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Financial maturity concepts with application to three hardwood timber stands

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Timber is "financially mature" when its rate of value increase falls below what the landowner can earn in alternative investments that are comparable in duration, risk, liquidity, and other factors. The basic concept of financial maturity is simple, but in application it involves several very important, basic questions and issues.

For example, should the landowner consider taxes, inflation, and the value of the underlying land when estimating the rate of value increase of a timber stand?

How do you find alternative investments that are comparable to a specific hardwood timber investment in terms of duration, risk, and other factors?

In this report we summarize basic financial maturity concepts from the applied standpoint of a forester or other timber management professional. The report was developed because of needs expressed at a workshop on "Economics of Hardwood Management" held at Mississippi State University. Our intent is to help foresters and others understand the background and usefulness of financial maturity concepts. The concepts can be applied to many types of existing stands to determine the optimal age of final harvest from a financial standpoint.

Background and Model Development

Background

Earlier we stated that timber is "financially mature" when its rate of value growth falls below the rate that can be earned on alternative investments of comparable duration, risk, liquidity, and other factors like taxes. This basic concept was introduced as a decision-making model for timber managers in a 1951 report titled "Financial Maturity of Bottomland Red Oaks and Sweetgum," by Sam Guttenberg and John Putnam. These authors summarized the concept by saying the manager "*appraises his trees with the object of putting the ax to those that are reaching the crucial point where the tree ceases to pay its way*."

The concept was more formally discussed in an application to selection forests by Duerr and Bond (1952), and over the years many articles and reports have been published on the theory and application of financial maturity. Financial maturity and rate of value increase guidelines have been particularly widely applied to hardwood stand types – see the inset box at right, for example.

Although the basic concept of financial maturity is relatively simple, its application in timber management involves important assumptions. All of the published reports in the box at right, for example, include

Some publications that apply financial maturity and rate of value increase concepts to hardwood timber stands:

Buongiorno, J., and J.S. Hseu, 1993. Volume and value growth of hardwood trees in Wisconsin. North. J. Appl. For. 10(2):63-69.

Campbell, R.A. 1955. Tree grades and economic maturity for some Appalachian hardwoods. USDA For. Serv. Southeast. For. Exp. Stn., Station Pap. 53, 22p.

DeBald, P.S., and J.J. Mendel. 1971. Determining the rate of value increase for oaks. In: The Oak Symp. Proc., Morgantown, WV, Un-numbered series, USDA For. Serv., NE For. Exp. Stn. pp. 142-151.

Gansner, D.A., S.L. Arner and S.J. Zarnoch. 1990. Timber value growth rates in Maine. North. J. Appl. For. 7(2):62-64.

Guttenberg, S., and J.A. Putnam. 1951. Financial maturity of bottomland red oaks and sweetgum. USDA For. Serv., South. For. Exp. Stn. Occas. Pap. 117, 24p.

Herrick, O.W., and D. A. Gansner. 1985. Forest-tree value growth rates. North. J. Appl. For. 2:11-13.

Martin, A.J. 1988. What's a forest tree worth? Nat. Woodlands 11(6):8-10.

Mendel, JJ. and G.R. Trimble, Jr. 1969. The rate of value increase for yellow-poplar and beech. USDA For. Serv. Res. Pap. NE-140, 27p.

Mendel, JJ., T.G. Grisez and G.R. Trimble, Jr. 1973. The rate of value increase for sugar maple. USDA For. Serv. Res. Pap. NE-250, 19p.

Mills, W.L., Jr., and J.C. Callahan. 1979. Financial maturity: A guide to when trees should be harvested. Purdue Univ. Exten. Publ. FNR 91, 10p.

Perkey, A.W. 1993. Managing red oak crop trees to produce financial benefits. Woodland Steward 1(4):4-6.

Smith, H.C., G.R. Trimble, Jr. and P.S. DeBald. 1979. Raise cutting diameters for increased returns. USDA For. Serv. Res. Pap. NE-445, 7p.

Trimble, G.R., Jr., and Mendel, JJ. 1969. The rate of value increase for northern red oak, white oak, and chestnut oak. USDA For. Serv. Res. Pap. NE-129, 29p.

Trimble, G.R., Jr. and Mendel, JJ. and R.A. Kennell. 1974. A procedure for selection marking in hardwoods combining silvicultural considerations with economic guidelines. USDA For. Serv. Res. Pap. NE-292, 12p.

