

L6 (By Peter Lohmander 2009-10-05)

Deterministic dynamic programming. General theory, application examples, analytical solutions and numerical solutions via computer programming.

Useful links:

Lohmander, P., Presentation of (stochastic and deterministic) dynamic programming:

http://www.lohmander.com/UPV/Lohmander_UPV_08.ppt

(Pages 3 – 11)

The presentation covers one section of the following text:

Lohmander, P., Adaptive Optimization of Forest Management in a Stochastic World, in Weintraub A. et al (Editors), Handbook of Operations Research in Natural Resources, Springer, Springer Science, International Series in Operations Research and Management Science, New York, USA, pp 525-544, 2007

http://www.amazon.ca/gp/reader/0387718141/ref=sib_dp_pt/701-0734992-1741115#reader-link

Lohmander, P., Optimal dynamic industrial production and stock levels with production set up costs, arbitrary variable cost functions and discounting via dynamic programming, 2004-05-05

<http://www.lohmander.com/CallDynProgInd5ice.htm>

**Optimal dynamic industrial production and stock levels
with production set up costs, arbitrary variable cost functions and discounting
via dynamic programming**
Peter Lohmander 2004-05-05

*Please, input the parameters.
Then, please click on the button!*

<i>Demand Level</i>	<i>Horizon</i>	<i>Storage Capacity</i>
<input type="text" value="3"/>	<input type="text" value="10"/>	<input type="text" value="4"/>
<i>Production Capacity</i>	<i>Storage Cost</i>	<i>Period Interest Rate (%)</i>
<input type="text" value="5"/>	<input type="text" value="1"/>	<input type="text" value="0"/>
<i>Cost(prod=0)</i>	<i>Cost(prod=1)</i>	<i>Cost(prod=2)</i>
<input type="text" value="0"/>	<input type="text" value="15"/>	<input type="text" value="17"/>
<i>Cost(prod=3)</i>	<i>Cost(prod=4)</i>	<i>Cost(prod=5)</i>
<input type="text" value="19"/>	<input type="text" value="21"/>	<input type="text" value="23"/>
<i>Cost(prod=6)</i>	<i>Cost(prod=7)</i>	<i>Cost(prod=8)</i>
<input type="text" value="25"/>	<input type="text" value="27"/>	<input type="text" value="29"/>
<i>Cost(prod=9)</i>	<i>Cost(prod=10)</i>	*
<input type="text" value="31"/>	<input type="text" value="33"/>	*
<input type="button" value="Calculate!"/>		

Optimal dynamic programming results
Peter Lohmander 2004-04-21

Optimal Production in Different States and Present Values of Total Costs

i =	0	1	2	3	4	0	1	2	3	4
t = 10	3	2	1	0	0	19	17	15	0	1
t = 9	3	5	4	0	0	38	26	24	19	18
t = 8	4	5	4	0	0	48	45	43	38	27
t = 7	3	5	5	0	0	67	64	54	48	46
t = 6	5	5	4	0	0	79	74	72	67	65
t = 5	4	5	4	0	0	96	93	91	79	75
t = 4	3	5	5	0	0	115	105	102	96	94
t = 3	4	5	4	0	0	127	122	120	115	106
t = 2	4	5	5	0	0	144	141	133	127	123
t = 1	5	5	5	0	0	158	153	150	144	142
t = 0	4	5	4	0	0	175	170	168	158	154

```
! DP via calc lingo;
! Peter Lohmander 091005;
```

```
model:
```

```
sets:
```

```
time/1..11/;;
stindex/1..5/:stock;
timestock(time,stindex):f,optprod;
prindex/1..6/:prod,cost;
endsets
```

```
data:
```

```
stock = 0 1 2 3 4;
prod = 0 1 2 3 4 5;
cost = 0 15 17 19 21 23;
enddata
```

```
CALC:
```

```
TMAX = 11;
imax = 4;
h = 1;
d = 3;
```

```
@for(stindex(i): f(TMAX,i) = 0);
@for(stindex(i):optprod(TMAX,i) = 0);
```

```
t = tmax;
```

```
@while(t #GT#1:
```

```
t=t-1;
@write(@newline(1), 't = ', t);
```

```
  i = 5;
```

```
  @while(i #GT#0:
```

```
    i = i-1;
    @write(@newline(1), '  i = ', i);
```

```
      fopt = 9999999;
```

```
      xopt = 99;
```

```
      x = 6;
```

```
      @while(x #GT#0:
```

```
        x = x-1;
        prodindex = x+1;
        stocknext = i+x-d;
        indexnext = stocknext+1;
        fev = 9999999;
```

```
        @IFC( indexnext#GE#1 #AND# indexnext#LE#5 :
          fev = cost(prodindex) + h*(i+x-d) + f(t+1,indexnext));
```

```
        @IFC( indexnext#GE#1 #AND# indexnext#LE#5 #AND# fev#LT#fopt :
          xopt = x);
```

```
        @IFC( indexnext#GE#1 #AND# indexnext#LE#5 #AND# fev#LT#fopt :
          fopt = fev);
```

```
      f(t,i+1) = fopt;
```

```

    optprod(t,i+1) = xopt;

    @write(@newline(1), '      x = ', x, ' fev = ', fev,
      ' fopt = ',fopt, ' xopt = ', xopt, ' stocknext = ', stocknext );

  );
  @write(@newline(1));

);
@write(@newline(1));

ENDCALC

end

