Appraising Damaged Timber

By Thomas J. Straka

Abstract

Estimation of the value of damaged timber stands can be complicated. The foundation for any valuation calculations involving damaged timber is land expectation value (LEV). A timber damage model using LEV is described in detail. The concept is economically sound as it ignores sunk costs and considers land opportunity cost and the impact on future rotations. The method described is an income approach. The results can also be applied to a replacement cost model. The two approaches will produce consistent results. FORVAL is a free computer software model that uses the same methodology and will produce the same results.

Consider a 12-year old pine plantation that is damaged by fire, a storm or herbicide drift. Estimating the amount of damage seems simple. The damage value is the market value of the plantation before the damage minus the market value after the damage. However, it is not likely an estimate of market value before the damage will exist and extremely unlikely that an estimate of market value after the damage will exist.

One situation poses a small appraisal problem. That is when stand age is equal to harvest age. At this age the stand has a determinable market value and a salvage value. Market harvest value minus salvage value equals damage. In addition there might be incremental site preparation charged to clean up the damage. The appraisal problem arises when the timber stand is less than harvest age.

There are two theoretical concerns in appraising damaged stands: first sunk costs must be ignored in the analysis and land opportunity cost must be included. This is generally true for all immature stands (Straka 2007). Bare land value (BLV) or land expectation value (LEV) is the basis of most forest and timber valuation problems and is the basis of this problem (Klemperer 1996, Straka and Bullard 1996).

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Damage to an Immature Stand

LEV assumes the bare land will be managed identically from rotation to rotation and uses the formula for a perpetual periodic series (called Faustmann's formula) to obtain a net present value of all cash flows (and this is BLV or LEV). The basic methodology is described in Bullard and Straka (1998). Essentially it involves calculating the "net future value" (NFV) of a single rotation. All costs and revenues are compounded to the end of rotation, the opposite calculation of discounting all cash flows. This NFV is assumed to occur on regular basis into perpetuity and the net present value of a perpetual periodic series is used to obtain LEV. The mathematics and formulas of the process are described in Straka (2007).

This is best illustrated with an example. Consider a timber stand being managed on a 30-year rotation. It is bare land, requires $125 dollars per acre of regeneration cost at the start of each rotation, has a $900 per acre net thinning revenue at age 20 and a $3,000 per acre net harvest revenue at age 30 when it is regenerated again. Annual costs (e.g., property taxes and management fees) equal annual revenues (e.g., hunting lease and pine straw revenues) to keep the problem simple. Assume a 7 percent real interest rate. The cash flow is shown in Figure 1. NFV is calculated as the future value of all the costs and revenues at year 30. Thus, this rotation is equal to $3,818.90 per acre at every rotation end. This is shown in Figure 2. Bare land in permanent timber production is worth $577.55 per acre at 7 percent interest.

Now assume the same stand is eight years old. Regeneration is a sunk cost and not relevant. The thinning and harvest are the relevant revenues as they occur after year 8. NFV = $900 (1.07)10 + $3,000 = $4,770.44. Figure 3 shows the new sequence of cash flows and the new value. Note that timber is worth $629.89 and that land is worth $577.55. Figure 4 shows the same situation, but for an 18-year old stand. Note that the timber is worth $1,797.02 and that the land is worth $577.55.

Now assume the same stand is 25 years old. The thinning is now "sunk" revenue. The only relevant cash flow is the $3,000 harvest revenue. Figure 5 shows the new sequence of cash flows and the new value. Note that timber is worth $1,973.19 and that land is worth $577.55. To illustrate further, assume the stand is exactly 30 years old and is destroyed just prior to harvest. The timber obviously is worth $3,000. Figure 6 shows the model produces timber value of $3,000 for that case with a land value of $577.55.

Three important concepts when using the income approach

These calculations are based on three important concepts. First, all prior costs and revenues are sunk costs and revenues and thus, are irrelevant. That is why only future costs and revenues were considered in the model. All value accrues to the future cash flow; prior cash flows don't impact the present value. Second, the value of the current immature stand, if just timber is considered, is the discounted value of all costs and revenues between the current age and harvest age (i.e., the present value of all future costs and revenues for that rotation.)

