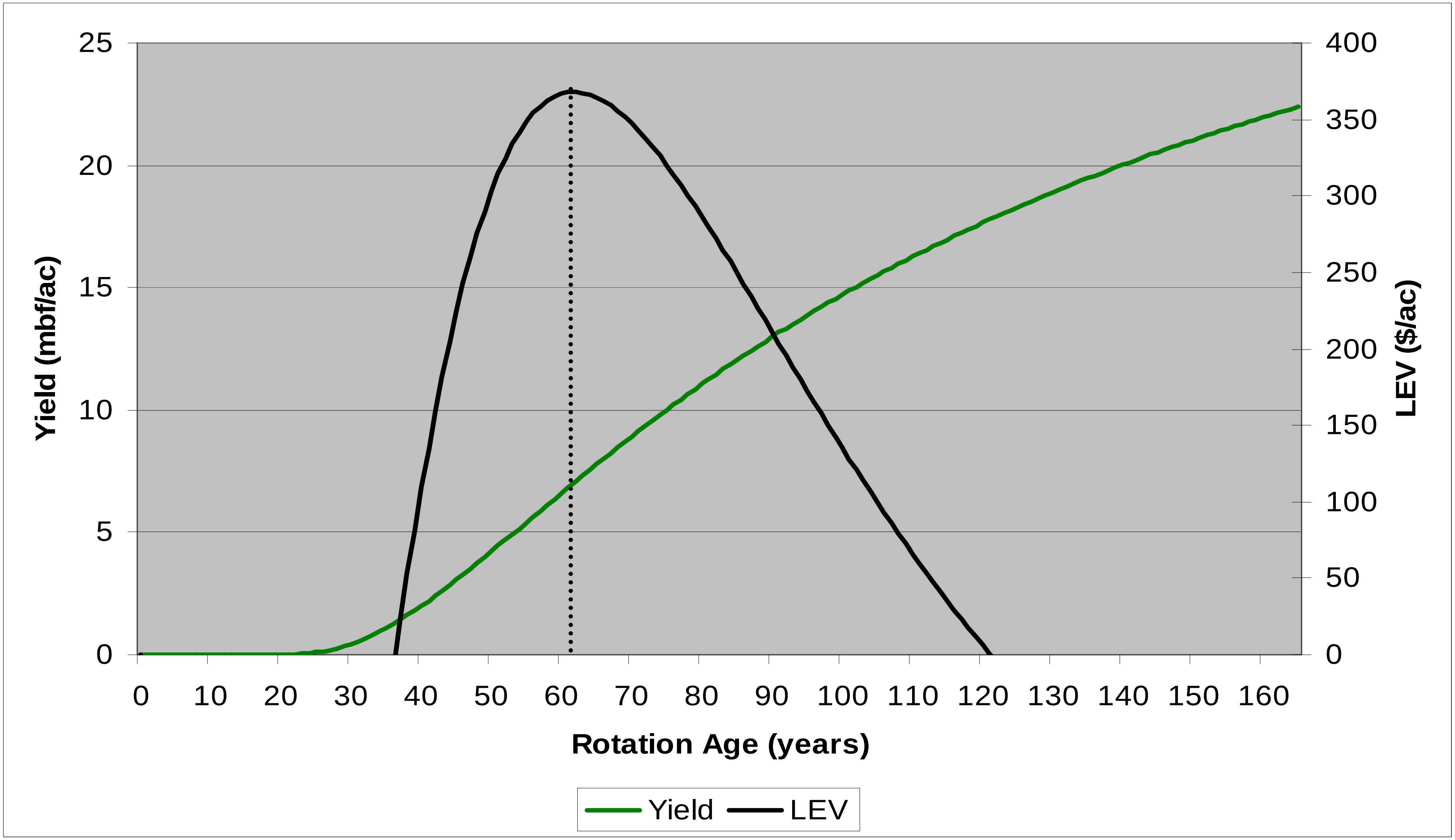