```

```

t = 10
i = 4
x = 5 fev = 9999999 fopt = 9999999 xopt = 99 stocknext = 6
x = 4 fev = 9999999 fopt = 9999999 xopt = 99 stocknext = 5
x = 3 fev = 23 fopt = 23 xopt = 3 stocknext = 4
x = 2 fev = 20 fopt = 20 xopt = 2 stocknext = 3
x = 1 fev = 17 fopt = 17 xopt = 1 stocknext = 2
x = 0 fev = 1 fopt = 1 xopt = 0 stocknext = 1

i = 3
x = 5 fev = 9999999 fopt = 9999999 xopt = 99 stocknext = 5
x = 4 fev = 25 fopt = 25 xopt = 4 stocknext = 4
x = 3 fev = 22 fopt = 22 xopt = 3 stocknext = 3
x = 2 fev = 19 fopt = 19 xopt = 2 stocknext = 2
x = 1 fev = 16 fopt = 16 xopt = 1 stocknext = 1
x = 0 fev = 0 fopt = 0 xopt = 0 stocknext = 0

i = 2
x = 5 fev = 27 fopt = 27 xopt = 5 stocknext = 4
x = 4 fev = 24 fopt = 24 xopt = 4 stocknext = 3
x = 3 fev = 21 fopt = 21 xopt = 3 stocknext = 2
x = 2 fev = 18 fopt = 18 xopt = 2 stocknext = 1
x = 1 fev = 15 fopt = 15 xopt = 1 stocknext = 0
x = 0 fev = 9999999 fopt = 15 xopt = 1 stocknext = -1

i = 1
x = 5 fev = 26 fopt = 26 xopt = 5 stocknext = 3
x = 4 fev = 23 fopt = 23 xopt = 4 stocknext = 2
x = 3 fev = 20 fopt = 20 xopt = 3 stocknext = 1
x = 2 fev = 17 fopt = 17 xopt = 2 stocknext = 0
x = 1 fev = 9999999 fopt = 17 xopt = 2 stocknext = -1
x = 0 fev = 9999999 fopt = 17 xopt = 2 stocknext = -2

i = 0
x = 5 fev = 25 fopt = 25 xopt = 5 stocknext = 2
x = 4 fev = 22 fopt = 22 xopt = 4 stocknext = 1
x = 3 fev = 19 fopt = 19 xopt = 3 stocknext = 0
x = 2 fev = 9999999 fopt = 19 xopt = 3 stocknext = -1
x = 1 fev = 9999999 fopt = 19 xopt = 3 stocknext = -2
x = 0 fev = 9999999 fopt = 19 xopt = 3 stocknext = -3

```

```

t = 9
i = 4
x = 5 fev = 9999999 fopt = 9999999 xopt = 99 stocknext = 6
x = 4 fev = 9999999 fopt = 9999999 xopt = 99 stocknext = 5
x = 3 fev = 24 fopt = 24 xopt = 3 stocknext = 4
x = 2 fev = 20 fopt = 20 xopt = 2 stocknext = 3
x = 1 fev = 32 fopt = 20 xopt = 2 stocknext = 2
x = 0 fev = 18 fopt = 18 xopt = 0 stocknext = 1

i = 3
x = 5 fev = 9999999 fopt = 9999999 xopt = 99 stocknext = 5
x = 4 fev = 26 fopt = 26 xopt = 4 stocknext = 4
x = 3 fev = 22 fopt = 22 xopt = 3 stocknext = 3
x = 2 fev = 34 fopt = 22 xopt = 3 stocknext = 2
x = 1 fev = 33 fopt = 22 xopt = 3 stocknext = 1
x = 0 fev = 19 fopt = 19 xopt = 0 stocknext = 0

i = 2
x = 5 fev = 28 fopt = 28 xopt = 5 stocknext = 4
x = 4 fev = 24 fopt = 24 xopt = 4 stocknext = 3
x = 3 fev = 36 fopt = 24 xopt = 4 stocknext = 2
x = 2 fev = 35 fopt = 24 xopt = 4 stocknext = 1
x = 1 fev = 34 fopt = 24 xopt = 4 stocknext = 0
x = 0 fev = 9999999 fopt = 24 xopt = 4 stocknext = -1

i = 1
x = 5 fev = 26 fopt = 26 xopt = 5 stocknext = 3
x = 4 fev = 38 fopt = 26 xopt = 5 stocknext = 2
x = 3 fev = 37 fopt = 26 xopt = 5 stocknext = 1
x = 2 fev = 36 fopt = 26 xopt = 5 stocknext = 0
x = 1 fev = 9999999 fopt = 26 xopt = 5 stocknext = -1
x = 0 fev = 9999999 fopt = 26 xopt = 5 stocknext = -2

i = 0
x = 5 fev = 40 fopt = 40 xopt = 5 stocknext = 2
x = 4 fev = 39 fopt = 39 xopt = 4 stocknext = 1
x = 3 fev = 38 fopt = 38 xopt = 3 stocknext = 0
x = 2 fev = 9999999 fopt = 38 xopt = 3 stocknext = -1
x = 1 fev = 9999999 fopt = 38 xopt = 3 stocknext = -2
x = 0 fev = 9999999 fopt = 38 xopt = 3 stocknext = -3

