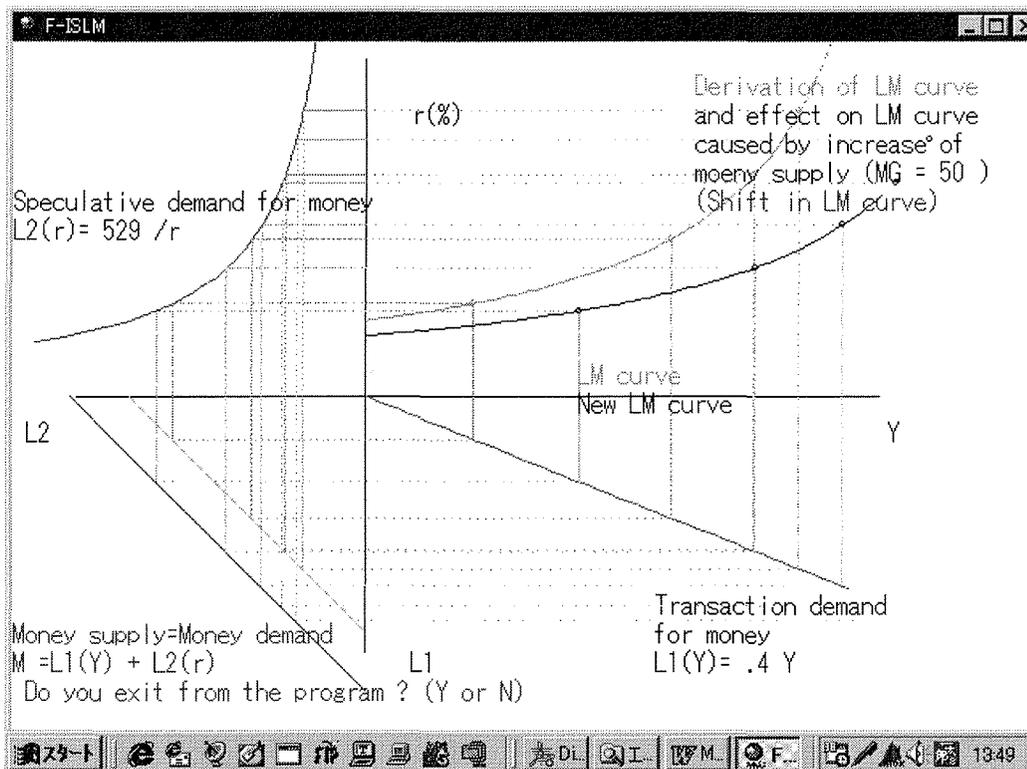
Figure 12.2.2 Derivation of New LM curve due to increase of money supply.
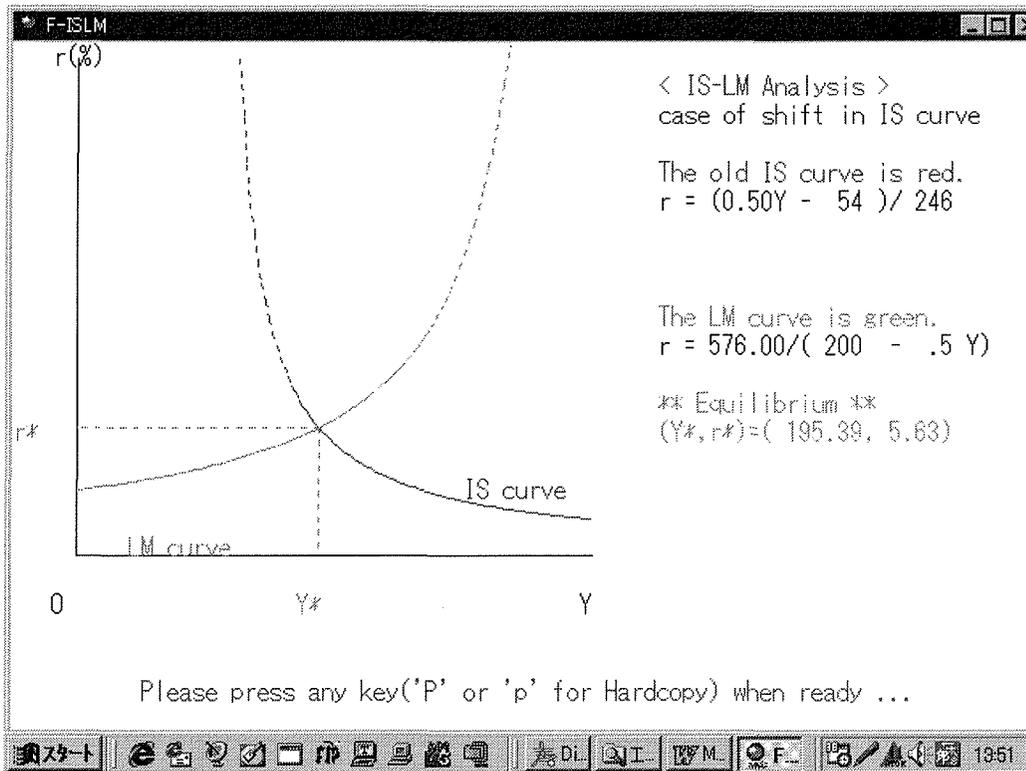
Figure 12.3.1 Equilibrium in IS-LM analysis.
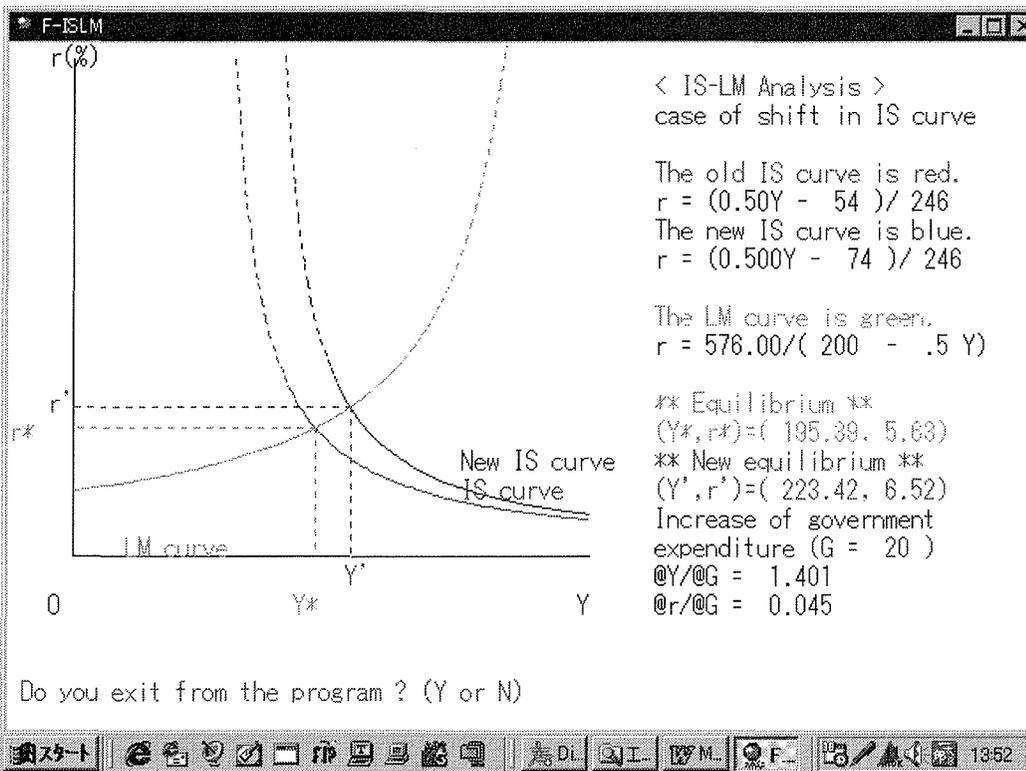
Figure 12.3.2 New equilibrium in IS-LM analysis due to increase of investment.

F-ISLM

r(%)

< IS-LM Analysis >
case of shift in LM curve

The IS curve is red.
r = (0.400Y - 69)/ 248

The old LM curve is green.
r = 600.00/(200 - .4 Y)

** Equilibrium **
(Y*,r*)=(268.28, 6.47)

IS curve

LM curve

0   Y*   Y

Please press any key('P' or 'p' for Hardcopy) when ready ...