Utz, K.A., and D.H. Sims. 1981. Investment analysis of upland oak stands. USDA For. Serv. Southeast. Area, For. Rep. SA-FR 12, 44p.

assumptions – in some cases they are explicitly discussed, in others they are simply implied by the analytical methods used.

In the present report, we make two very important assumptions – two assumptions that will help define the financial maturity model we apply to hardwoods. In this report we discuss both "simple" and "adjusted" financial maturity models, and we apply the "adjusted" financial maturity model to three example stands.

What we assume:

1. The goal of the forest manager in applying financial maturity to timber stand management is to maximize the present value of **all** future net income.

2. The management unit is a **stand** or group of trees rather than a single tree, and the stands managed are sufficiently large in area that their presence (or their removal) has a negligible total impact on the timber production of surrounding stands. Note that this assumption does not exclude management by group selection, but we do assume that groups of trees are large enough in area that surrounding trees are not affected by their management.

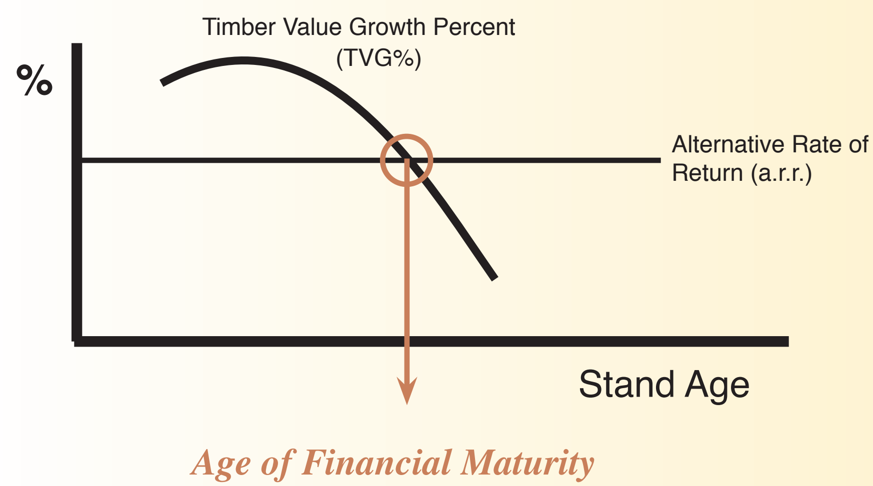
The "simple" financial maturity model

"Simple" financial maturity involves comparing the current rate of timber value growth with the rate of return that can be earned elsewhere. As shown in Figure 1, a tree or stand whose rate of value increase is at or below the rate that can be earned elsewhere is said to be "financially mature." This model is the basic, original concept developed in the 1950s. It's been widely applied by timber managers because it's relatively simple to apply and the overall approach has intuitive appeal.

Several important points should be understood before using simple financial maturity as a guideline for timber management:

Why is this method referred to as the "simple" financial maturity model? Simple financial matu-

Figure 1. Diagram of the
Simple Financial Maturity Model



Using simple financial maturity as a model, a tree or stand "*ceases to pay its way*" (Guttenberg and Putnam 1951) when its timber value growth percent (TVG%) reaches the alternative rate of return (a.r.r.).

rity considers the timber value of the current stand *only*. The approach therefore omits an important aspect of timber production that should be reflected by the analysis if the timber management objective is correctly stated in assumption 1 on page 3. That is, if we want to maximize the present value of *all* future net income, we should also consider the timber stands (or other land use opportunities) that follow the stand that currently exists. [As will be discussed, this factor is considered in the "adjusted" financial maturity model.] It can be shown that the net result of our simple financial maturity guideline will be to maximize the present value of *one* rotation of timber (Figure 2).

The model considers only the financial aspects of a stand. If a tree, group of trees, or an entire stand has a lower value growth rate than could be earned elsewhere, it doesn't necessarily mean that the tree or stand should be harvested as soon as possible. It should be remembered that the model is a simple guideline that considers only the current or projected monetary value of the timber. Other factors may also be important in setting timber management objectives. Also, even if monetary value is the only consideration involved, a tree or stand whose value growth rate is currently unacceptable should be considered for harvest only after the potential impacts of short-term timber price changes have been evaluated.

Figure 2.
Simple financial maturity guidelines are consistent with maximizing the present value of <u>one</u> timber stand …

Assume we're calculating the present value of one stand of timber:

Using the compound interest formula for discrete periods, the present value of the future harvest (HV) would be:

$$\text{Present Value} = \frac{HV}{(1+i)^n}$$

Where i is the discount rate (the interest rate) and n is the number of years (the stand age).