Third, the value of the immature timber when calculated using an LEV format includes the impact of the non-bare land (when LEV by definition is calculated for bare land). The existence of the immature stand on the otherwise bare land requires a delay in all subsequent rotations of the remaining years until first harvest. Thus, both net future value of the current immature stand and LEV must be discounted for the number of years remaining until the first harvest. For example, consider the 18-year old immature stand (Figure 4). The two revenues in the remaining cash flow are worth $4,770.44 at 7 percent interest and occur 12 years from today. All the future harvests after that next harvest are on a 30-year cycle that begins with the next harvest in 12 years. So the value of all those future harvest past the next harvest is LEV and that LEV must also be discounted for 12 years, along with the $4,770.44.

Note that timber rotations span fairly long time periods. Three of them can easily exceed 100 years in the South and the West has much longer rotations. So it follows that most of the net present value for perpetual timber is in the first few rotations (due to discounting). Looking at a typical timber rotation and using a four percent interest rate, fifty-four percent of timber value was in the first rotation, seventy-nine percent in the first two rotations and ninety percent in the first three rotations. At ten percent interest, eighty-five percent of timber value is in the first rotation, ninety-eight percent in the first two rotations and 99.7 percent is in the first three rotations. That explains why damaged timber stands can have such high values. Most of the value of a series of perpetual harvests is represented by that first harvest.

An additional factor is that our model assumes "normal" site preparation cost after each harvest. Suppose the damage causes the immediate site preparation costs to exceed normal cost. Since our land value is based on bare land value and is subtracted from the calculated value to get timber value, this is a reduction in land value.

Thus additional cleanup costs are added to the damage estimate. Assume the event caused extra cleanup costs of $100 per acre. Salvage value would have the opposite effect and diminish the damage value. Assume salvage value is $300 per acre. The damaged timber, incremental cleanup costs and salvage value result in a damage estimate at various ages of:

Age 0 timber damage = $0
Age 8 timber damage = $629.80 + $100.00 - $300.00 = $429.80.
Age 18 timber damage = $1,797.02 + $100.00 - $300.00 = $1,597.02.
Age 25 timber damage = $1,973.19 + $100.00 - $300.00 = $1,773.19.
Age 30 timber damage = $3,000.00 + $100.00 - $300.00 = $2,800.00.

Keep in mind that the LEV calculation produces the value of bare land in perpetual forest production. In these calculations, land value has been constant ($577.55) and timber has been a residual value. These calculations would still be appropriate if land or timber experienced real price increases. Since the basic calculation is nothing more than discounted perpetual cash flow analysis, geometric cash flow series could be used when price appreciation exists. What is important is the concept and it is best illustrated with a real discount rate and no price appreciation.

Replacement cost method

The method described above is clearly an income approach. The replacement cost approach is available to help establish value, but it has a weakness. This method involves compounding costs and revenues to the age of the damaged stand or discounting future costs and revenues to the same age. The weakness of the method is that results consistent with the income approach are only produced when the discount rate used is the internal rate of return (IRR) for a complete timber rotation investment (Straka 1991).

Notice in the case where land cost is exactly equal to LEV that the IRR will be equal to the discount rate used to calculate LEV. In Table 1, the net present value of a timber rotation is zero if land is purchased and sold for LEV, meaning the discount rate is equal to the IRR. For this one situation, compounding or discounting cash flows to the damaged stand age will produce results consistent with the income approach.

An equivalent method to include land opportunity cost is to add annual land "rental" cost to the cash flows (Table 2). Since the value of the bare land is LEV, the annual land rental cost would be LEV times the discount rate. For the example 20-year timber rotation, land opportunity cost equals $577.55 X 0.07 = $40.43. Buying and selling land at $577.55 and an annual cost of $40.43 are exactly equivalent at seven percent interest.

Using damaged timber stand age 18 as an example, the replacement cost approach in Equation (1) gives the same value as the income approach if land is bought and sold at LEV and a 7 percent discount rate is used.