スタート   Di. I M. F.   13:54
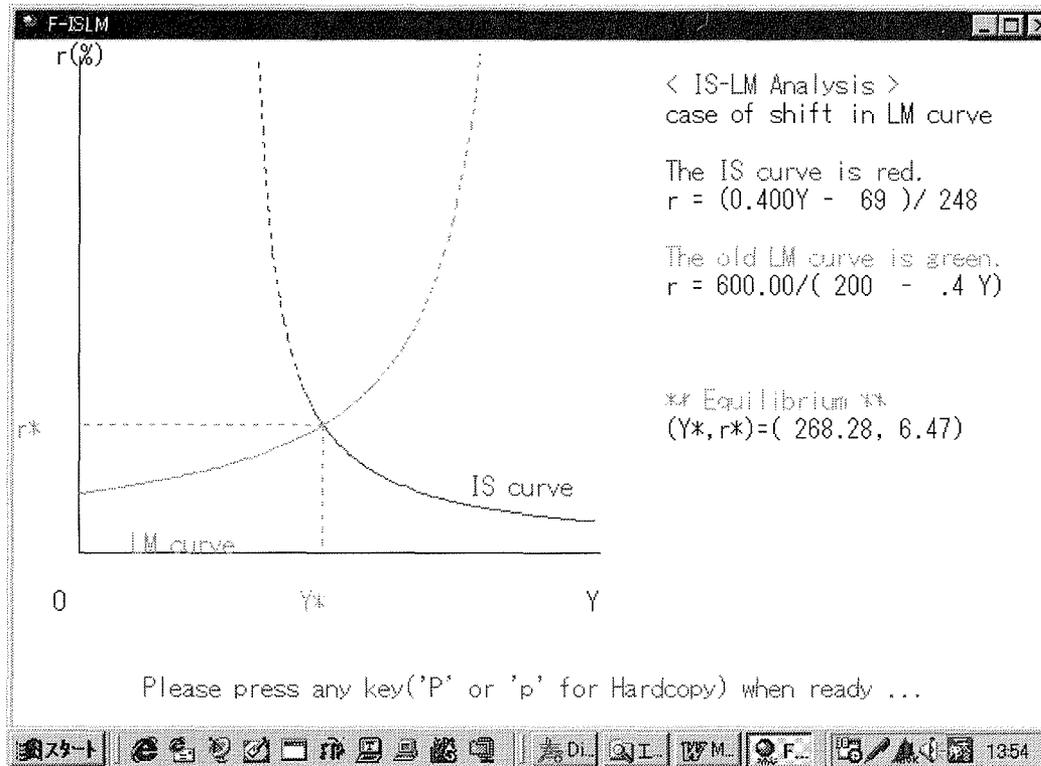
Figure 12.4.1 Equilibrium in IS-LM analysis.

F-ISLM

r(%)

< IS-LM Analysis >
case of shift in LM curve

The IS curve is red.
r = (0.400Y - 69)/ 248

The old LM curve is green.
r = 600.00/(200 - .4 Y)
The new LM curve is blue.
r = 600.00/(250 - .4 Y)

** Equilibrium **
(Y*,r*)=(268.28, 6.47)
** New equilibrium **
(Y',r')=(304.83, 4.69)
Increase of money supply
(MG = 50)
@Y/@MG = 0.731
@r/@MG = -0.036

r*

r'

IS curve

LM curve
New LM curve

0   Y* Y'   Y

Do you exit from the program ? (Y or N)

スタート   Di. I M. F.   13:55
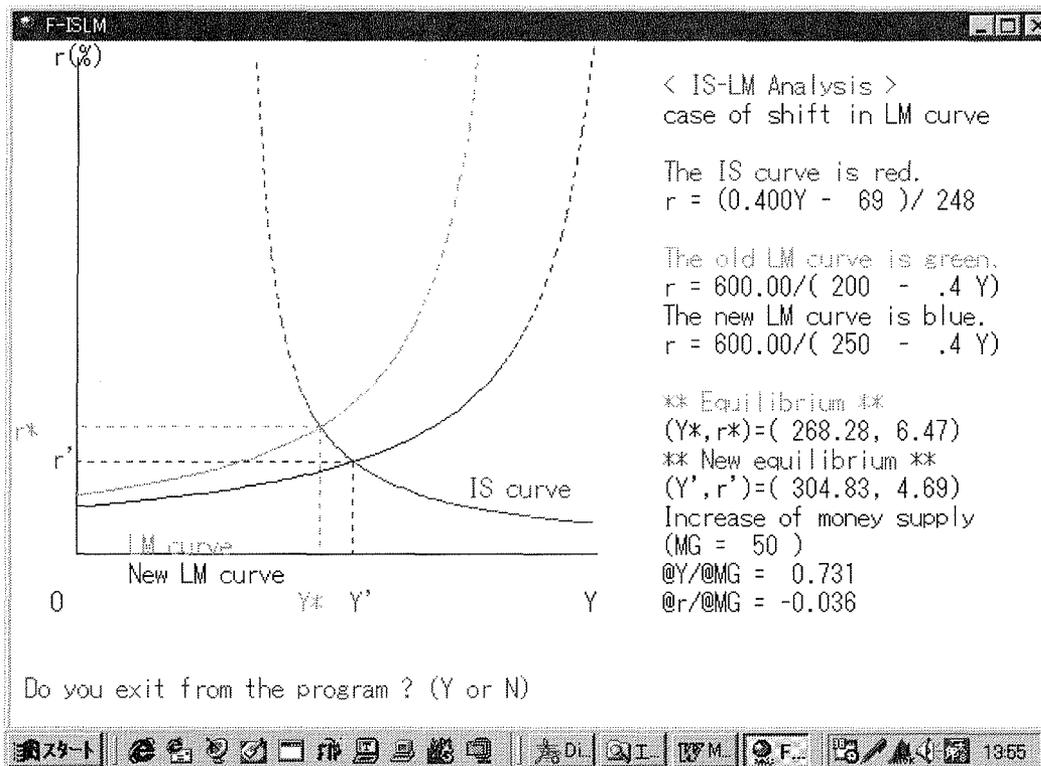
Figure 12.4.2 New equilibrium in IS-LM analysis due to increase of money supply.

Collection of graphs will be gathered in another brochure for your reference.
You can see the same type of graphics on the screen step by step.

Chapter 13 Marginal efficiency of investment
        No exe file
        <F-INVST.exe>

This program shows you the simulation of marginal efficiency of investment.
RHO is the marginal efficiency of investment which satisfies the following
relation : K=R1/(1+RHO)+R2/(1+RHO)^2

        This program was programmed by Masaru UZAWA (Otaru University of Commerce).
1990-12-08 Ver. 1.0 for J-3100SS (Japanese version)
1990-12-09 Ver. 1.01 for J-3100SS (English version)
05/04/92   Ver. 1.00 for IBM PC

        Program begins with the following menu message screen:

Marginal efficiency of investment
Copyright(C) Masaru UZAWA (Otaru University of Commerce)
1990-12-08 Ver. 1.0   for J-3100SS
05/04/92 Ver. 1.00 for IBM PC

        You can choose a number for which your computer can be done.
        The following menu screen appears when you choose, say,'3'.

  Let's define K to be an initial investment,
  R1 to be a first period reward, and,
  R2 to be a second period reward.
  The marginal efficiency of investment(RHO) satisfies the
following relation:

  K=R1/(1+RHO)+R2/(1+RHO)^2

  Let's define 1+RHO to be X.
  From K*X^2 - R1*X - R2 = 0,we have
  X =(R1 + SQR(R1^2 + 4*R2*K))/(2*K).
  Then we obtain RHO = X - 1.

  *********** M E N U ***********
  1. You can change an initial investment
  2. You can change a first period reward
  3. You can change a second period reward
  4. You can choose a set of parameters

  0. Quit from the program

    Please press a number(1,2,3,4 or 0).

        You can get the marginal efficiency of investment(RHO) in the
tabular form.You can also compare the effect of one factor change
on the marginal efficiency of investment.

Chapter 14 Simulated money creation process
No exe file
<F-MONY.exe>

This program shows you the simulation of money creation process.

    This program was programmed by Masaru Uzawa (Otaru University of Commerce) on July 12, 1988 for FM-R60&70.
It was translated in English on December 1, 1991 for DynaBook(J-3100SS).
It was also transferred in English on May 16, 1992 for IBM PC/AT.
This verison is for Windows95/98.

    Program begins with the following menu message screen:
Display of the money creation process
Copyright (C) by Masaru UZAWA (Otaru Univ. of Commerce)
1988-07-12 Ver. 1.0   for FM-R60&70
05/16/92   Ver. 1.00 for IBM PC(English version)

   **************** M   E   N   U ************
 1. Display the money creation effect
 2. Display and compare two money creation effects

    Please press a number (1 or 2).

    If you choose '1', then you are requested to input a number(%) for the deposit reserve requirement ratio and the periods of spill over effects less than 36.
    If you choose '2', then you are requested to input two numbers (%) for the deposit reserve requirement ratio and the periods of spill over effects less than 36.

    Money creation and accumulated money are displayed in a tabular form.
    You can also see the graphic representation of money creation and accumulated money.

    You can confirm that the more the deposit reserve requirement ratio, the more the money creation and the accumulated money.

Chapter 15 Iso-profit curve and Cournot and Stackelberg equilibria
<F-ISOPR.exe>

This program is to show the iso-profit and Cournot and Stackelberg equilibria in the framework of two firms model.

This program was programmed by M. Uzawa (Otaru University of Commerce) on October 12, 1991 for DynaBook (J-3100SS).
It was translated in English on January 28, 1992 for DynaBook (J-3100) series.
This version is for Windows95/98.

Let firm 1's cost function to be C1=M*Q1 and firm 2's C2=M*Q2, respectively.
Let the market demand function to be p=AA - (Q1+Q2).
You can choose numbers M and AA.

We have a reaction function of firm 1 as Q1=r1(Q2)=(AA - M - Q2)/2 and a reaction function of firm 2 as Q2=r2(Q1)=(AA - M - Q1)/2.