Or we can rewrite the present value relationship using continuous compounding:

$$\text{Present Value} = \frac{HV}{e^{in}}$$

Where i is the discount rate (the interest rate), n is the number of years (the stand age), and e is the base of the natural logarithms.

To find the stand age that maximizes present value, we set the first derivative of this relationship with respect to stand age equal to zero. If this is done, after simplifying we have:

$$\frac{\frac{dHV}{dn}}{HV} = i$$

Note that the left side of this relationship is timber value growth percent (the left side is the change in the HV with respect to stand age divided by HV). The relationship above is therefore the simple financial maturity guideline, and this guideline is consistent with maximizing the present value of one timber stand.

Further discussion of this consistency is in Bullard (1985), as well as in the classic references on the topic. See Bentley and Teeguarden (1965) and Gaffney (1957), for example.

The timber value growth rate that's calculated may be projected or historical. That is, forest managers may measure the timber value growth percent earned by the stand in the recent past, or they may estimate the value growth rate expected for the stand in the coming year or other time period. In either case, the value growth rate is compared to the interest rate expected for investments of similar duration and risk.

The financial maturity guideline is not the same as saying "*the value growth rate is decreasing so the timber is financially mature*." Notice in Figure 1 that the value growth rate of a stand may be at a maximum at an early stand age, and the rate may decrease each year that follows. This relationship is general, of course, and value growth rates may actually increase later in the development of a stand. Obviously, price changes, quality changes, and many other factors are involved in determining value growth rates for a stand during a given time period. The important point to note, however, is that although a stand's rate of value growth may be decreasing year after year, the stand isn't financially mature until the rate of value growth falls below the alternative rate of return.

Financial maturity guidelines are a good example of marginal analysis in forest management. Since the development of marginal productivity theory in the late 1800s, economists have applied calculus to revenue and cost relationships to show that producers maximize profits by setting production levels where marginal revenue (MR) equals marginal cost (MC). For maximum profit, the marginal, or additional, benefit of producing the last unit of a good or service should be equal to the added cost of producing that unit. In applying financial maturity to determining harvest age for a stand, we are using the MR = MC guideline – the timber value growth earned by a stand is the marginal revenue and the alternative rate of return is the marginal cost. Financial maturity guidelines therefore result in maximum profit for the timber producer; as shown on page 4, simple financial maturity guidelines are consistent with maximizing the present value of a single stand.

The following discussion of "adjusted" financial maturity doesn't change the basic modeling approach, but simply "adjusts" the model to ensure that the opportunity cost of land is included in the marginal analysis. With this adjustment, financial maturity guidelines will be shown to be consistent with maximizing the present value of *all* future net income from a tract of land.

Financial maturity guidelines ...

... consider financial or monetary value only. Of course other factors may also be important in determining the best harvest age for a stand.

... may be applied to projected stand performance or to the value growth rate earned by a stand in the past.

... suggest that a stand is mature when its rate of value growth falls below the rate that can be earned in other investments of similar duration and risk. This is not the same as saying that a stand should be harvested when its value growth rate begins to decrease.

... are consistent with the marginal analysis guidelines for profit maximization ... MR=MC. Also "simple" financial maturity is consistent with maximizing the present value of one timber stand; as will be discussed in the next section, "adjusted" financial maturity is consistent with maximizing the present value of all future income from a given tract of land.

Note: In the discussion that follows, the "adjusted" financial maturity model is developed intuitively and mathematically. Readers without interest in model development may want to skip to Summary of Model Development (page 12), where the adjusted financial maturity approach applied to three hardwood stands is briefly summarized compared to simple financial maturity guidelines.

The "adjusted" financial maturity model

Earlier we assumed that the goal of the forest manager in applying financial maturity guidelines to timber stand management was to maximize the present value of all income from a tract of land (assumption 1 on page 3). To do this, forest economists have developed two basic approaches to "adjust" or modify analyses of financial maturity. As demonstrated in the following discussion, the two approaches are the same in theory; either one of them may be used because they're both consistent with maximizing the present value of all future income from the land.

To derive the first approach, we begin with a time-line for an infinite series of timber rotations (Figure 3).