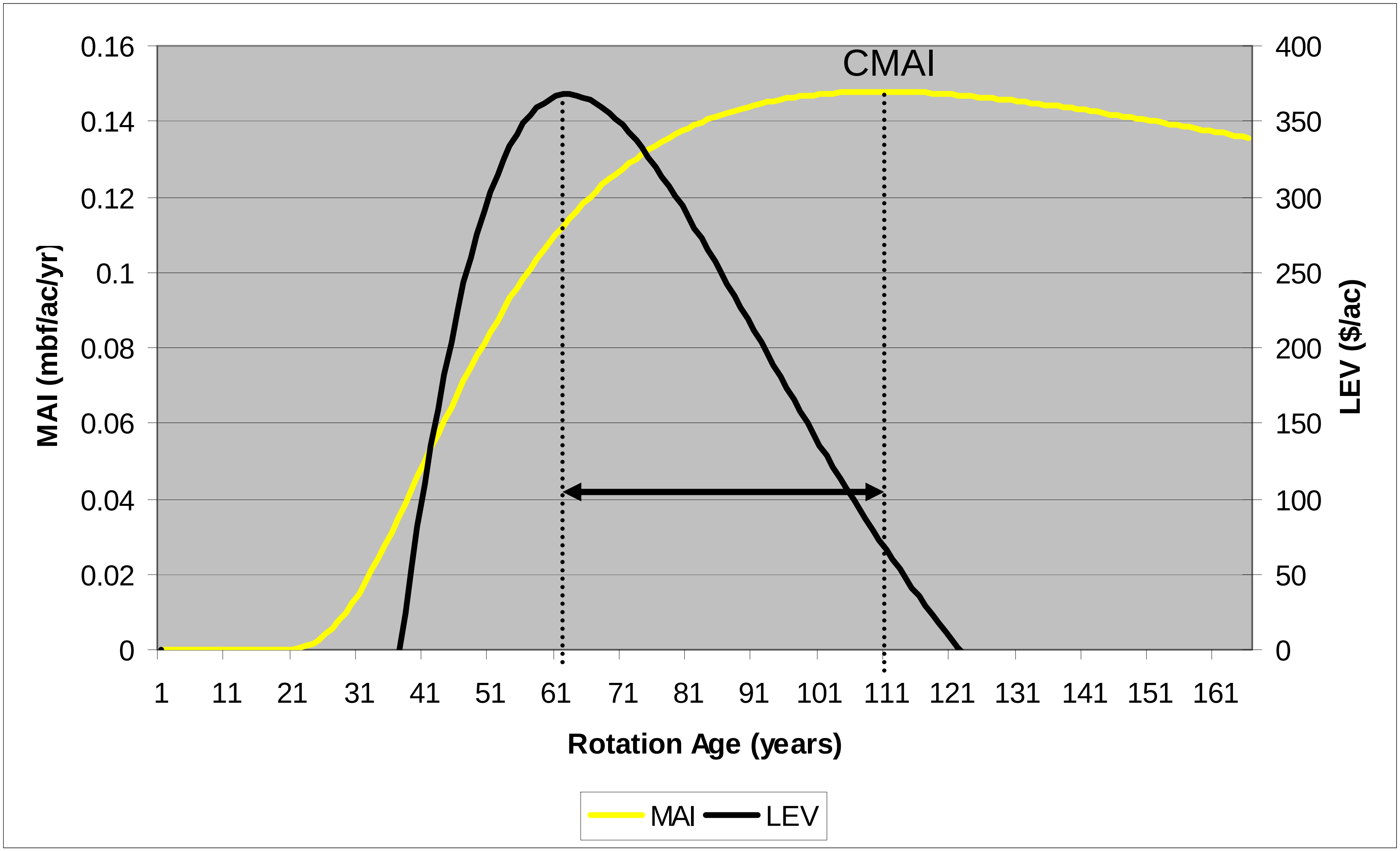
LEV and the Forest Value