You can see the iso-profit curves of firm 1 and firm 2, step by step.
In the next screen, you can see the Cournot equilibrium and the Stackelberg equilibria by using the iso-profit curves.
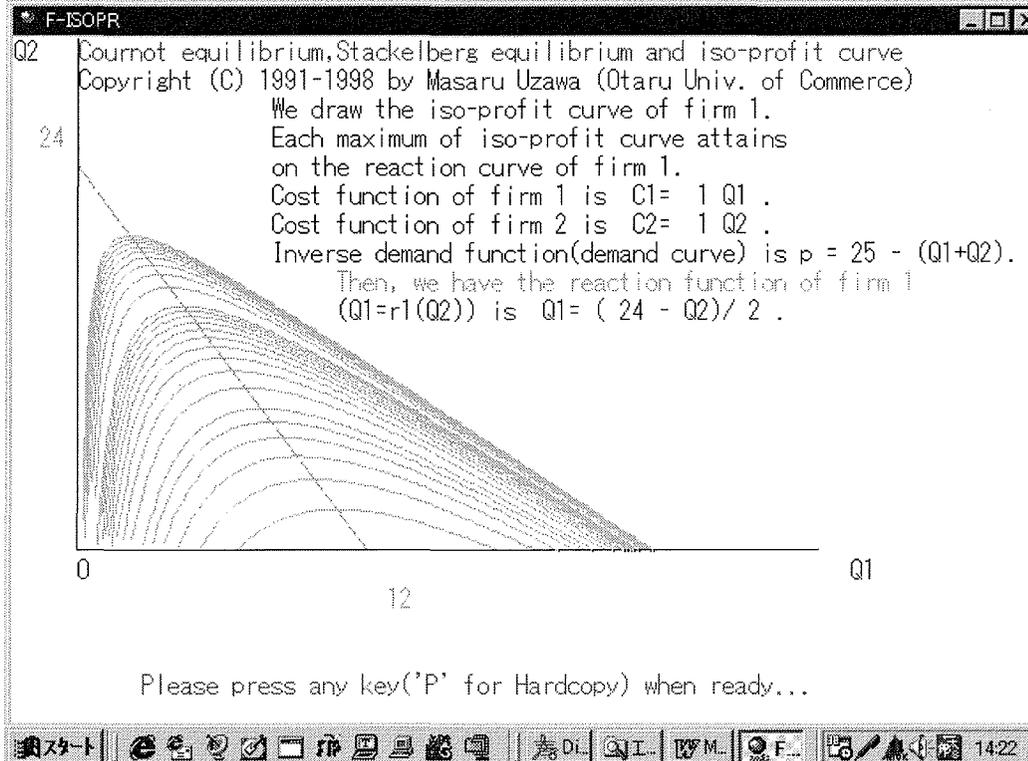
Figure 15.1 Firm 1's reaction curve and its iso-profit curves.
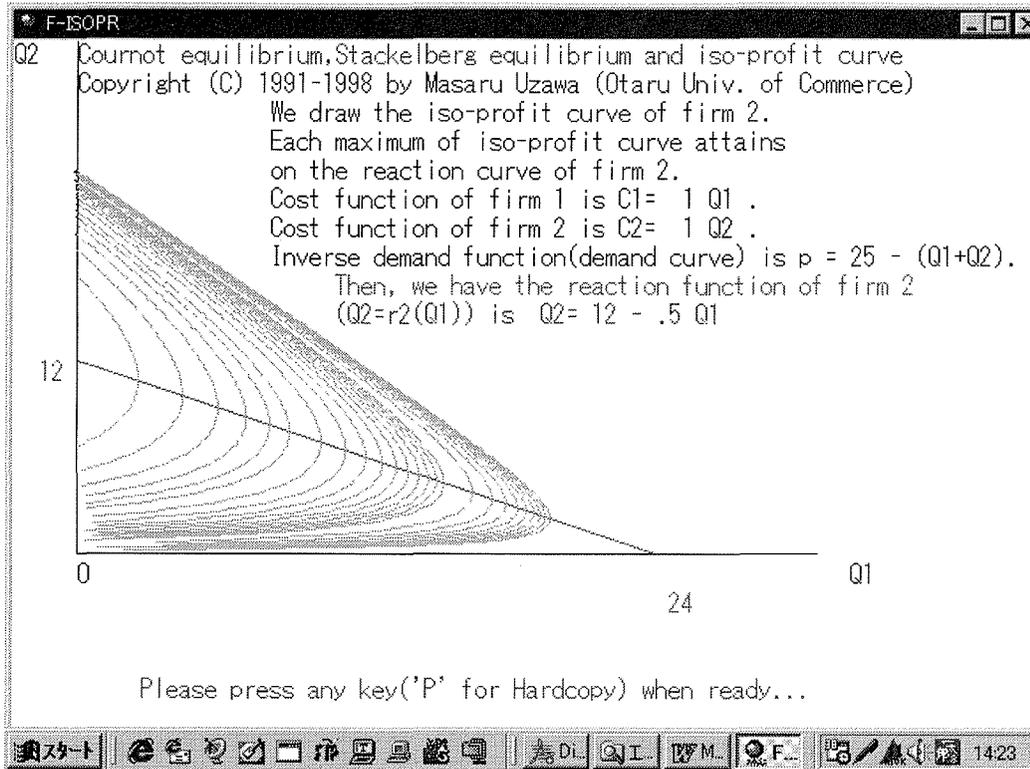
Figure 15.2 Firm 2's reaction curve and its iso-profit curves.
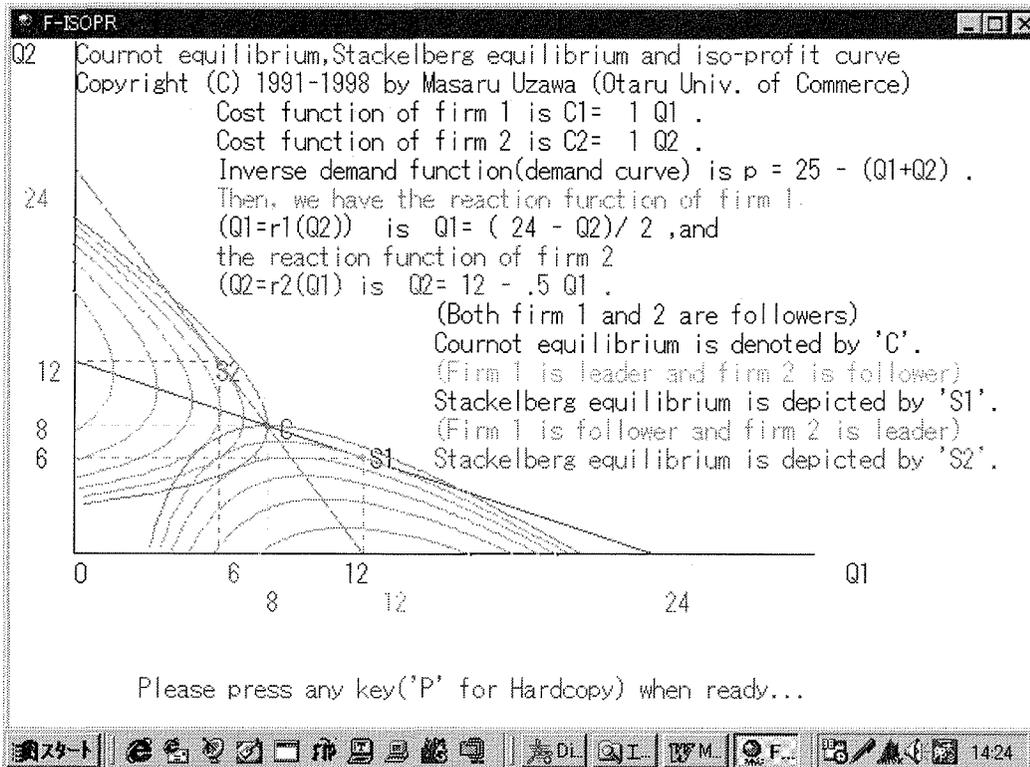
Figure 15.3 Cournot equilibrium, Stackelberg equilibria, and iso-profit curves

Chapter 16   Entry Deterrence due to Prof. Dixit(1979)
〈F-DIXIT2.exe〉

This program was created by Masaru Uzawa (Otaru University of Commerce) on 11/06/94 for Toshiba's DynaBook.
Original paper by Dixit, "A Model of Duopoly Suggesting a Theory of Entry Barriers", *Bell Journal of Economics*, Vol. 10, No. 1(Spring 1979), pp. 20-32 is acknowledged.
This version is programmed on 06/16/98 Ver. 1.00 for Windows95 by F-BASIC97.

     This program shows you the explanation by Prof. Dixit(1979) for "Entry Deterrence" on the screen. You can see the three types of demonstration and also you can choose any parameters.
You can see the following menu screen when you started the program.


```
 F-DIXIT2                                                  _ □ ×
     Entry Barriers by Dixit: Stackelberg equilibrium and isoprofit contour
     Copyright (C) Masaru Uzawa (Otaru Univ. of Commerce)
     11/06/94  Ver. 1.00  for Toshiba's DynaBook series
     06/16/98  Ver. 1.00  for Windows95  by F-BASIC97



     *******   M   E   N   U   *******

     1. Demonstration: Approve Entry and Stackelberg Equilibrium

     2. Demonstration: Entry Deterrence and 'limit output'

     3. Demonstration: Blockaded Entry and Monopoly Equilibrium

     4. The case where you can choose the parameters


     0. Exit(!!)

     Please press a number(1,2,3,4, or 0).
```

Figure 16.1   The menu screen

Please choose any number(1, 2, 3, 4, or 0) so as to do so.
If you choose 1, then you can see the case of "Approve Entry by Incumbent firm" and Incumbent firm produces at Stackelberg Equilibrium.