According to our initial assumption on page 3, we want to manage stands to maximize the present value of the entire perpetual series. We want to determine the "n" (final harvest age) that maximizes the present value of the perpetual periodic series of timber stands (the HVs on the time-line in Figure 3). The time-line values are discounted to the present using the compound interest formula for a perpetual periodic series (Figure 4).

We've now derived an approach

Figure 3. Time-line 1.

An infinite series of identical harvest values ... the stands are assumed to provide $HV every "n" years in perpetuity.

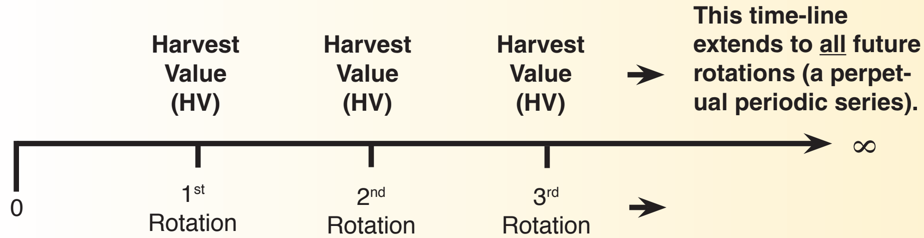


Figure 4.
Adjusted financial maturity guideline derived from the present value of the perpetual periodic series of timber harvests shown in Time-line 1 (Figure 3).

$$\text{Present Value} = \frac{HV}{(1+i)^n - 1}$$

Where **i** is the discount rate (the interest rate) and **n** is the length of the rotation.

This formula can be restated using continuous compounding:

$$\text{Present Value} = \frac{HV}{e^{in} - 1}$$

Where **i** is the discount rate (the interest rate), **n** is the length of the rotation, and **e** is the base of the natural logarithms.

To find the rotation age that maximizes the present value relationship, we take the first derivative of the relationship with respect to rotation age, then set the derivative equal to zero[1], If this is done, after simplifying we have:

$$\frac{\frac{dHV}{dn}}{HV} = i\left[\frac{e^{in}}{e^{in}-1}\right]$$

Note that the **left** side of this relationship is timber value growth percent (the left side is the change in HV with respect to age divided by HV). The **Right** side of the relationship is the interest rate multiplied by a factor in brackets - an "adjustment" factor. This adjustment factor, restated using discrete periodic compounding is the adjustment factor presented by Duerr (1988) for adjusted financial maurity, i.e., timber should be harvested when its rate of value increase falls below the "adjusted" alternative rate of return.

[1] Further derivation, including information on second order conditions for optimization is available in Bentley and Teeguarden (1965), Bullard (1985), and Gaffney (1957).

to financial maturity that will result in maximum present value for all future income from a property. As shown in Figure 5 (restated assuming discrete compounding periods), we would harvest timber when the timber value growth percent (TVG%) falls below our alternative rate of return (a.r.r.) adjusted by the term in brackets.

Notice that the "adjustment factor" (the term in brackets) moves the alternative rate of return *upward* - using this approach to adjusted financial maturity, we're essentially saying we expect our timber to earn a higher rate of return at the margin. As shown in Figure 6, shifting the a.r.r. line upward will result in harvesting stands at a younger age than would occur using the simple financial maturity model.

Approach 1 is consistent with maximizing the present value of *all* future income because that's how we began the derivation; we started with a time-line that included all future timber rotations. A restrictive assumption for "Approach 1," however, was that the future income series would follow the pattern shown in **Time-line 1** – a perpetual series of *identical* timber rotations.

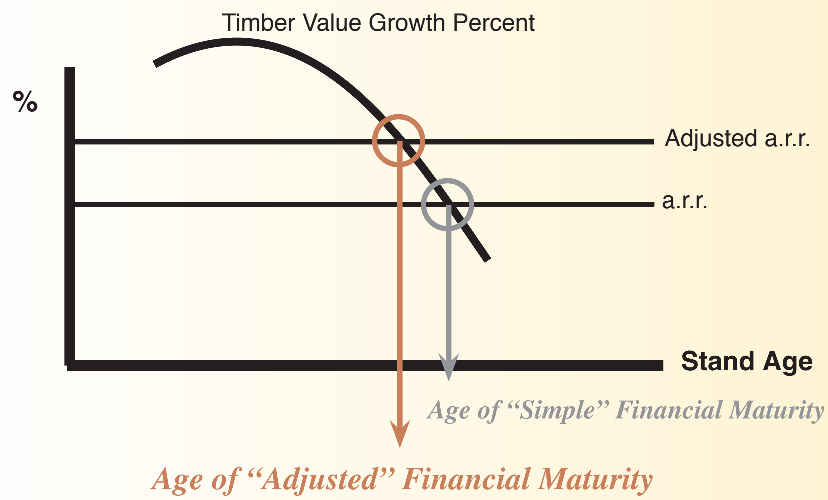
As noted in Figure 5, adjusting the alternative rate of return by the term in brackets is an appropriate means of determining the best rotation age for even-aged stands that meet the assumptions of **Time-line 1**. We can, however, derive another, more general approach to financial maturity that's also consistent with