(1) Replacement Cost = $\$125\,(1.07)^{18} + \$577.55(1.07)^{18} - \$577.55 = \$1{,}797.02$

Note that incremental cleanup cost and salvage value must also be included as above. The same result is obtained in Equation (2) using annual land opportunity cost.

(2) Replacement Cost = $\$125(1.07)^{18} + \$40.43[(1.07)^{18} - 1] / 0.07 = \$1{,}797.02$

The same results could be obtained by discounting future costs and revenuers (Equation (3)).

(3) Replacement Cost = $\$3{,}577.55/(1.07)^{12} + \$900/(1.07)^{2} - \$577.55 = \$1{,}797.02$

Or, the same results could be obtained by discounting and using annual land opportunity rent (Equation [4]).

(4) Replacement Cost = $\$3{,}000/(1.07)^{12} + \$900(1.07)^{2} - \$40.43[(1.07)^{12} - 1] / [(0.07)\,(1.07)^{12}] = \$1{,}797.02$

FORVAL software package

FORVAL is a computer software package designed to perform forest valuation problems. It was fully-described in Straka and Bullard (2006). One option in the model is Precommercial Timber Valuation. The model determines IRR and values immature timber stands. Recall when LEV is calculated and land is valued at that amount, the interest rate used to calculate LEV will be IRR automatically. Thus, if the land value used in the calculation is LEV, the precommercial timber valuation function in FORVAL can be used to perform the damage valuation calculations described above.

Consider the same example used above. The regeneration cost of $125, thinning of $900, and final harvest of $3,000 are the three cash flows entered. Land value is $577.55 at the beginning and end of the rotation. We will use the model to determine the value of an 18-year old damaged timber stand with a 30-year timber rotation.

Figure 7 shows the output page from FORVAL. Estimated value of the timber equals $1,797.02. Like above, adjustments must be made for incremental cleanup costs and salvage value. FORVAL provides an efficient tool to accomplish the methodology described in this article.

Summary

Valuation of damaged timber value can be complicated. The foundation for any valuation calculations involving damaged timber is land expectation value (LEV). A timber damage model using LEV was described in detail. The model is economically sound as it ignores sunk costs and considers land opportunity cost and the impact on future rotations. The method described is an income approach and follows established discounted cash flow methodology.

The results from the income approach were applied to a replacement cost model. The two approaches will produce consistent results when the discount rate used in the analysis is the internal rate of return produced by the cash flow. This consistency could prove valuable in complex appraisal situations. FORVAL is a free computer software model that uses the same methodology and will produce the same results described in this article. Appraisers will find it appropriate to both approaches.

References

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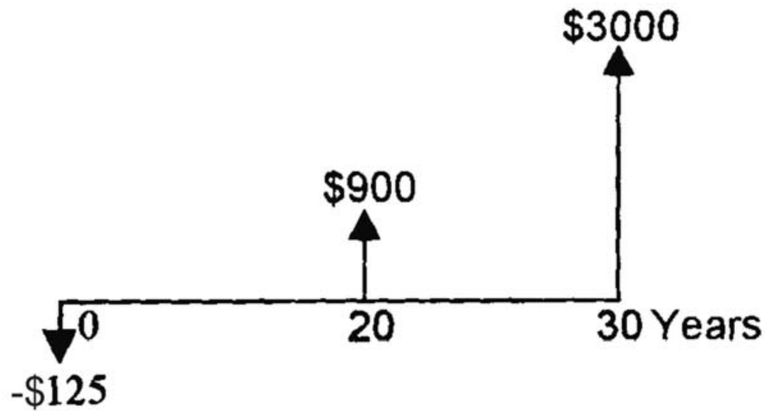
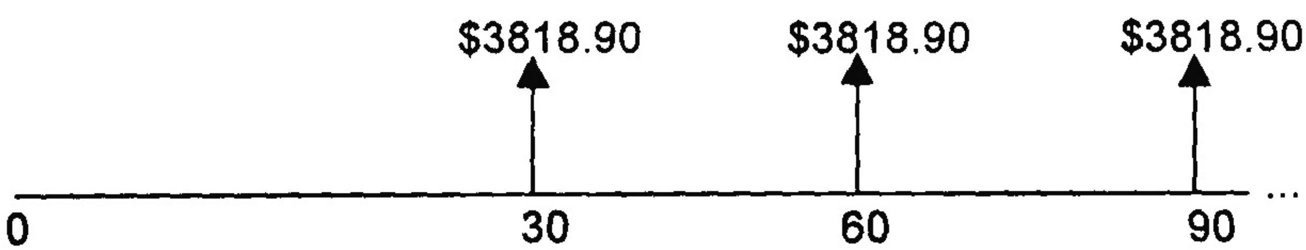
Figure 1. Bare land, stand age = 0 years (calculation of net future value per acre of a forest at a 7 percent real interest rate assuming bare land, all costs and revenues compounded to year 30)