```

```

t = 8
i = 4
x = 5 fev = 9999999 fopt = 9999999 xopt = 99 stocknext = 6
x = 4 fev = 9999999 fopt = 9999999 xopt = 99 stocknext = 5
x = 3 fev = 41 fopt = 41 xopt = 3 stocknext = 4
x = 2 fev = 39 fopt = 39 xopt = 2 stocknext = 3
x = 1 fev = 41 fopt = 39 xopt = 2 stocknext = 2
x = 0 fev = 27 fopt = 27 xopt = 0 stocknext = 1

i = 3
x = 5 fev = 9999999 fopt = 9999999 xopt = 99 stocknext = 5
x = 4 fev = 43 fopt = 43 xopt = 4 stocknext = 4
x = 3 fev = 41 fopt = 41 xopt = 3 stocknext = 3
x = 2 fev = 43 fopt = 41 xopt = 3 stocknext = 2
x = 1 fev = 42 fopt = 41 xopt = 3 stocknext = 1
x = 0 fev = 38 fopt = 38 xopt = 0 stocknext = 0

i = 2
x = 5 fev = 45 fopt = 45 xopt = 5 stocknext = 4
x = 4 fev = 43 fopt = 43 xopt = 4 stocknext = 3
x = 3 fev = 45 fopt = 43 xopt = 4 stocknext = 2
x = 2 fev = 44 fopt = 43 xopt = 4 stocknext = 1
x = 1 fev = 53 fopt = 43 xopt = 4 stocknext = 0
x = 0 fev = 9999999 fopt = 43 xopt = 4 stocknext = -1

i = 1
x = 5 fev = 45 fopt = 45 xopt = 5 stocknext = 3
x = 4 fev = 47 fopt = 45 xopt = 5 stocknext = 2
x = 3 fev = 46 fopt = 45 xopt = 5 stocknext = 1
x = 2 fev = 55 fopt = 45 xopt = 5 stocknext = 0
x = 1 fev = 9999999 fopt = 45 xopt = 5 stocknext = -1
x = 0 fev = 9999999 fopt = 45 xopt = 5 stocknext = -2

i = 0
x = 5 fev = 49 fopt = 49 xopt = 5 stocknext = 2
x = 4 fev = 48 fopt = 48 xopt = 4 stocknext = 1
x = 3 fev = 57 fopt = 48 xopt = 4 stocknext = 0
x = 2 fev = 9999999 fopt = 48 xopt = 4 stocknext = -1
x = 1 fev = 9999999 fopt = 48 xopt = 4 stocknext = -2
x = 0 fev = 9999999 fopt = 48 xopt = 4 stocknext = -3