Lecture 7 (04/18/2016)

The Financially Optimal Rotation Age



LEV and MAI



CMAI
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
400
350
300
250
200
150
100
50
0
MAI (mbf/ac/yr)
LEV ($/ac)
1 11 21 31 41 51 61 71 81 91 101 111 121 131 141 151 161
Rotation Age (years)
MAI
LEV

Marginal Analysis of the Rotation Decision

- The marginal benefits:

$$MB_a = P \cdot \Delta Y_{a+1} \cdot (1 - t_{inc})$$

Price of wood (P)

Growth of wood b/w age *a* and *a+1* (ΔY_{a+1})

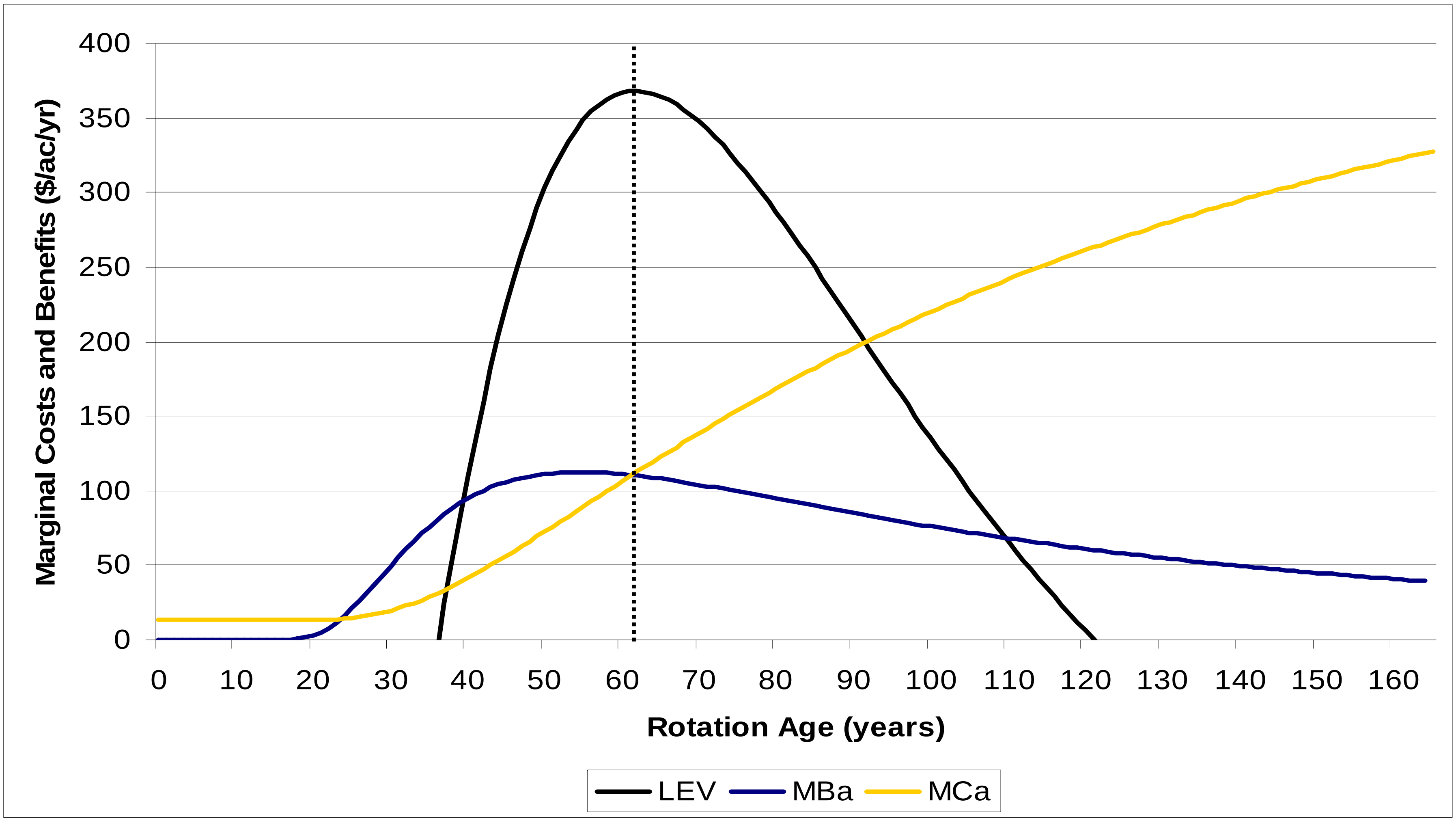
Income tax rate (t_{inc})

- The marginal costs:

$$MC_a = \underbrace{A(1 - t_{inc})}_{annual\ management\ costs} \underbrace{+ t_{prop}(1 - t_{inc})}_{property\ taxes} \underbrace{+ r \cdot LEV^*}_{land\ rent} +$$