At first, you can confirm that the more profit accrued by firm 1(Incumbent firm), the lower position of isoprofit contour.

F-DIXIT2

X2   Entry Barriers by Dixit: Stackelberg equilibrium and isoprofit contour
      [Approve Entry]   The firm 1's isoprofit contour:
24   Each isoprofit contour achieves at maximum
                         on the firm 1's reaction curve.
                         Firm 1's cost function is C1= 1 X1
                         Firm 2's cost function is C2= 1 X2
                         Inverse demand function is p = 25 - (X1+X2).
                         Then we have the following:
                         the firm 1's reaction function(X1=r1(X2)) is
                          X1= (24 - 1 *X2)/ 2

                         Please input a number for profit less than 144

                                        PAI1(1)=? 30
                                        PAI1(2)=? 50
                                        PAI1(3)=? 90

0

          12

                                                              X1

      Please press any key ['P' or 'p' for HardCopy] when ready ...

スタート ... 0:45

Figure 16.2   The shape and position of isoprofit contours of firm 1.
The same figure is seen for firm 2(Entry firm).

F-DIXIT2

X2   Entry Barriers by Dixit: Stackelberg equilibrium and isoprofit contour
      [Approve Entry]   The firm 2's isoprofit contour:
                         Each isoprofit contour achieves at maximum
                         on the firm 2's reaction curve.
                         Firm 1's cost function is C1= 1 X1
                         Firm 2's cost funciton is C2= 1 X2
                         Inverse demand function is p = 24 - 1 *(X1+X2)
                         Fixed cost is 1 .
                         The firm 2's reaction curve is the bold line
                         of X2=(24 - 1 *X1)/ 2
12
                         Please input a number for profit less than 144

                                        PAI2(1)=? 20
                                        PAI2(2)=? 50
                                        PAI2(3)=? 100

0

                           24
                           Q1   X1

      Please press any key ['P' or 'p' for HardCopy] when ready ...

スタート ... 0:53

Figure 16.3   The shape and the position of isoprofit contours of firm 2.

You can see the case of Approve Entry by the firm 1(Incumbent firm) and
firm 1 and firm 2(Entry firm) are at the Stackelberg Equilibrium.

F-DIXIT2 [_][□][X]

```
X2    Entry Barriers by Dixit: Stackelberg equilibrium and isoprofit contour
      [Approve Entry]  The firm 1's cost function is C1= 1 *X1
24                     The firm 2's cost function is C2= 1 *X2
                       The inverse demand function is p = 25 - 1 *(X1+X2)
                       Fixed cost is = 1 . Then we have
                       firm 1's reaction function: X1=r1(X2)) is
                       X1= ( 24 - 1 *X2)/ 2
                       firm 2's reaction function: X2=r2(X1)) is
                       the bold line of X2= ( 24 - 1 *X1)/ 2
                       The Stackelberg equilibrium is denoted by S1
12                     where firm 1 is leader and firm 2 is follower.
                   S1( QS1, QS2,PS1)=( 12 , 6 , 7 )
                C           Firm 1 admits entry of firm 2, and
                   S1       the Stackelberg equilibrium S1 prevails.
6                                     output (X1,X2)     profit(pai1)
                                  A1   S1:( 12.00,   6.00)   72.00
                                       Z1:( 20.49,   0.00)   72.00
                                       B1:( 22.00,   0.00)   44.00
0              M1          B1Q1 Q1:( 24.00,   0.00)    0.00
               12          Z1  24
                                              X1

      Please press any key ['P' or 'p' for HardCopy] when ready ...
```

Figure 16.4   The case of Approval of the Incumbet firm and the Stackelberg Equilibrium.

The other cases proceed in the same way. Please see the following figures.