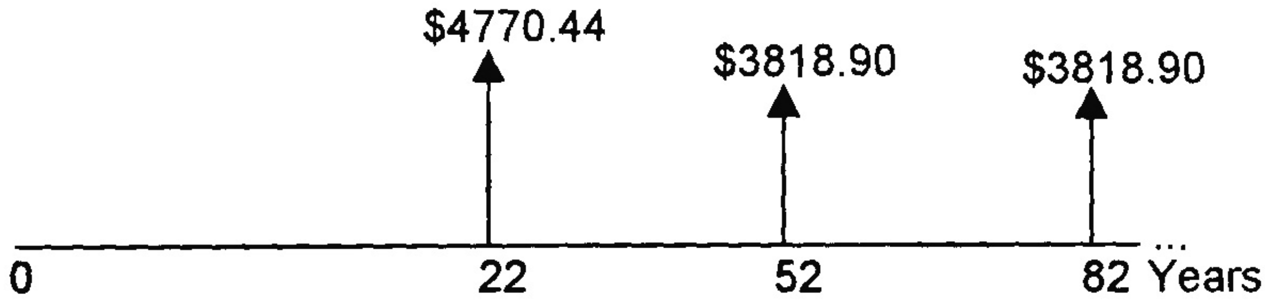
$$NFV_{30} = -\$125\,(1.07)^{30} + \$900\,(1.07)^{10} + \$3000$$
$$= \$3818.90$$

Figure 2. Bare land, stand age = 0 years (calculation of land expectation value, using a 7 percent real interest rate and assuming net future value from Figure 1 occurs every 30 years)



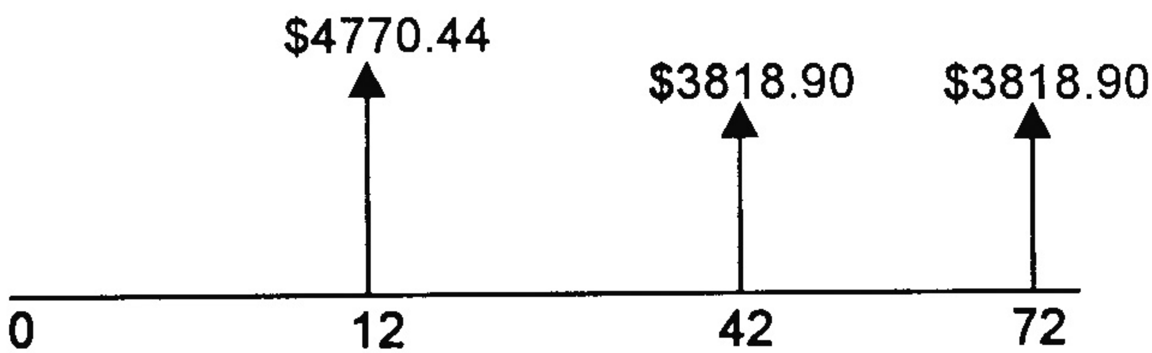
$$LEV = \frac{\$3818.90}{(1.07)^{30} - 1} = \$577.55$$

Figure 3. Immature stand, aged 8 years (net thinning revenue and net harvest revenue are compounded to year 22 and are worth $4,770.44 in 22 years, all subsequent harvest after the immature stand is harvested are worth $577.55 at year 22)