```

```

t = 7
i = 4
x = 5 fev = 9999999 fopt = 9999999 xopt = 99 stocknext = 6
x = 4 fev = 9999999 fopt = 9999999 xopt = 99 stocknext = 5
x = 3 fev = 50 fopt = 50 xopt = 3 stocknext = 4
x = 2 fev = 58 fopt = 50 xopt = 3 stocknext = 3
x = 1 fev = 60 fopt = 50 xopt = 3 stocknext = 2
x = 0 fev = 46 fopt = 46 xopt = 0 stocknext = 1

i = 3
x = 5 fev = 9999999 fopt = 9999999 xopt = 99 stocknext = 5
x = 4 fev = 52 fopt = 52 xopt = 4 stocknext = 4
x = 3 fev = 60 fopt = 52 xopt = 4 stocknext = 3
x = 2 fev = 62 fopt = 52 xopt = 4 stocknext = 2
x = 1 fev = 61 fopt = 52 xopt = 4 stocknext = 1
x = 0 fev = 48 fopt = 48 xopt = 0 stocknext = 0

i = 2
x = 5 fev = 54 fopt = 54 xopt = 5 stocknext = 4
x = 4 fev = 62 fopt = 54 xopt = 5 stocknext = 3
x = 3 fev = 64 fopt = 54 xopt = 5 stocknext = 2
x = 2 fev = 63 fopt = 54 xopt = 5 stocknext = 1
x = 1 fev = 63 fopt = 54 xopt = 5 stocknext = 0
x = 0 fev = 9999999 fopt = 54 xopt = 5 stocknext = -1

i = 1
x = 5 fev = 64 fopt = 64 xopt = 5 stocknext = 3
x = 4 fev = 66 fopt = 64 xopt = 5 stocknext = 2
x = 3 fev = 65 fopt = 64 xopt = 5 stocknext = 1
x = 2 fev = 65 fopt = 64 xopt = 5 stocknext = 0
x = 1 fev = 9999999 fopt = 64 xopt = 5 stocknext = -1
x = 0 fev = 9999999 fopt = 64 xopt = 5 stocknext = -2

i = 0
x = 5 fev = 68 fopt = 68 xopt = 5 stocknext = 2
x = 4 fev = 67 fopt = 67 xopt = 4 stocknext = 1
x = 3 fev = 67 fopt = 67 xopt = 4 stocknext = 0
x = 2 fev = 9999999 fopt = 67 xopt = 4 stocknext = -1
x = 1 fev = 9999999 fopt = 67 xopt = 4 stocknext = -2
x = 0 fev = 9999999 fopt = 67 xopt = 4 stocknext = -3

```



```

t = 6
i = 4
x = 5 fev = 9999999 fopt = 9999999 xopt = 99 stocknext = 6
x = 4 fev = 9999999 fopt = 9999999 xopt = 99 stocknext = 5
x = 3 fev = 69 fopt = 69 xopt = 3 stocknext = 4
x = 2 fev = 68 fopt = 68 xopt = 2 stocknext = 3
x = 1 fev = 71 fopt = 68 xopt = 2 stocknext = 2
x = 0 fev = 65 fopt = 65 xopt = 0 stocknext = 1

i = 3
x = 5 fev = 9999999 fopt = 9999999 xopt = 99 stocknext = 5
x = 4 fev = 71 fopt = 71 xopt = 4 stocknext = 4
x = 3 fev = 70 fopt = 70 xopt = 3 stocknext = 3
x = 2 fev = 73 fopt = 70 xopt = 3 stocknext = 2
x = 1 fev = 80 fopt = 70 xopt = 3 stocknext = 1
x = 0 fev = 67 fopt = 67 xopt = 0 stocknext = 0

i = 2
x = 5 fev = 73 fopt = 73 xopt = 5 stocknext = 4
x = 4 fev = 72 fopt = 72 xopt = 4 stocknext = 3
x = 3 fev = 75 fopt = 72 xopt = 4 stocknext = 2
x = 2 fev = 82 fopt = 72 xopt = 4 stocknext = 1
x = 1 fev = 82 fopt = 72 xopt = 4 stocknext = 0
x = 0 fev = 9999999 fopt = 72 xopt = 4 stocknext = -1

i = 1
x = 5 fev = 74 fopt = 74 xopt = 5 stocknext = 3
x = 4 fev = 77 fopt = 74 xopt = 5 stocknext = 2
x = 3 fev = 84 fopt = 74 xopt = 5 stocknext = 1
x = 2 fev = 84 fopt = 74 xopt = 5 stocknext = 0
x = 1 fev = 9999999 fopt = 74 xopt = 5 stocknext = -1
x = 0 fev = 9999999 fopt = 74 xopt = 5 stocknext = -2

i = 0
x = 5 fev = 79 fopt = 79 xopt = 5 stocknext = 2
x = 4 fev = 86 fopt = 79 xopt = 5 stocknext = 1
x = 3 fev = 86 fopt = 79 xopt = 5 stocknext = 0
x = 2 fev = 9999999 fopt = 79 xopt = 5 stocknext = -1
x = 1 fev = 9999999 fopt = 79 xopt = 5 stocknext = -2
x = 0 fev = 9999999 fopt = 79 xopt = 5 stocknext = -3