F-DIXIT2 [_][□][X]

```
X2    Entry Barriers by Dixit: Stackelberg equilibrium and isoprofit contour
      [Entry Deterrence]The firm 1's cost function is C1= 1 *X1
24                      The firm 2's cost function is C2= 1 *X2
                        The inverse demand function is p = 25 - 1 *(X1+X2)
                        Fixed cost is = 25 . Then we have
                        firm 1's reaction function: X1=r1(X2)) is
                        X1= ( 24 - 1 *X2)/ 2
                        firm 2's reaction function: X2=r2(X1)) is
                        the bold line of X2= ( 24 - 1 *X1)/ 2
                        The Stackelberg equilibrium is denoted by S1
12                      where firm 1 is leader and firm 2 is follower.
                    S1( QS1, QS2,PS1)=( 12 , 6 , 7 )
                C           Firm 1 can deter the entry of firm 2, and
                   S1  A1   firm 1 produces the output more than B1.
6                                      output (X1,X2)     profit(pai1)
                                   A1:( 14.00,   5.00)   70.00
                                   B1:( 14.00,   0.00)  140.00
                                   Z1:( 20.49,   0.00)   72.00
0              M1  B1         Q1 Q1:( 24.00,   0.00)    0.00
               12          Z1  24
                                              X1

      Please press any key ['P' or 'p' for HardCopy] when ready ...
```
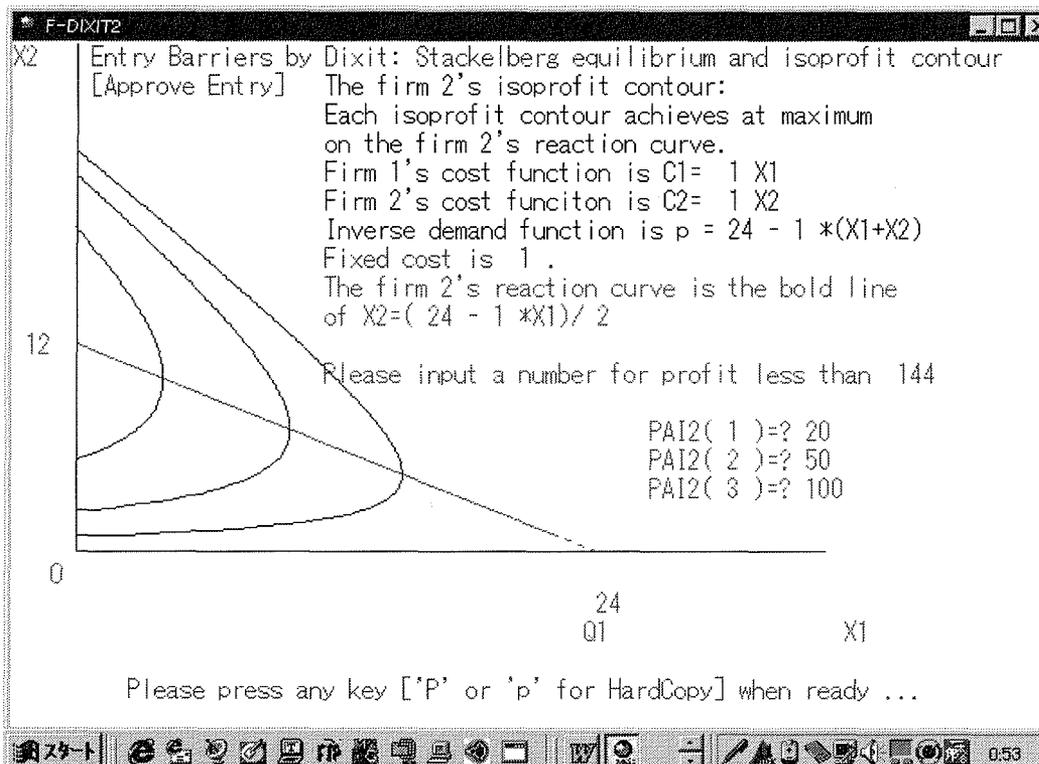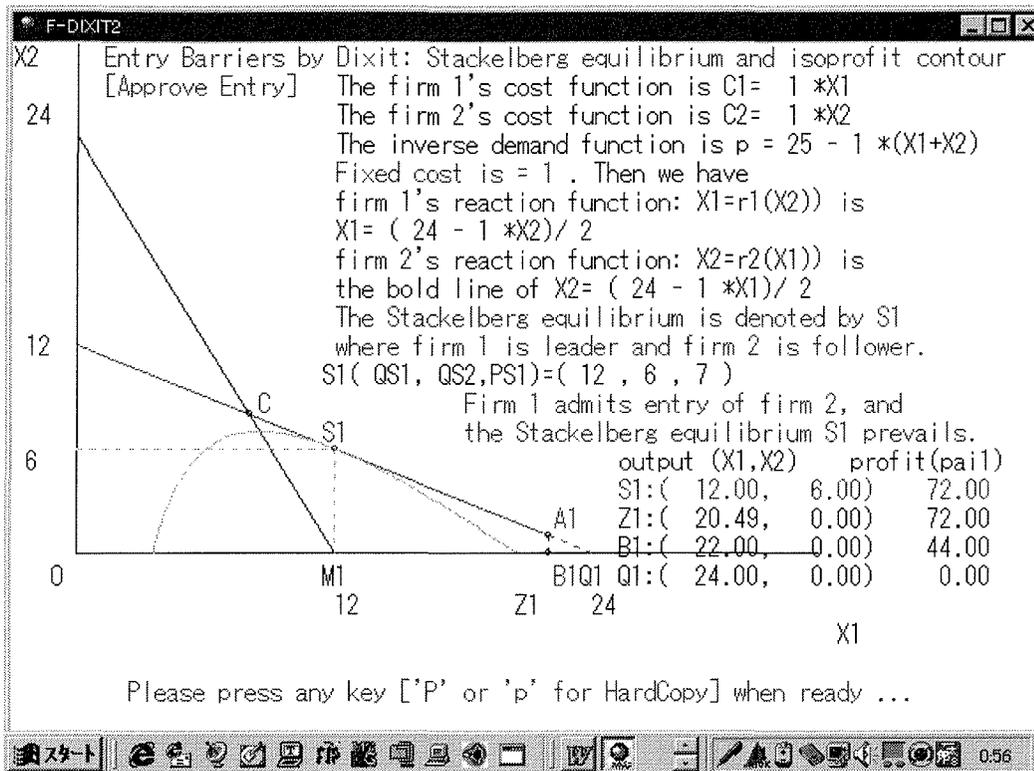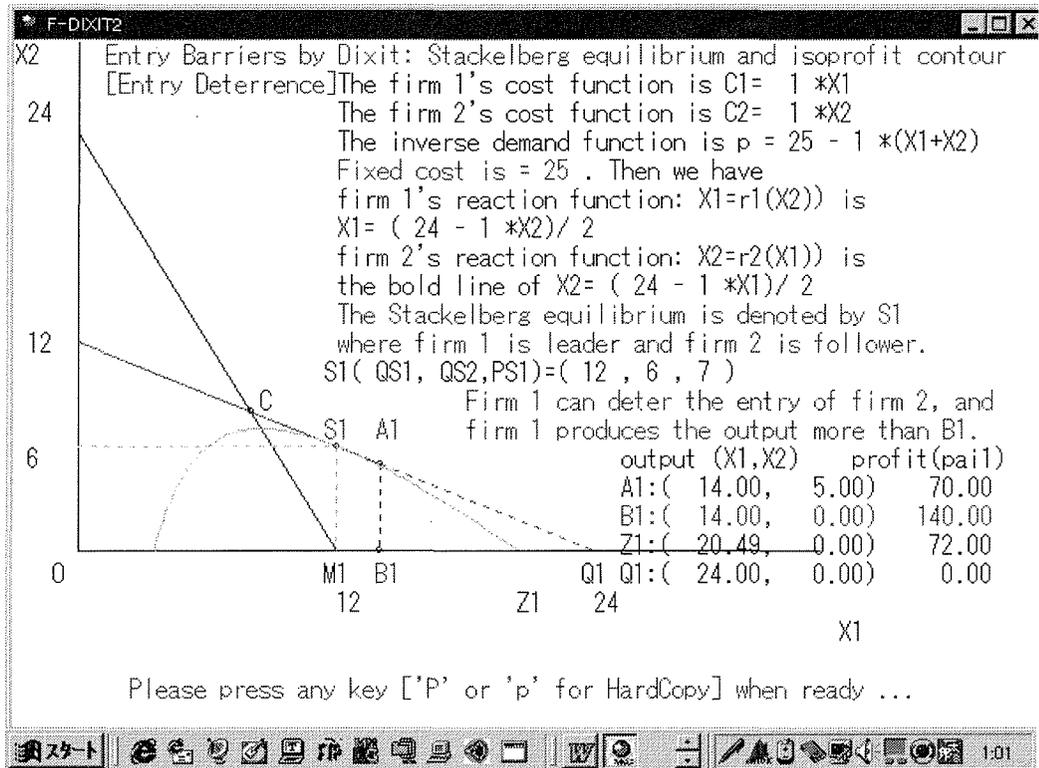
Figure 16.5 The case of Entry Deterrence by the firm 1(Incumbent firm) and firm 1 produces output more than B1.

```
┌─────────────────────────────────────────────────────────────────────┐
│ ◆ F-DIXIT2                                                    _ □ ×   │
├─────────────────────────────────────────────────────────────────────┤
│ X2  Entry Barriers by Dixit: Stackelberg equilibrium and isoprofit contour
│     [Blockaded Entry] The firm 1's cost function is C1=  1 *X1
│ 24                  The firm 2's cost function is C2=  1 *X2
│                     The inverse demand function is p = 25 - 1 *(X1+X2)
│                     Fixed cost is = 81 . Then we have
│                     firm 1's reaction function: X1=r1(X2)) is
│                     X1= ( 24 - 1 *X2)/ 2
│                     firm 2's reaction function: X2=r2(X1)) is
│                     the bold line of X2= ( 24 - 1 *X1)/ 2
│                     The Stackelberg equilibrium is denoted by S1
│ 12                  where firm 1 is leader and firm 2 is follower.
│        A1       S1( QS1, QS2,PS1)=( 12 , 6 , 7 )
│         C                 Firm 1 can block the entry of firm 2, and
│           S1              firm 1 produces at M1(Monopoly).
│ 6                                  output (X1,X2)      profit(pai1)
│                                   B1:(   6.00,   0.00)   108.00
│                                   M1:(  12.00,   0.00)   144.00
│                                   Z1:(  20.49,   0.00)    72.00
│ 0      B1      M1          Q1 Q1:(  24.00,   0.00)     0.00
│                12        Z1  24
│                                           X1
│
│     Please press any key ['P' or 'p' for HardCopy] when ready ...
└─────────────────────────────────────────────────────────────────────┘
```
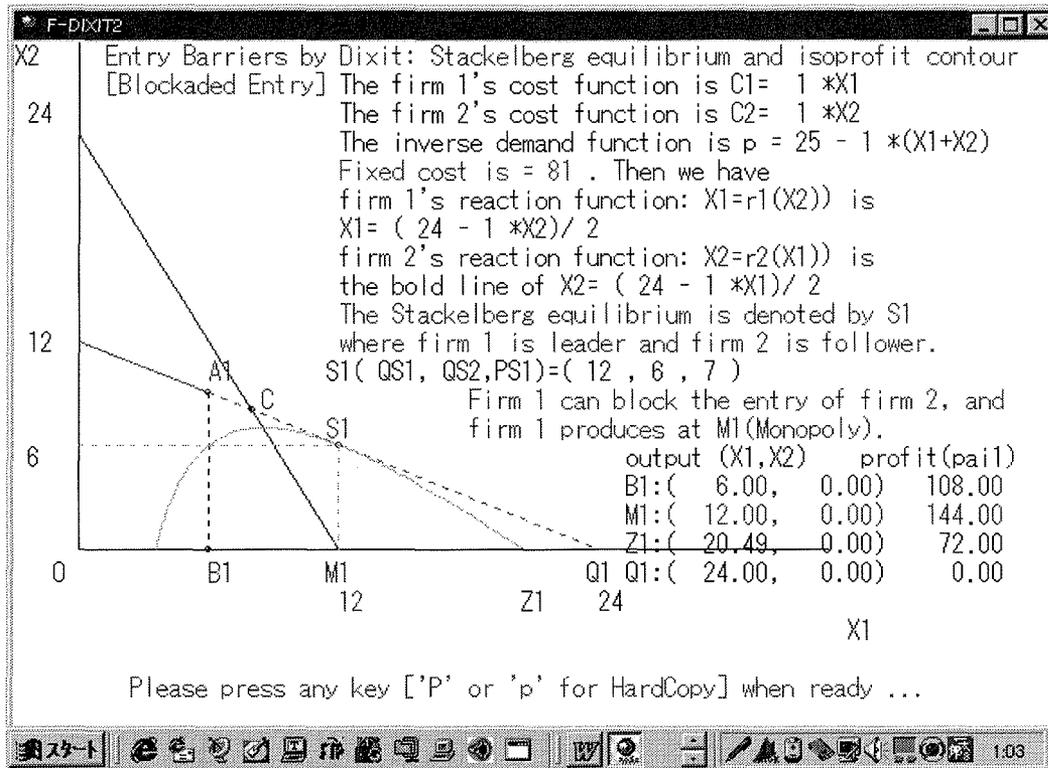
Figure 16.6   The case of Blockaded Entry by the firm 1(Incumbent firm) and firm 1 produces at Monopoly equilibrium.