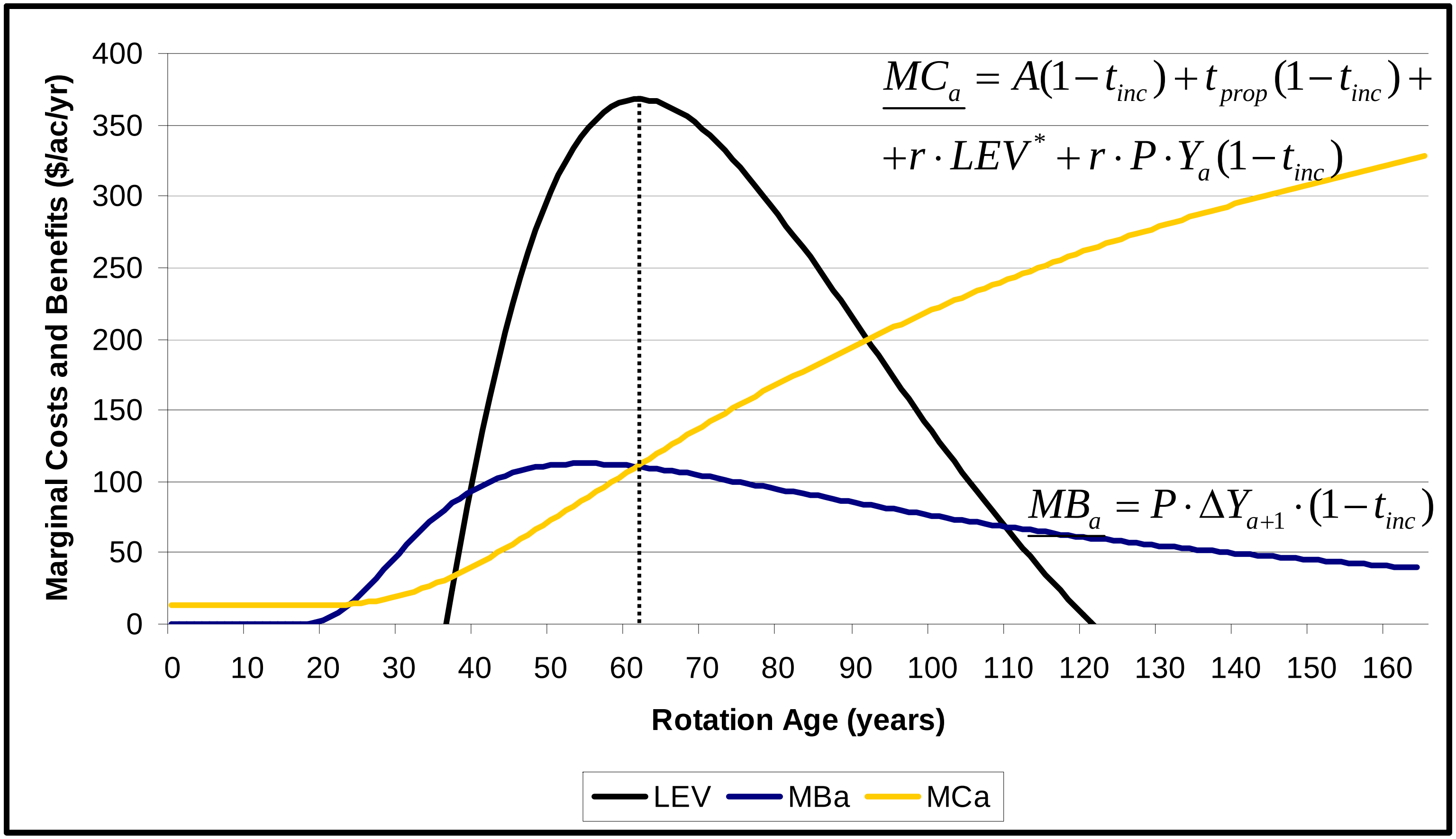
$$\underbrace{+ r \cdot P \cdot Y_a (1 - t_{inc})}_{inventory\ cost}$$