```

```

t = 5
i = 4
x = 5 fev = 99999999 fopt = 99999999 xopt = 99 stocknext = 6
x = 4 fev = 99999999 fopt = 99999999 xopt = 99 stocknext = 5
x = 3 fev = 88 fopt = 88 xopt = 3 stocknext = 4
x = 2 fev = 87 fopt = 87 xopt = 2 stocknext = 3
x = 1 fev = 89 fopt = 87 xopt = 2 stocknext = 2
x = 0 fev = 75 fopt = 75 xopt = 0 stocknext = 1

i = 3
x = 5 fev = 99999999 fopt = 99999999 xopt = 99 stocknext = 5
x = 4 fev = 90 fopt = 90 xopt = 4 stocknext = 4
x = 3 fev = 89 fopt = 89 xopt = 3 stocknext = 3
x = 2 fev = 91 fopt = 89 xopt = 3 stocknext = 2
x = 1 fev = 90 fopt = 89 xopt = 3 stocknext = 1
x = 0 fev = 79 fopt = 79 xopt = 0 stocknext = 0

i = 2
x = 5 fev = 92 fopt = 92 xopt = 5 stocknext = 4
x = 4 fev = 91 fopt = 91 xopt = 4 stocknext = 3
x = 3 fev = 93 fopt = 91 xopt = 4 stocknext = 2
x = 2 fev = 92 fopt = 91 xopt = 4 stocknext = 1
x = 1 fev = 94 fopt = 91 xopt = 4 stocknext = 0
x = 0 fev = 99999999 fopt = 91 xopt = 4 stocknext = -1

i = 1
x = 5 fev = 93 fopt = 93 xopt = 5 stocknext = 3
x = 4 fev = 95 fopt = 93 xopt = 5 stocknext = 2
x = 3 fev = 94 fopt = 93 xopt = 5 stocknext = 1
x = 2 fev = 96 fopt = 93 xopt = 5 stocknext = 0
x = 1 fev = 99999999 fopt = 93 xopt = 5 stocknext = -1
x = 0 fev = 99999999 fopt = 93 xopt = 5 stocknext = -2

i = 0
x = 5 fev = 97 fopt = 97 xopt = 5 stocknext = 2
x = 4 fev = 96 fopt = 96 xopt = 4 stocknext = 1
x = 3 fev = 98 fopt = 96 xopt = 4 stocknext = 0
x = 2 fev = 99999999 fopt = 96 xopt = 4 stocknext = -1
x = 1 fev = 99999999 fopt = 96 xopt = 4 stocknext = -2
x = 0 fev = 99999999 fopt = 96 xopt = 4 stocknext = -3

```

```

t = 4
i = 4
x = 5 fev = 9999999 fopt = 9999999 xopt = 99 stocknext = 6
x = 4 fev = 9999999 fopt = 9999999 xopt = 99 stocknext = 5
x = 3 fev = 98 fopt = 98 xopt = 3 stocknext = 4
x = 2 fev = 99 fopt = 98 xopt = 3 stocknext = 3
x = 1 fev = 108 fopt = 98 xopt = 3 stocknext = 2
x = 0 fev = 94 fopt = 94 xopt = 0 stocknext = 1

i = 3
x = 5 fev = 9999999 fopt = 9999999 xopt = 99 stocknext = 5
x = 4 fev = 100 fopt = 100 xopt = 4 stocknext = 4
x = 3 fev = 101 fopt = 100 xopt = 4 stocknext = 3
x = 2 fev = 110 fopt = 100 xopt = 4 stocknext = 2
x = 1 fev = 109 fopt = 100 xopt = 4 stocknext = 1
x = 0 fev = 96 fopt = 96 xopt = 0 stocknext = 0

i = 2
x = 5 fev = 102 fopt = 102 xopt = 5 stocknext = 4
x = 4 fev = 103 fopt = 102 xopt = 5 stocknext = 3
x = 3 fev = 112 fopt = 102 xopt = 5 stocknext = 2
x = 2 fev = 111 fopt = 102 xopt = 5 stocknext = 1
x = 1 fev = 111 fopt = 102 xopt = 5 stocknext = 0
x = 0 fev = 9999999 fopt = 102 xopt = 5 stocknext = -1

i = 1
x = 5 fev = 105 fopt = 105 xopt = 5 stocknext = 3
x = 4 fev = 114 fopt = 105 xopt = 5 stocknext = 2
x = 3 fev = 113 fopt = 105 xopt = 5 stocknext = 1
x = 2 fev = 113 fopt = 105 xopt = 5 stocknext = 0
x = 1 fev = 9999999 fopt = 105 xopt = 5 stocknext = -1
x = 0 fev = 9999999 fopt = 105 xopt = 5 stocknext = -2

i = 0
x = 5 fev = 116 fopt = 116 xopt = 5 stocknext = 2
x = 4 fev = 115 fopt = 115 xopt = 4 stocknext = 1
x = 3 fev = 115 fopt = 115 xopt = 4 stocknext = 0
x = 2 fev = 9999999 fopt = 115 xopt = 4 stocknext = -1
x = 1 fev = 9999999 fopt = 115 xopt = 4 stocknext = -2
x = 0 fev = 9999999 fopt = 115 xopt = 4 stocknext = -3