If you choose 4, then you can choose any parameters of M(marginal cost), AA(the highest price at which consumer can buy), BB(the slope of the demand curve), and F(the proxy variable of scale economy).
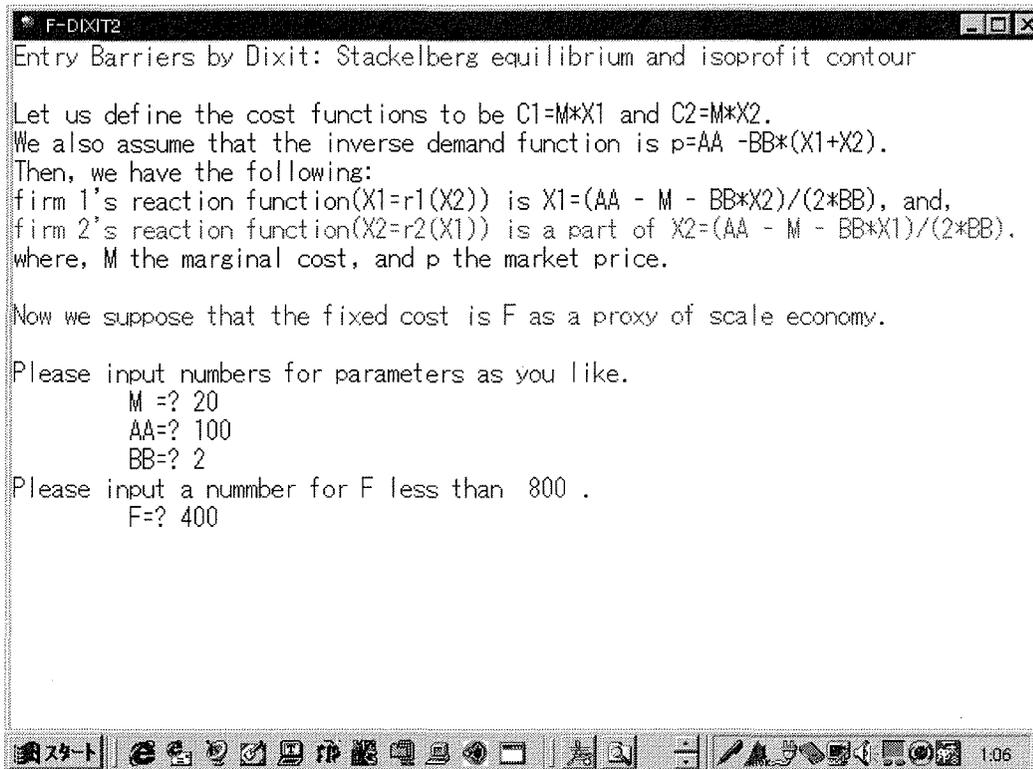
```
F-DIXIT2                                                    _ □ X
Entry Barriers by Dixit: Stackelberg equilibrium and isoprofit contour

Let us define the cost functions to be C1=M*X1 and C2=M*X2.
We also assume that the inverse demand function is p=AA -BB*(X1+X2).
Then, we have the following:
firm 1's reaction function(X1=r1(X2)) is X1=(AA - M - BB*X2)/(2*BB), and,
firm 2's reaction function(X2=r2(X1)) is a part of X2=(AA - M - BB*X1)/(2*BB),
where, M the marginal cost, and p the market price.

Now we suppose that the fixed cost is F as a proxy of scale economy.

Please input numbers for parameters as you like.
        M =? 20
        AA=? 100
        BB=? 2
Please input a nummber for F less than  800 .
        F=? 400
```

Figure 16.7 You can choose any parameters of M, AA, BB, and F.

In this case, you can see the case of Blockaded Entry by the firm 1 (Incumbent firm).

Chapter 17 Attainable set for two-person game including the battle-of-the-sexes game
<F-BOSG3.exe>

This program was programmed by M. Uzawa (Otaru University of Commerce) on January 24, 1993 for IBM PC/AT.
This version is programmed on October 4, 1998 for Windows95/98

This program shows you the attainable set for any two person game including the battle-of-the-sexes game.
For your reference, I will explain the case of the battle-of-the-sexes game.

The battle of the sexes game is a story of a man(Michael) and a woman(Rachel) planning an evening entertainment. The possible alternatives are to go to Opera or Football.
The Pay-off matrix[(Aij,Bij)] is given as follows:
Here, Aij is Michael's pay-off and Bij is Rachel's pay-off.

		Rachel	
		Opera	Football
Michael	Opera	(2,1)	(0,0)
	Football	(0,0)	(1,2)

Table 17.1 Pay-off matrix for the battle-of-the-sexes game

This means that both players would rather spend the evening together rather than apart, but Michael would rather they be together at the Opera, while Rachel would rather they be together at the Football.

There may be some case(s) where no player can improve upon his or her pay-off by changing his or her strategy unilaterally.
This solution is a Nash equilibium.

You can confirm that both (Opera, Opera) and (Football, Football) are Nash equilibria under pure strategies.
We can illustrate some of the attainable sets for two person games including the battle-of-the-sexes game.
Please see the following Figures 17.1-17.8.

Chapter 17　Attainable set for two-person game including the battle-of-the-sexes game
<F-BOSG3.exe>

This program was programmed by M. Uzawa (Otaru University of Commerce) on January 24, 1993 for IBM PC/AT.
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　　　The battle of the sexes game is a story of a man(Michael) and a woman(Rachel) planning an evening entertainment. The possible alternatives are to go to Opera or Football.
　　　The Pay-off matrix[(Aij,Bij)] is given as follows:
Here, Aij is Michael's pay-off and Bij is Rachel's pay-off.

```
                              Rachel
                      Opera       Football
                   ----------------------------
          Opera     |  (2, 1)   |   (0, 0)    |
Michael            ----------------------------
          Football  |  (0, 0)   |   (1, 2)    |
                   ----------------------------
```

Table 17.1　Pay-off matrix for the battle-of-the-sexes game

This means that both players would rather spend the evening together rather than apart, but Michael would rather they be together at the Opera, while Rachel would rather they be together at the Football.

There may be some case(s) where no player can improve upon his or her pay-off by changing his or her strategy unilaterally.
This solution is a Nash equilibium.

You can confirm that both (Opera, Opera) and (Football, Football) are Nash equilibria under pure strategies.
We can illustrate some of the attainable sets for two person games including the battle-of-the-sexes game.
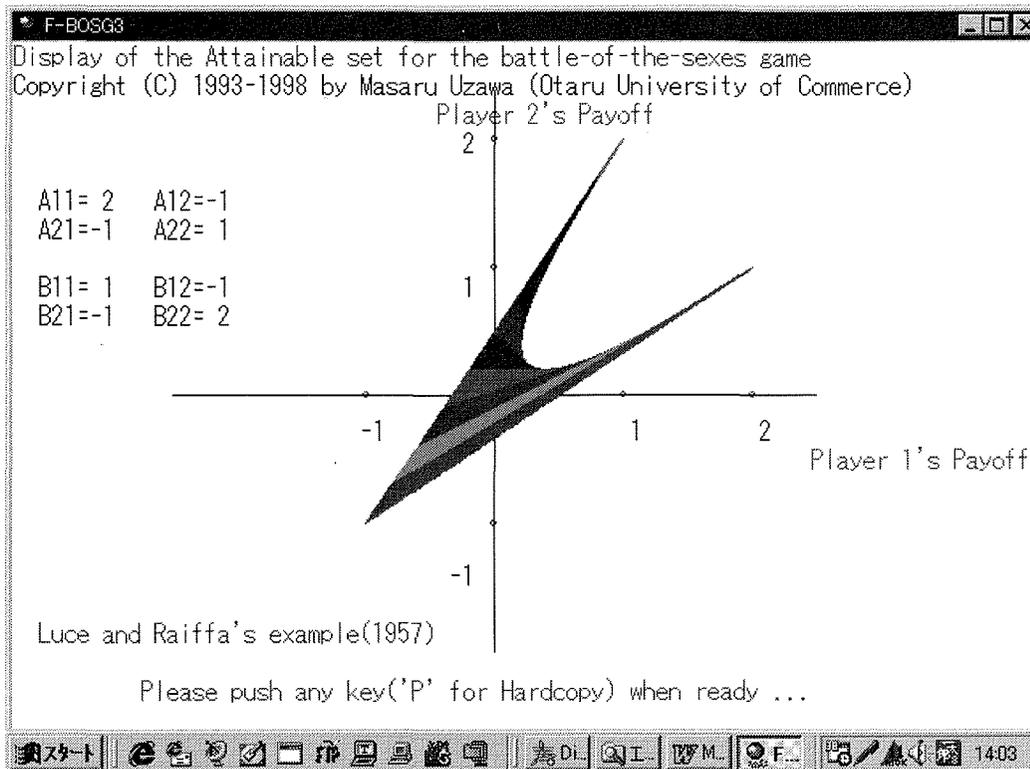Please see the following Figures 17.1-17.8.