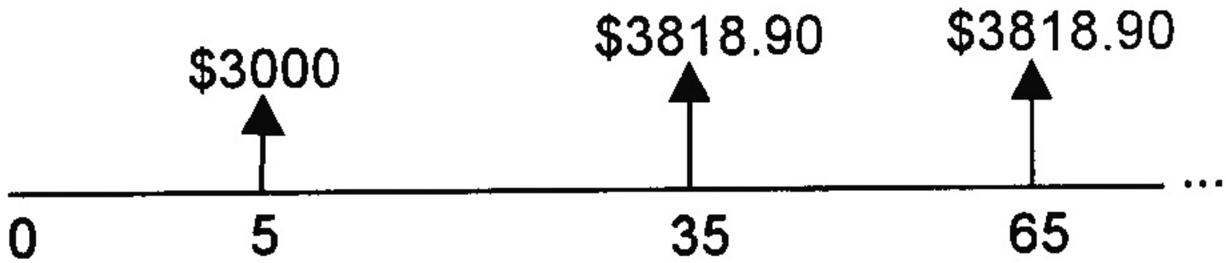
$$V_8 = \frac{\$4770.44 + \$577.55}{(1.07)^{22}} = \$1207.11$$

Figure 4. Immature stand, aged 18 years (net thinning and harvest revenues are compounded to year 12 and are worth $4,770.44 in 12 years, all subsequent harvest after the immature stand is harvested are worth $577.55 at year 12)



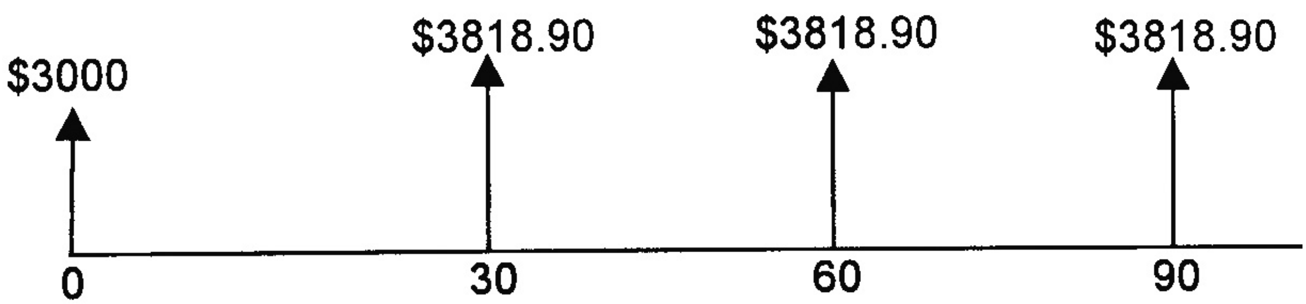
$$V_{18} = \frac{\$4770.44 + \$577.55}{(1.07)^{12}} = \$2374.57$$

Figure 5. Immature stand, aged 25 years (net harvest revenue is worth $3000 in 5 years, all subsequent harvest after the immature stand is harvested are worth $577.55 at year 5)



$$V_{25} = \frac{\$3000 + \$577.55}{(1.07)^5} = \$2550.74$$

Figure 6. Immature stand, aged 30 years (uncut), assumes stand is immediately harvested and the bare land is immediately regenerated