```

```

t = 3
i = 4
x = 5 fev = 9999999 fopt = 9999999 xopt = 99 stocknext = 6
x = 4 fev = 9999999 fopt = 9999999 xopt = 99 stocknext = 5
x = 3 fev = 117 fopt = 117 xopt = 3 stocknext = 4
x = 2 fev = 116 fopt = 116 xopt = 2 stocknext = 3
x = 1 fev = 119 fopt = 116 xopt = 2 stocknext = 2
x = 0 fev = 106 fopt = 106 xopt = 0 stocknext = 1

i = 3
x = 5 fev = 9999999 fopt = 9999999 xopt = 99 stocknext = 5
x = 4 fev = 119 fopt = 119 xopt = 4 stocknext = 4
x = 3 fev = 118 fopt = 118 xopt = 3 stocknext = 3
x = 2 fev = 121 fopt = 118 xopt = 3 stocknext = 2
x = 1 fev = 121 fopt = 118 xopt = 3 stocknext = 1
x = 0 fev = 115 fopt = 115 xopt = 0 stocknext = 0

i = 2
x = 5 fev = 121 fopt = 121 xopt = 5 stocknext = 4
x = 4 fev = 120 fopt = 120 xopt = 4 stocknext = 3
x = 3 fev = 123 fopt = 120 xopt = 4 stocknext = 2
x = 2 fev = 123 fopt = 120 xopt = 4 stocknext = 1
x = 1 fev = 130 fopt = 120 xopt = 4 stocknext = 0
x = 0 fev = 9999999 fopt = 120 xopt = 4 stocknext = -1

i = 1
x = 5 fev = 122 fopt = 122 xopt = 5 stocknext = 3
x = 4 fev = 125 fopt = 122 xopt = 5 stocknext = 2
x = 3 fev = 125 fopt = 122 xopt = 5 stocknext = 1
x = 2 fev = 132 fopt = 122 xopt = 5 stocknext = 0
x = 1 fev = 9999999 fopt = 122 xopt = 5 stocknext = -1
x = 0 fev = 9999999 fopt = 122 xopt = 5 stocknext = -2

i = 0
x = 5 fev = 127 fopt = 127 xopt = 5 stocknext = 2
x = 4 fev = 127 fopt = 127 xopt = 5 stocknext = 1
x = 3 fev = 134 fopt = 127 xopt = 5 stocknext = 0
x = 2 fev = 9999999 fopt = 127 xopt = 5 stocknext = -1
x = 1 fev = 9999999 fopt = 127 xopt = 5 stocknext = -2
x = 0 fev = 9999999 fopt = 127 xopt = 5 stocknext = -3