Figure 17.1   Attainable set for the Battle-of-the-Sexes game in Luce and Raiffa(1957).
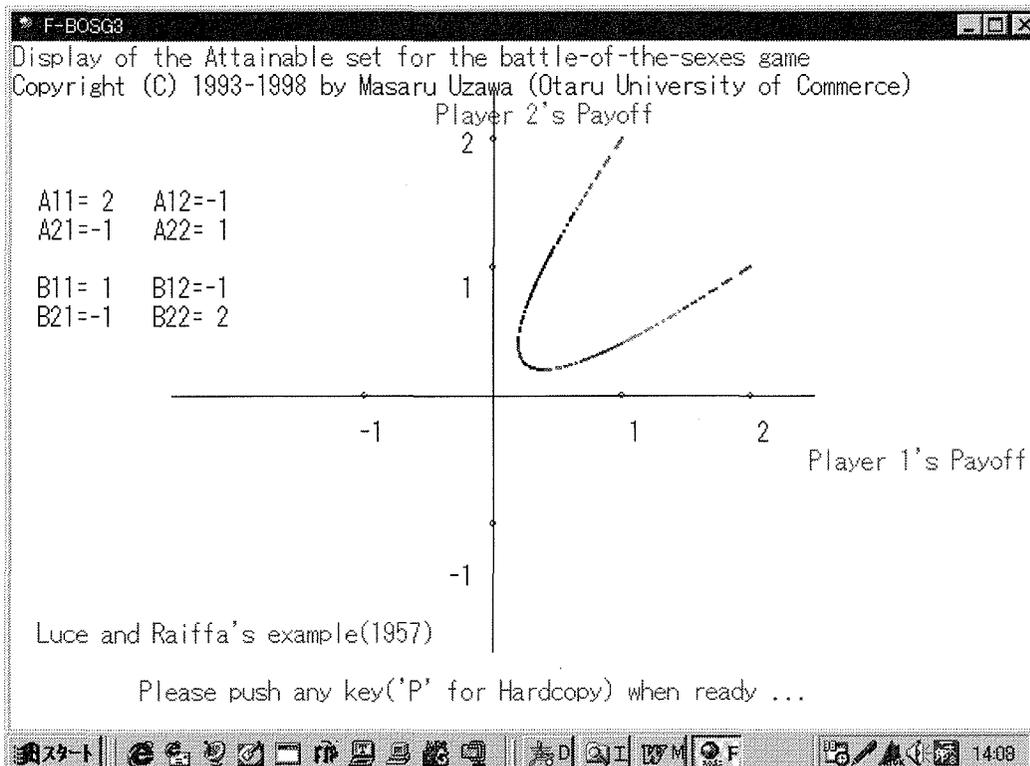

Figure 17.2   Attainable frontier in the Battle-of-the-Sexes game in Luce and Raiffa(1957).
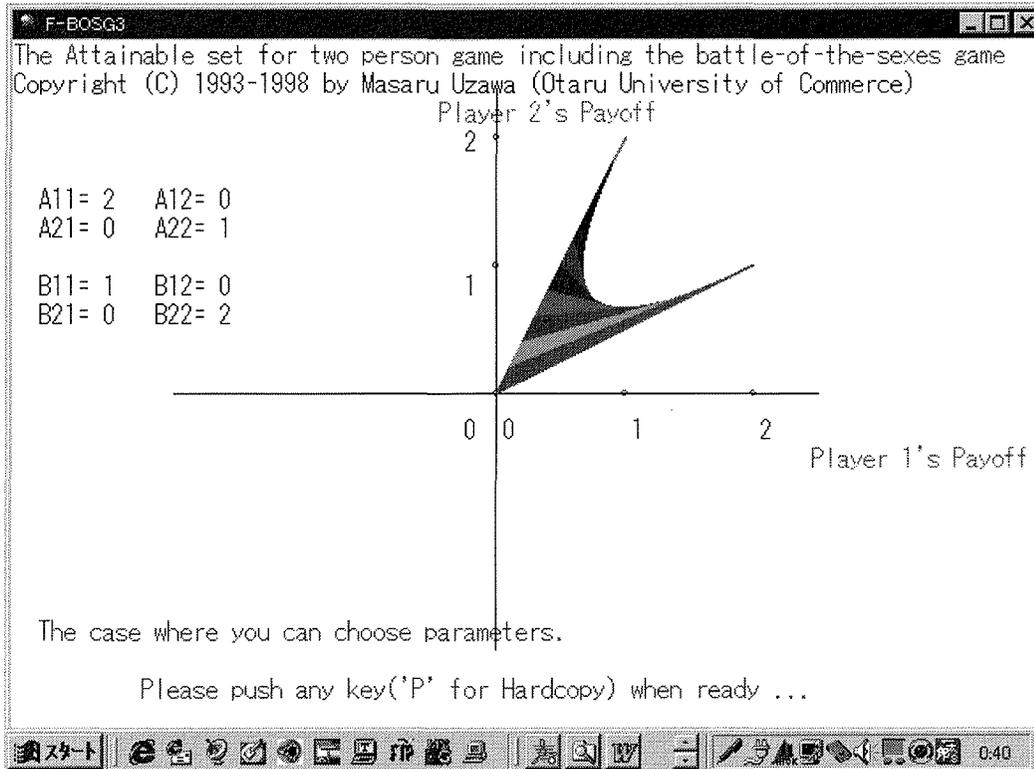
```
F-BOSG3                                                    _ □ ×
The Attainable set for two person game including the battle-of-the-sexes game
Copyright (C) 1993-1998 by Masaru Uzawa (Otaru University of Commerce)
                              Player 2's Payoff
                                 2

   A11= 2    A12= 0
   A21= 0    A22= 1

   B11= 1    B12= 0
   B21= 0    B22= 2         1

                           0  0         1         2
                                                      Player 1's Payoff

   The case where you can choose parameters.

       Please push any key('P' for Hardcopy) when ready ...
```

Figure 17.3 The attainable set for the battle-of-the-sexes game(another example)


```
F-BOSG3                                                    _ □ ×
The Attainable set for two person game including the battle-of-the-sexes game
Copyright (C) 1993-1998 by Masaru Uzawa (Otaru University of Commerce)
                              Player 2's Payoff
                                 6
                                 5

   A11= 4    A12= 2
   A21= 1    A22= 5

   B11= 2    B12= 6
   B21= 5    B22= 2         2

                              1  2      4  5
                                                      Player 1's Payoff

   The case where you can choose parameters.

       Please push any key('P' for Hardcopy) when ready ...
```
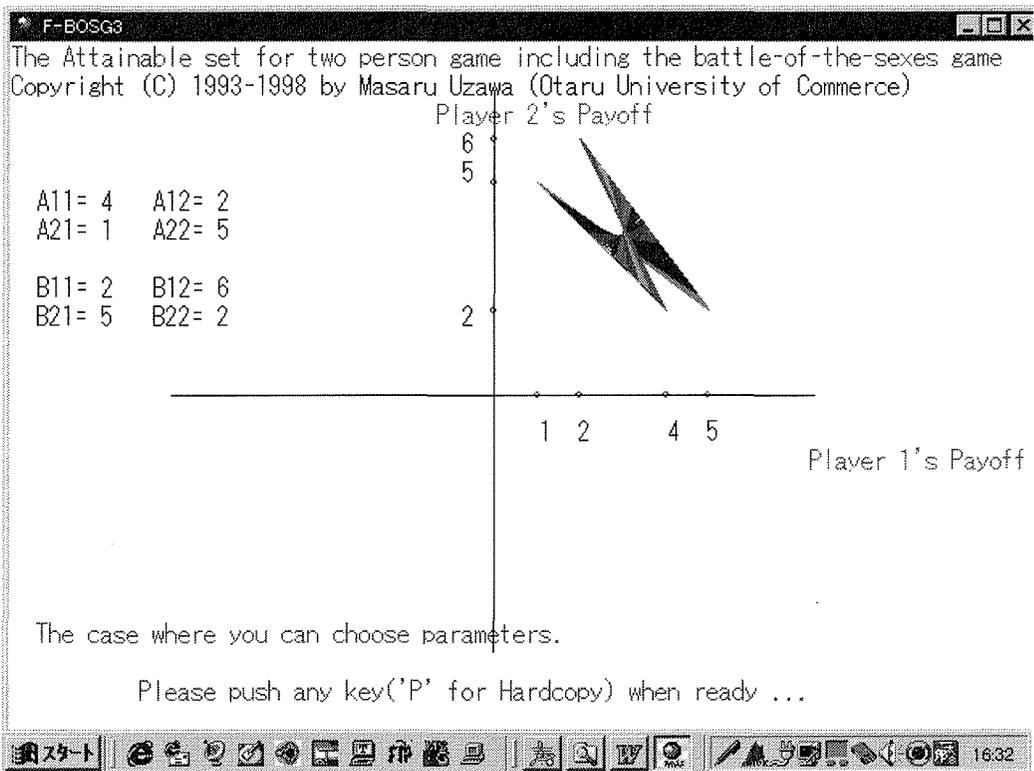
Figure 17.4 Attainable set for two person game.
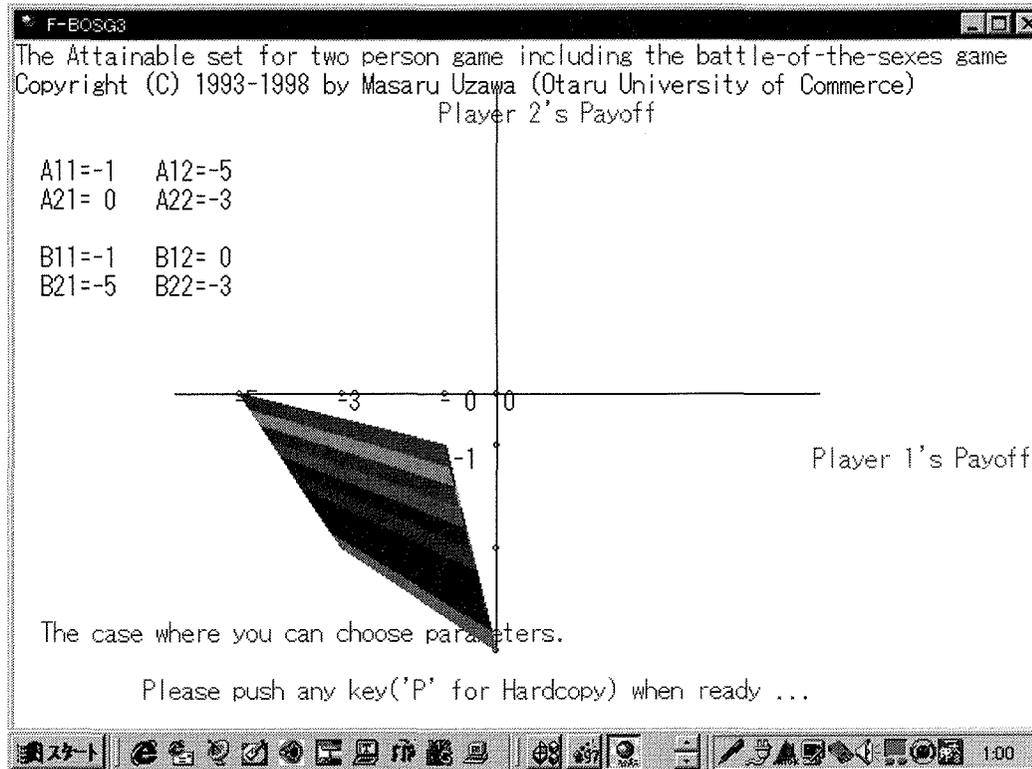
Figure 17.5   The attainable set for the prisoner's dilemma
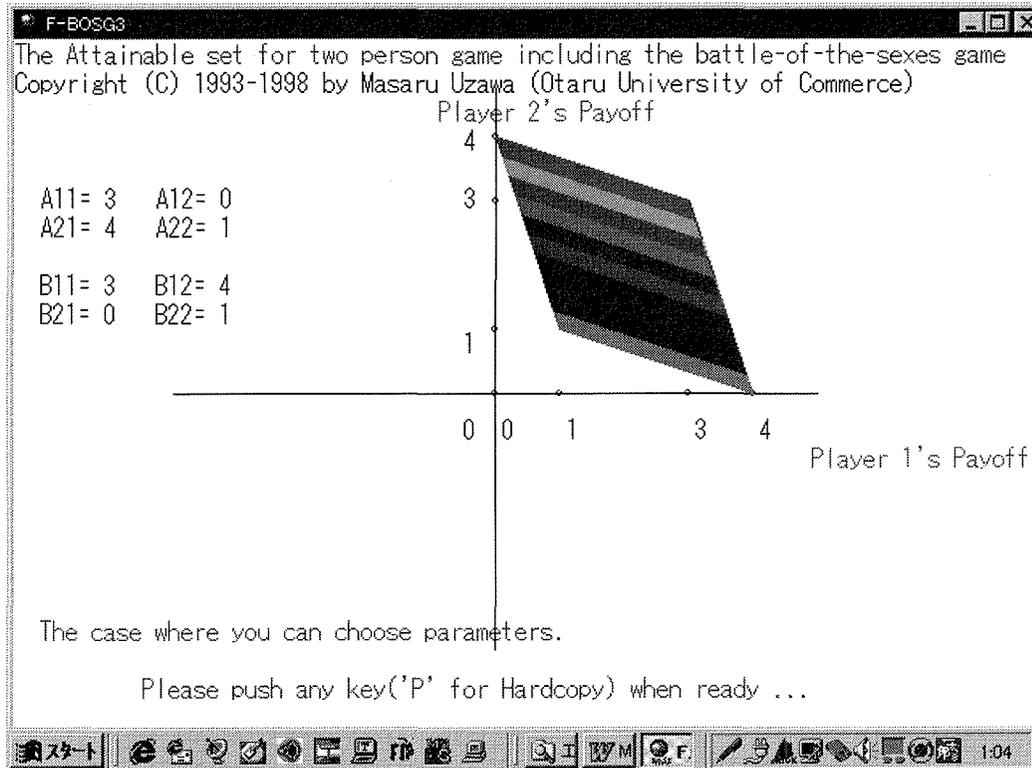