Marginal Costs and Revenues and the LEV



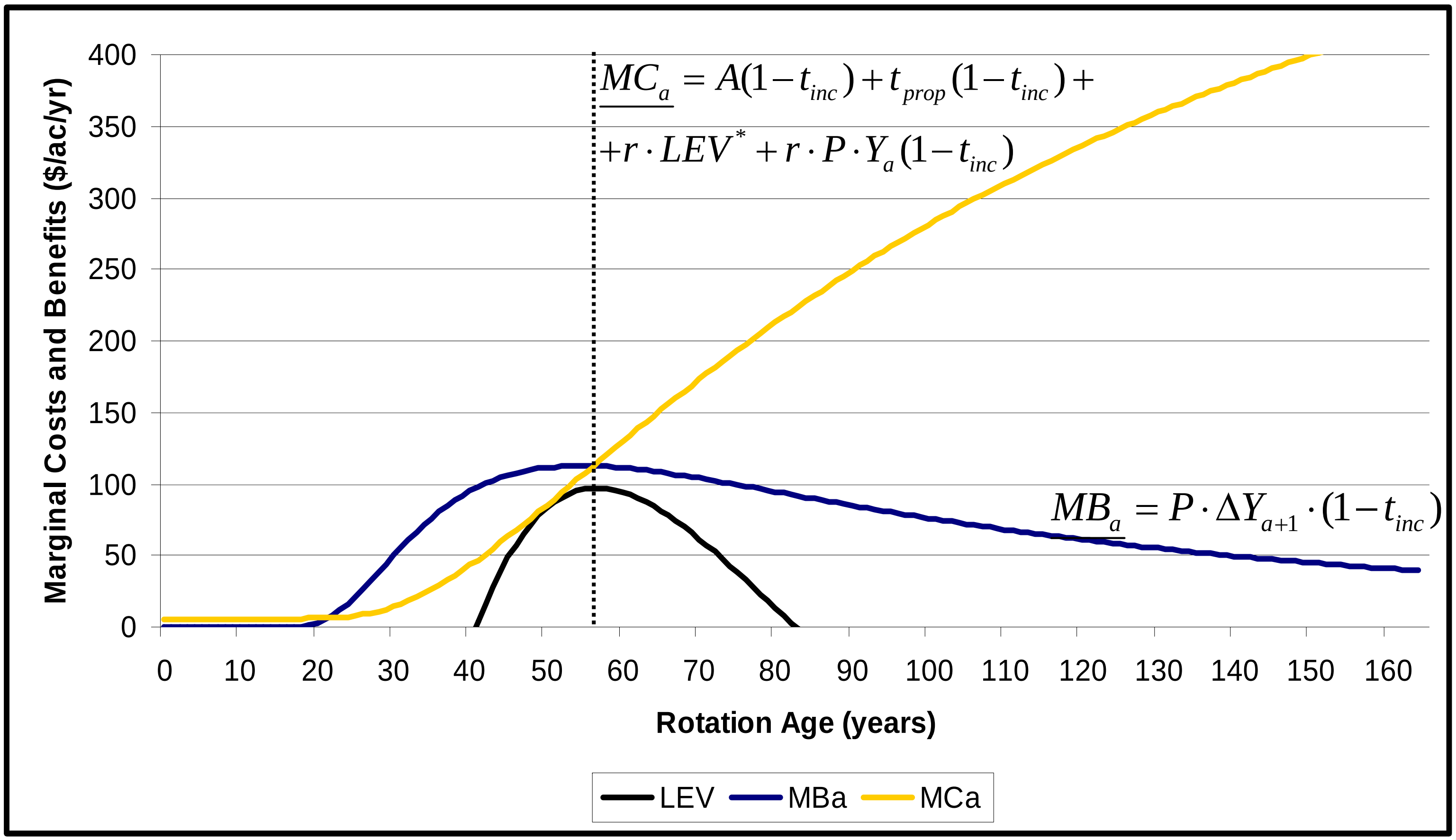
An increase in the Interest Rate

Establishment Cost (E)	200
Price of Wood(P)	600
Property Tax (t_{inc})	2
Annual Management Costs (A)	1
Income Tax (t_{inc})	0.22
Interest Rate r	0.03