```

```

t = 2
i = 4
x = 5 fev = 9999999 fopt = 9999999 xopt = 99 stocknext = 6
x = 4 fev = 9999999 fopt = 9999999 xopt = 99 stocknext = 5
x = 3 fev = 129 fopt = 129 xopt = 3 stocknext = 4
x = 2 fev = 135 fopt = 129 xopt = 3 stocknext = 3
x = 1 fev = 137 fopt = 129 xopt = 3 stocknext = 2
x = 0 fev = 123 fopt = 123 xopt = 0 stocknext = 1

i = 3
x = 5 fev = 9999999 fopt = 9999999 xopt = 99 stocknext = 5
x = 4 fev = 131 fopt = 131 xopt = 4 stocknext = 4
x = 3 fev = 137 fopt = 131 xopt = 4 stocknext = 3
x = 2 fev = 139 fopt = 131 xopt = 4 stocknext = 2
x = 1 fev = 138 fopt = 131 xopt = 4 stocknext = 1
x = 0 fev = 127 fopt = 127 xopt = 0 stocknext = 0

i = 2
x = 5 fev = 133 fopt = 133 xopt = 5 stocknext = 4
x = 4 fev = 139 fopt = 133 xopt = 5 stocknext = 3
x = 3 fev = 141 fopt = 133 xopt = 5 stocknext = 2
x = 2 fev = 140 fopt = 133 xopt = 5 stocknext = 1
x = 1 fev = 142 fopt = 133 xopt = 5 stocknext = 0
x = 0 fev = 9999999 fopt = 133 xopt = 5 stocknext = -1

i = 1
x = 5 fev = 141 fopt = 141 xopt = 5 stocknext = 3
x = 4 fev = 143 fopt = 141 xopt = 5 stocknext = 2
x = 3 fev = 142 fopt = 141 xopt = 5 stocknext = 1
x = 2 fev = 144 fopt = 141 xopt = 5 stocknext = 0
x = 1 fev = 9999999 fopt = 141 xopt = 5 stocknext = -1
x = 0 fev = 9999999 fopt = 141 xopt = 5 stocknext = -2

i = 0
x = 5 fev = 145 fopt = 145 xopt = 5 stocknext = 2
x = 4 fev = 144 fopt = 144 xopt = 4 stocknext = 1
x = 3 fev = 146 fopt = 144 xopt = 4 stocknext = 0
x = 2 fev = 9999999 fopt = 144 xopt = 4 stocknext = -1
x = 1 fev = 9999999 fopt = 144 xopt = 4 stocknext = -2
x = 0 fev = 9999999 fopt = 144 xopt = 4 stocknext = -3

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```

t = 1
i = 4
x = 5 fev = 9999999 fopt = 9999999 xopt = 99 stocknext = 6
x = 4 fev = 9999999 fopt = 9999999 xopt = 99 stocknext = 5
x = 3 fev = 146 fopt = 146 xopt = 3 stocknext = 4
x = 2 fev = 147 fopt = 146 xopt = 3 stocknext = 3
x = 1 fev = 150 fopt = 146 xopt = 3 stocknext = 2
x = 0 fev = 142 fopt = 142 xopt = 0 stocknext = 1

i = 3
x = 5 fev = 9999999 fopt = 9999999 xopt = 99 stocknext = 5
x = 4 fev = 148 fopt = 148 xopt = 4 stocknext = 4
x = 3 fev = 149 fopt = 148 xopt = 4 stocknext = 3
x = 2 fev = 152 fopt = 148 xopt = 4 stocknext = 2
x = 1 fev = 157 fopt = 148 xopt = 4 stocknext = 1
x = 0 fev = 144 fopt = 144 xopt = 0 stocknext = 0

i = 2
x = 5 fev = 150 fopt = 150 xopt = 5 stocknext = 4
x = 4 fev = 151 fopt = 150 xopt = 5 stocknext = 3
x = 3 fev = 154 fopt = 150 xopt = 5 stocknext = 2
x = 2 fev = 159 fopt = 150 xopt = 5 stocknext = 1
x = 1 fev = 159 fopt = 150 xopt = 5 stocknext = 0
x = 0 fev = 9999999 fopt = 150 xopt = 5 stocknext = -1

i = 1
x = 5 fev = 153 fopt = 153 xopt = 5 stocknext = 3
x = 4 fev = 156 fopt = 153 xopt = 5 stocknext = 2
x = 3 fev = 161 fopt = 153 xopt = 5 stocknext = 1
x = 2 fev = 161 fopt = 153 xopt = 5 stocknext = 0
x = 1 fev = 9999999 fopt = 153 xopt = 5 stocknext = -1
x = 0 fev = 9999999 fopt = 153 xopt = 5 stocknext = -2

i = 0
x = 5 fev = 158 fopt = 158 xopt = 5 stocknext = 2
x = 4 fev = 163 fopt = 158 xopt = 5 stocknext = 1
x = 3 fev = 163 fopt = 158 xopt = 5 stocknext = 0
x = 2 fev = 9999999 fopt = 158 xopt = 5 stocknext = -1
x = 1 fev = 9999999 fopt = 158 xopt = 5 stocknext = -2
x = 0 fev = 9999999 fopt = 158 xopt = 5 stocknext = -3

```

Feasible solution found.
 Total solver iterations:

0

Variable	Value
TMAX	11.00000
IMAX	4.000000
H	1.000000
D	3.000000
T	1.000000
I	0.000000
FOPT	158.0000
XOPT	5.000000
X	0.000000
PRODINDEX	1.000000
STOCKNEXT	-3.000000
INDEXNEXT	-2.000000
FEV	9999999.
STOCK(1)	0.000000
STOCK(2)	1.000000
STOCK(3)	2.000000
STOCK(4)	3.000000
STOCK(5)	4.000000
F(1, 1)	158.0000
F(1, 2)	153.0000
F(1, 3)	150.0000
F(1, 4)	144.0000
F(1, 5)	142.0000
F(2, 1)	144.0000
F(2, 2)	141.0000
F(2, 3)	133.0000
F(2, 4)	127.0000
F(2, 5)	123.0000
F(3, 1)	127.0000
F(3, 2)	122.0000
F(3, 3)	120.0000
F(3, 4)	115.0000
F(3, 5)	106.0000
F(4, 1)	115.0000
F(4, 2)	105.0000
F(4, 3)	102.0000
F(4, 4)	96.00000
F(4, 5)	94.00000
F(5, 1)	96.00000
F(5, 2)	93.00000
F(5, 3)	91.00000
F(5, 4)	79.00000
F(5, 5)	75.00000
F(6, 1)	79.00000
F(6, 2)	74.00000
F(6, 3)	72.00000
F(6, 4)	67.00000
F(6, 5)	65.00000
F(7, 1)	67.00000
F(7, 2)	64.00000
F(7, 3)	54.00000
F(7, 4)	48.00000
F(7, 5)	46.00000
F(8, 1)	48.00000
F(8, 2)	45.00000