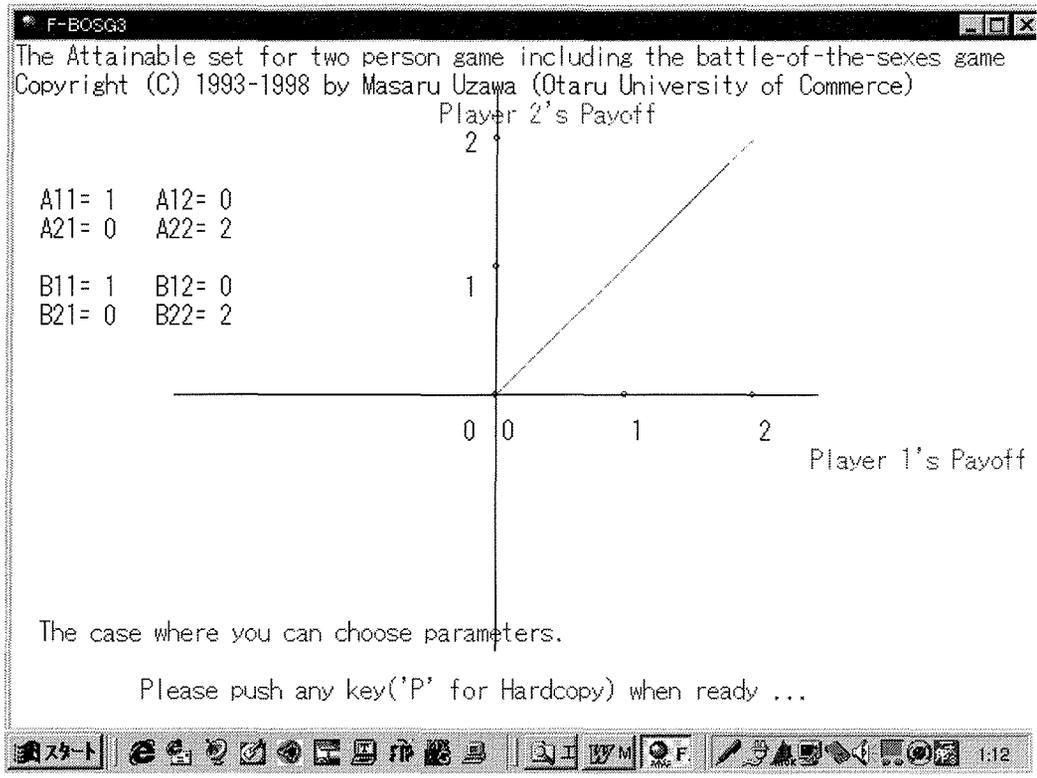Figure 17.6   The attainable set for the price war game
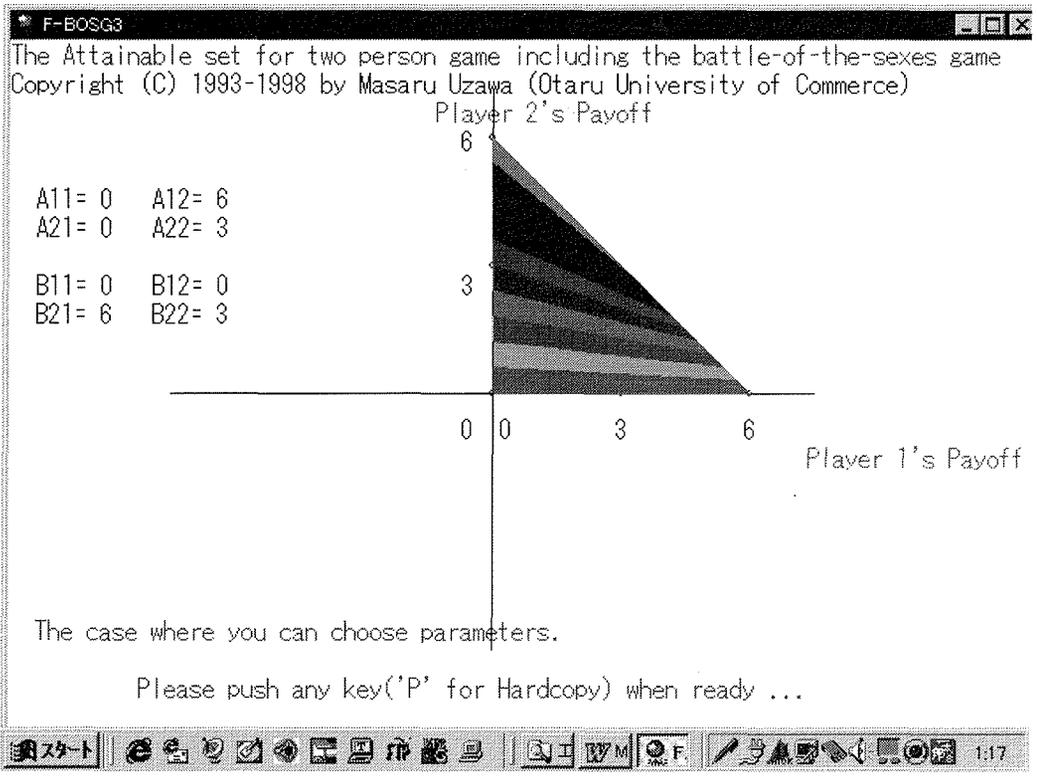
Figure 17.7   The attainable set for the coordination game

Figure 17.8   The attainable set for the Hawk-Dove game

***** End of CAL in Economics programs for Windows95/98   USER GUIDE *****