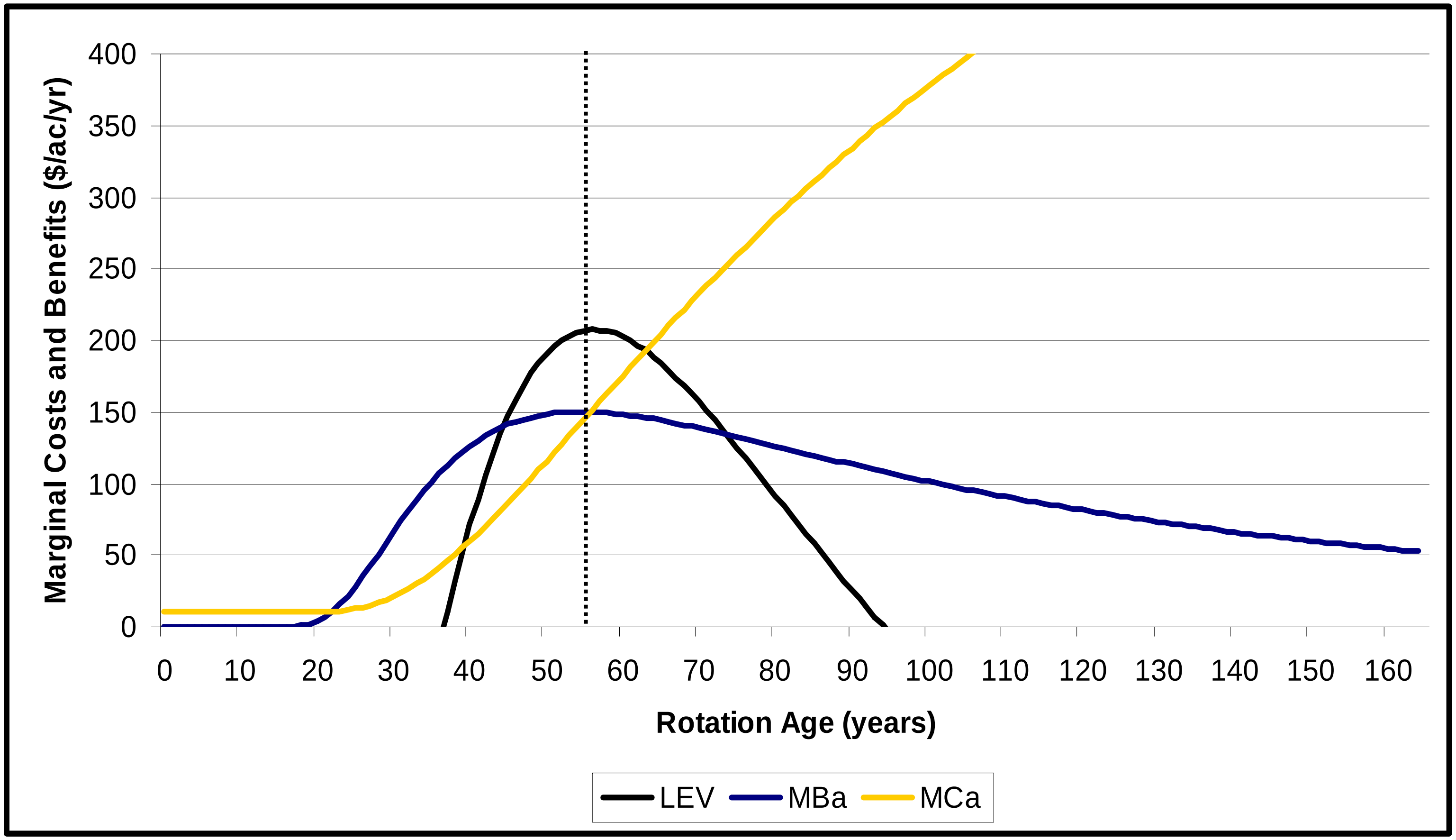


An increase in Stumpage Price

Establishment Cost (E)	200
Price of Wood(P)	600
Property Tax (t_{inc})	2
Annual Management Costs (A)	1
Income Tax (t_{inc})	0.22
Interest Rate r	0.04



Establishment Cost (E)	**200**
Price of Wood(P)	**800**
Property Tax (t_{inc})	**2**
Annual Management Costs (A)	**1**
Income Tax (t_{inc})	**0.22**
Interest Rate r	**0.04**



- In increase in establishment costs?
- In increase in annual management costs and property taxes?
- In increase in severance tax?
- In increase in income tax?

The impact of changes in economic variables on the financially optimal rotation age and LEV

	An increase in…	Financially Optimal Rotation Age (*R**)		LEV
r	Real rate	Negative		Negative
P	Price of wood	*E=0* 0	*E>0* Neg.	Positive
E	Establishment Cost	Positive		Negative
A	Annual man. costs	0		Negative
t_{prop}	Property tax	0		Negative
t_{inc}	Income tax	0		Negative
t_{sever}	Severance tax	*E=0* 0	*E>0* Pos.	Negative

$$LEV = \frac{-E(1+r)^{R} + \sum_{t=1}^{R-1} I_t (1+r)^{(R-t)} + \sum_{p=1}^{n} P_p \cdot Y_{p,R} - C_h}{(1+r)^{R} - 1} + \frac{A}{r}$$