F(8, 3)	43.00000
F(8, 4)	38.00000
F(8, 5)	27.00000
F(9, 1)	38.00000
F(9, 2)	26.00000
F(9, 3)	24.00000
F(9, 4)	19.00000
F(9, 5)	18.00000
F(10, 1)	19.00000
F(10, 2)	17.00000
F(10, 3)	15.00000
F(10, 4)	0.00000
F(10, 5)	1.00000
F(11, 1)	0.00000
F(11, 2)	0.00000
F(11, 3)	0.00000
F(11, 4)	0.00000
F(11, 5)	0.00000
OPTPROD(1, 1)	5.00000
OPTPROD(1, 2)	5.00000
OPTPROD(1, 3)	5.00000
OPTPROD(1, 4)	0.00000
OPTPROD(1, 5)	0.00000
OPTPROD(2, 1)	4.00000
OPTPROD(2, 2)	5.00000
OPTPROD(2, 3)	5.00000
OPTPROD(2, 4)	0.00000
OPTPROD(2, 5)	0.00000
OPTPROD(3, 1)	5.00000
OPTPROD(3, 2)	5.00000
OPTPROD(3, 3)	4.00000
OPTPROD(3, 4)	0.00000
OPTPROD(3, 5)	0.00000
OPTPROD(4, 1)	4.00000
OPTPROD(4, 2)	5.00000
OPTPROD(4, 3)	5.00000
OPTPROD(4, 4)	0.00000
OPTPROD(4, 5)	0.00000
OPTPROD(5, 1)	4.00000
OPTPROD(5, 2)	5.00000
OPTPROD(5, 3)	4.00000
OPTPROD(5, 4)	0.00000
OPTPROD(5, 5)	0.00000
OPTPROD(6, 1)	5.00000
OPTPROD(6, 2)	5.00000
OPTPROD(6, 3)	4.00000
OPTPROD(6, 4)	0.00000
OPTPROD(6, 5)	0.00000
OPTPROD(7, 1)	4.00000
OPTPROD(7, 2)	5.00000
OPTPROD(7, 3)	5.00000
OPTPROD(7, 4)	0.00000
OPTPROD(7, 5)	0.00000
OPTPROD(8, 1)	4.00000
OPTPROD(8, 2)	5.00000
OPTPROD(8, 3)	4.00000
OPTPROD(8, 4)	0.00000
OPTPROD(8, 5)	0.00000
OPTPROD(9, 1)	3.00000
OPTPROD(9, 2)	5.00000
OPTPROD(9, 3)	4.00000

OPTPROD(9, 4)	0.000000
OPTPROD(9, 5)	0.000000
OPTPROD(10, 1)	3.000000
OPTPROD(10, 2)	2.000000
OPTPROD(10, 3)	1.000000
OPTPROD(10, 4)	0.000000
OPTPROD(10, 5)	0.000000
OPTPROD(11, 1)	0.000000
OPTPROD(11, 2)	0.000000
OPTPROD(11, 3)	0.000000
OPTPROD(11, 4)	0.000000
OPTPROD(11, 5)	0.000000
PROD(1)	0.000000
PROD(2)	1.000000
PROD(3)	2.000000
PROD(4)	3.000000
PROD(5)	4.000000
PROD(6)	5.000000
COST(1)	0.000000
COST(2)	15.000000
COST(3)	17.000000
COST(4)	19.000000
COST(5)	21.000000
COST(6)	23.000000

```
! Dynopt1_080916 ;
! Peter Lohmander ;
```

```
min = w1 + w2;
```

```
d = .9;
```

```
[u11] w1 >= 5 + d*w1;
```

```
[u12] w1 >= 0 + d*w2;
```

```
[u21] w2 >= 14 + d*w1;
```

```
[u22] w2 >= 6 + d*w2;
```

```
end
```

Global optimal solution found.

Objective value:	140.0000
Infeasibilities:	0.000000
Total solver iterations:	0

Variable	Value	Reduced Cost
W1	66.31579	0.000000
W2	73.68421	0.000000
D	0.9000000	0.000000

Row	Slack or Surplus	Dual Price
1	140.0000	-1.000000
2	0.000000	-1400.000
U11	1.631579	0.000000
U12	0.000000	-10.00000
U21	0.000000	-10.00000
U22	1.368421	0.000000