$$V_{30} = \frac{\$3000 + \$577.55}{(1.07)^0} = \$3577.55$$

Figure 7. FORVAL example

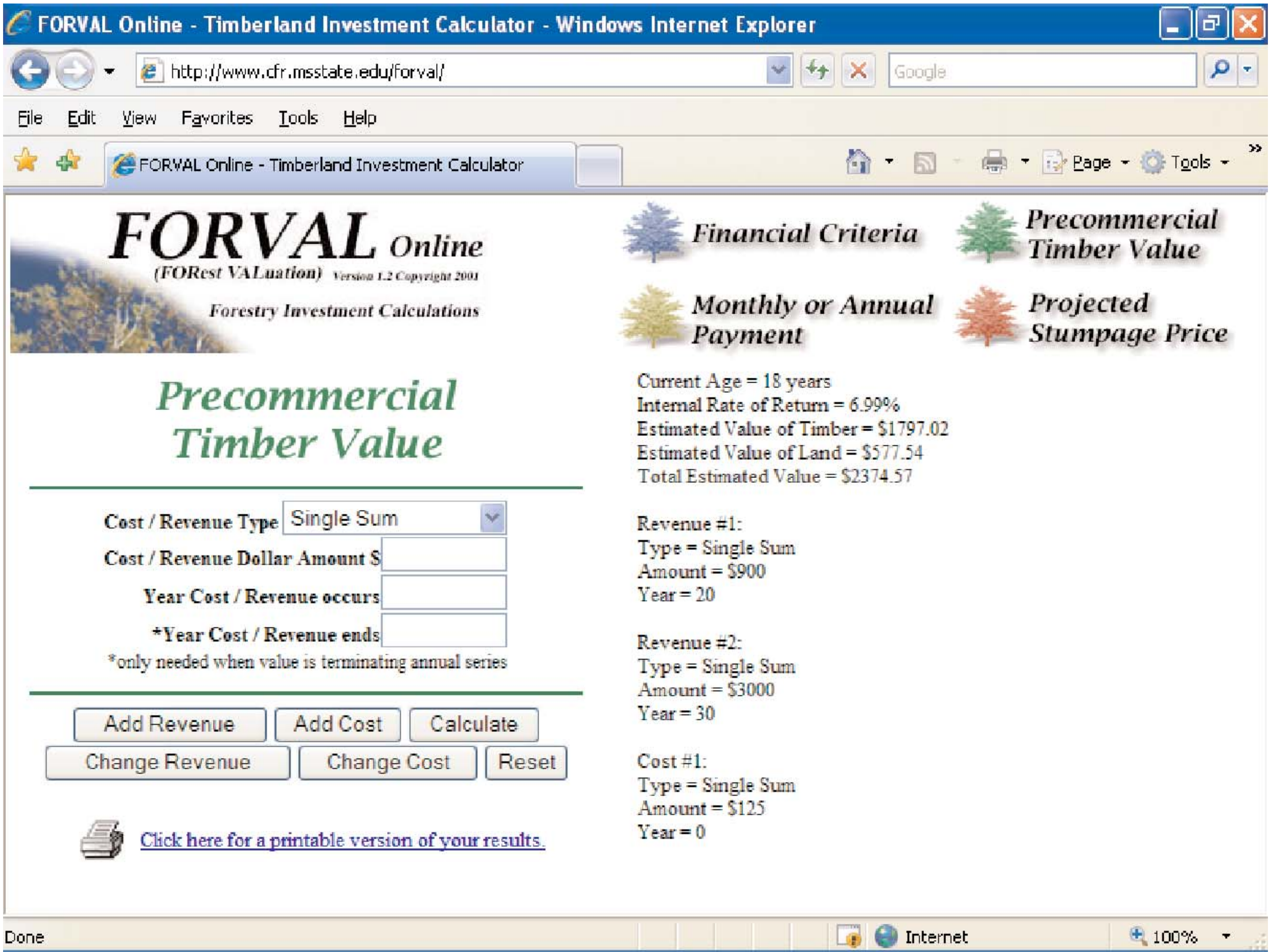


Table 1. Net present value calculation for example problem, buying and selling land

Year	Item	Amount	Present Value @ 7%
0	Buy land	-$577.55	-$577.55
0	Regenerate	-125.00	-125.00
20	Thin	900.00	232.58
30	Harvest	3,000.00	394.10
30	Sell land	-$577.55	75.87
	Net Present Value		0.00

Table 2. Net present value calculation for example problems, changing annual land opportunity cost

Year	Item	Amount	Present Value @ 7%
0	Regenerate	-$125.00	-$125.00
20	Thin	900.00	232.58
30	Harvest	3,000.00	394.10
1-30	Land opportunity cost	-40.43	-501.68
	Net Present Value		0.00