Forest Value

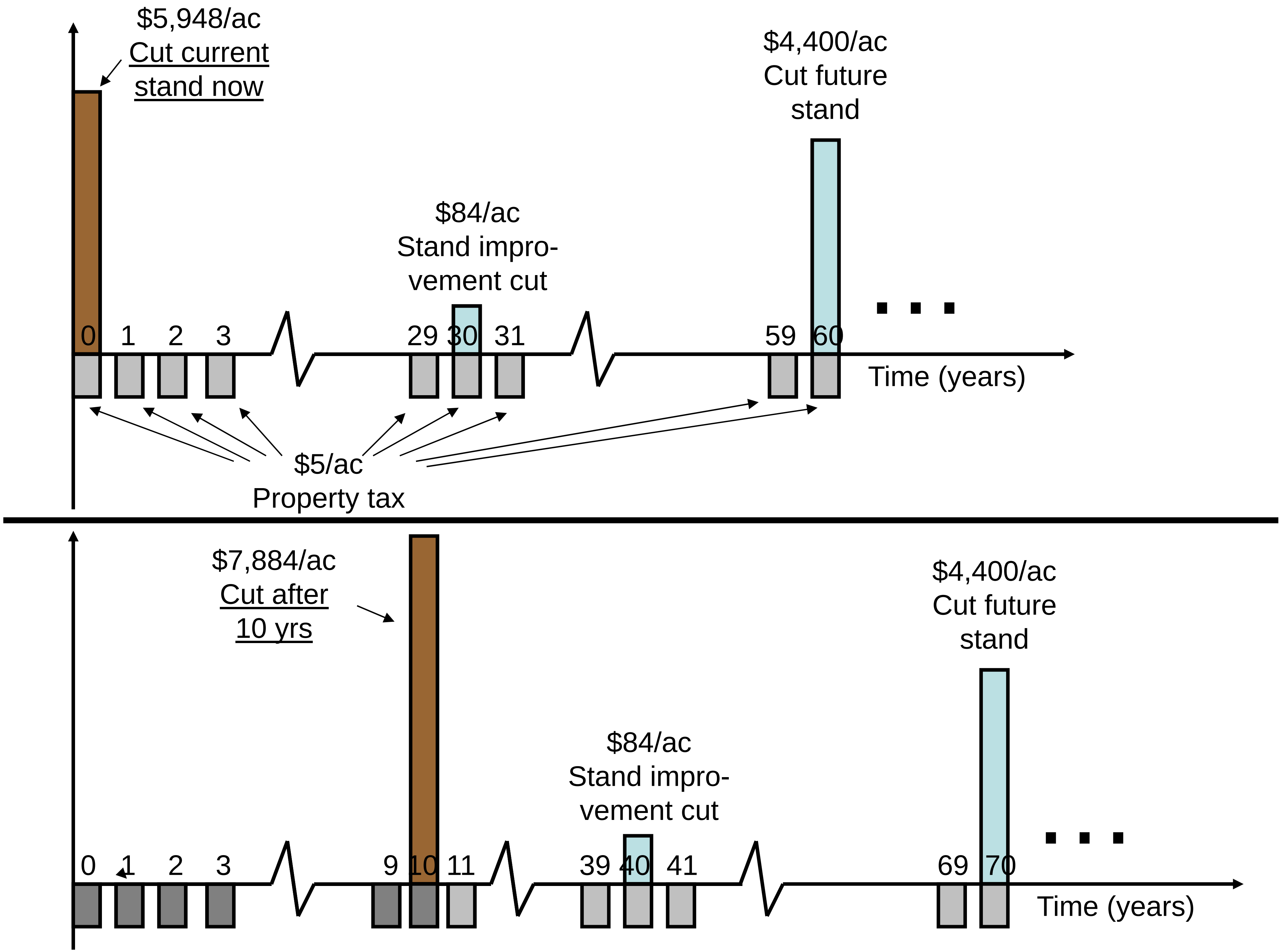
- <u>Land Expectation Value:</u> present value of costs and revenues from an infinite series of identical even-aged forest rotations starting from bare land;

- <u>Forest Value (a generalization of LEV):</u> the present value of a property with an existing stand of trees + the present value of a LEV for all future rotations of timber that will be grown on the property after harvesting the current stand.

The Forest Value allows us:

- To determine when a given stand should be cut;
- To separate the management of the current stand from that of future stands;
- To account for price changes that might occur during the life of the current stand;

Note: We will still assume that the rotations and prices associated with the future stands (i.e., the stands that are established after the current stand is cut) will be the same.



$5,948/ac
Cut current stand now
$84/ac
Stand impro-vement cut
$4,400/ac
Cut future stand
0
1
2
3
29
30
31
59
60
Time (years)
$5/ac
Property tax
$7,884/ac
Cut after 10 yrs
$84/ac
Stand impro-vement cut
$4,400/ac
Cut future stand
0
1
2
3
9
10
11
39
40
41
69
70
Time (years)

When to cut the stand?

- Cut it now:
  - Forest Value = $\underbrace{\text{Current Timber Value}}_{\$5{,}948/\text{ac}}$ + LEV

$$LEV = \frac{-E(1+r)^R + \sum_{t=1}^{R-1} I_t (1+r)^{(R-t)} + \sum_{p=1}^{n} P_p \cdot Y_{p,R} - C_h}{(1+r)^R - 1} + \frac{A}{r} =$$

$$= \frac{\$84(1.05)^{(60-30)} + \$4,400}{(1.05)^{60} - 1} - \frac{\$5}{0.05} =$$

$$= \frac{\$363.04316 + \$4,400}{17.67919} - \$100 = \underline{\$169.42 / ac}$$

$$FV_0 = \$5,948 / ac + \$169.42 / ac = \underline{\underline{\$6,117.42 / ac}}$$

When to cut the stand?

- Cut it 10 years from now:
  - Forest Value = Present Value of Costs and Revenues for first 10 years + Present Value of LEV

$$PV_{LEV} = \frac{LEV}{(1+0.05)^{10}} = \frac{\$169.42}{1.62889} = \underline{\$104.01/ac}$$

$$PV_{CurrentRotation} = \frac{\$7,884}{(1.05)^{10}} - \frac{\$5(1.05^{10}-1)}{0.05(1.05)^{10}} =$$

$$= \$4,840.09 - \$38.61 = \underline{\$4,801.48/ac}$$

$$FV_{10} = PV_{CurrentRotation} + PV_{LEV} = \underline{\underline{\$4,905.49/ac}}$$

Forest Value

- Assumptions:
  1. The current stand will be harvested;
  2. A new stand will be established;
  3. All future rotations of the new stand will be identical.

- Definition:
  – The *Forest Value* is the present value of the projected costs and revenues from an existing forest tract, plus the present value of an infinite series of identical future forest rotations that starts after the current tract is harvested.

Calculating the Forest Value

- New notation:

T_0 = the time when the currect stand is to be cut;

Y^{C}_{p,T_0} = the expected yield of product p from the current stand at time T_0; and

C^{C}_{h} = the cost of selling the current stand of timber.

- Forest Value formula:

$$FV = \underbrace{\frac{\sum_{p=1}^{n} P_p \cdot Y^{C}_{p,T_0} - C^{C}_{h}}{(1+r)^{T_0}}}_{\substack{\textit{Net present value} \text{ of harvest revenues} \\ \text{from the current stand}}} + \underbrace{\frac{A[(1+r)^{T_0} - 1]}{r(1+r)^{T_0}}}_{\substack{\textit{Net} \text{ present value of annual} \\ \text{revenues up to when the current} \\ \text{stand is cut}}} + \underbrace{\frac{LEV}{(1+r)^{T_0}}}_{\substack{\textit{Discounted} \text{ LEV} \\ \text{of future rotations}}}$$

Land value and timber value

- Forest Value = Land Value + Timber Value
  - Land Value = LEV
  - Timber Value = Forest Value – LEV

$$Timber\ Value = \frac{\sum_{p=1}^{n} P_p \cdot Y_{p,T_0}^{C} - C_h^{C}}{(1+r)^{T_0}} - \frac{\overbrace{(r \cdot LEV - A)}^{Annual\ Land\ Cost} \cdot [(1+r)^{T_0} - 1]}{r(1+r)^{T_0}}$$

What if real prices change?

- Assumption: the price changes will end by the end of the current rotation

$$Timber\ Value = \frac{\sum_{p=1}^{n} P_{p,T_0} \cdot Y_{p,T_0}^{C} - C_h^C}{(1+r)^{T_0}} - \frac{\overbrace{(r \cdot LEV - A)}^{Annual\ Land\ Cost} \cdot [(1+r)^{T_0} - 1]}{r(1+r)^{T_0}}$$

When calculating the LEV, use the new, steady state price: $P_{p,\infty}$

An example

Item	Amount
Assumptions for the Current and Future Stands	
Current sawtimber volume	18 mbf/ac
Current pulpwood volume	14 cords/ac
Current sawtimber price	$325/mbf
Current pulpwood price	$7/cord
Expected sawtimber volume in 10yrs	24 mbf/ac
Expected pulpwood volume in 10yrs	12 cords/ac
Expected real sawtimber price in 10yrs	$450/mbf
Expected real pulpwood price in 10yrs	$15/cord
Property tax	$5
Real alternate rate of return	5%
Assumptions for the Current and Future Stands	
Timber stand improvement cut (age 30 yrs) pulpwood harvest	12 cords/ac
Final (age 60) sawtimber harvest	13 mbf/ac
Final (age 60) pulpwood harvest	25 cords/ac

Cut now:

$$Timber\ \ value = \sum_{p=1}^{2} P_{p,0} \cdot Y_{p,0}^{C} = \$325 / mbf \cdot 18 mbf + \$7 / cd \cdot 14 cd = \$5,948$$

$$FV'_{R1} = 12 \cdot \$15 \cdot (1.05)^{30} + 13 \cdot \$450 + 25 \cdot \$15 = \$7,002.95$$

$$LEV = \frac{FV'_{R1}}{(1+r)^{R} - 1} - \frac{tax}{r} = \frac{\$7,002.95}{(1.05)^{60} - 1} - \frac{\$5}{0.05} = \$296.11$$

$$ForestValue_{CutNow} = \$5,948 + \$296.11 = \underline{\underline{\$6,244.13}}$$

Cut in 10 yrs:

$$Timber\ \ value = \sum_{p=1}^{2} P_{p,10} \cdot Y_{p,10}^{C} = \$450 / mbf \cdot 24mbf + \$15 / cd \cdot 12cd = \$10,980$$

$$PV_{timber} = \frac{\$10,980}{(1.05)^{10}} - \$38.61 = \$6,740.77 - \$38.61 = \$6,702.16$$

$$PV_{LEV} = \frac{\$296.11}{(1.05)^{10}} = \$181.79$$

$$ForestValue_{CutIn10yrs} = \$6,702.16 + \$181.79 = \underline{\underline{\$6,883.95}}$$