Figure 5.
Approach 1 to adjusted financial maturity: Compare TVG% to the "adjusted" alternative rate of return.

$$\text{TVG\%} \gtreqless \text{a.r.r.}\left[\frac{(1+\text{a.r.r.})^n}{(1+\text{a.r.r.})^n-1}\right]$$

Harvest when the timber value growth percent falls below the alternative rate of return adjusted by the term in brackets. Note that this approach is most applicable to setting rotation age (n) for even-aged stands that meet the assumptions of the time-line we started with – a perpetual series of identical timber rotations.

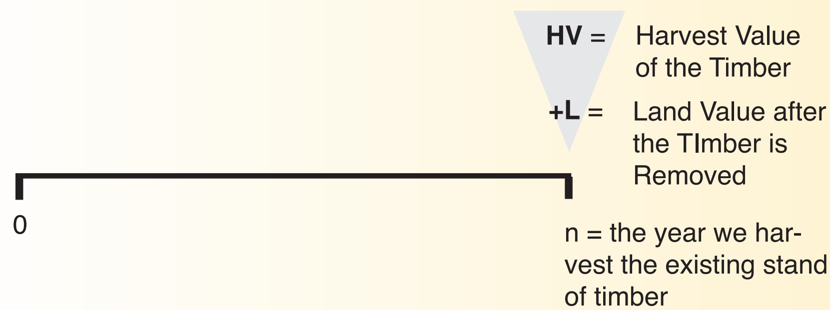
Figure 6. Diagram of Approach 1 to Adjusted Financial Maturity.



Since we adjust the interest rate upward, financial maturity occurs at a younger age using the "adjusted" financial maturity model.

maximizing the present value of all future income from a tract. For this approach, we begin with a time-line that doesn't specify the age or condition of our current stand, and that doesn't show the specific source of all future value (Figure 7).

Figure 7. Time-line 2.
Timber value and land value in general terms – we obtain $HV "n" years from the present, and at that time we also realize $L from the value of the underlying land.



The reason "HV+L" reflects **all** future net income from the tract is that the value of the land in year "n" should be equal to the value of all net income that's expected after the existing stand is removed, discounted to year "n."

The second approach to "adjusted" financial maturity is more general than Approach 1. Rather than starting with a restrictive assumption of a perpetual annual series of identical timber rotations, we start with a time-line that shows a **general**[2] pattern of future value.

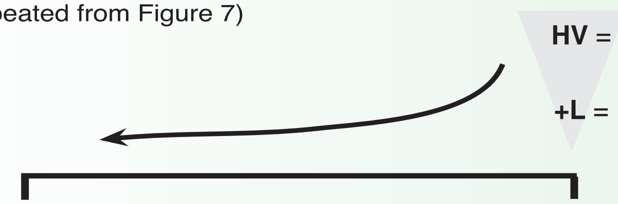
[2]To see just how general **Time-line 2** is, note that **Time-line 1** is a special case of **Time-line 2** – if "L" in **Time-line 2** represents the discounted value of identically managed and valued even-aged stands of timber (the "HVs" in **Time-line 1**), then the time-lines are identical.

In deriving the second approach to adjusted financial maturity, our next step is to determine the “n” that maximizes the present value of HV+L … all future net value from the tract (Figure 8).

Again, “HV” represents the direct monetary income received from selling the timber from the existing stand. “L” represents the dollar value we place on the land - it’s what the land is “worth” to the owner after the existing stand is harvested. To determine the “n” that maximizes all future net income, HV+L, we again start with the present value relationship:

Figure 8.
Adjusted financial maturity guideline derived from Time-line 2 (Figure 7).

Time-line 2
(repeated from Figure 7)



$$\text{Present Value} = \frac{HV+L}{(1+i)^n}$$

Where **i** is the discount rate (the interest rate) and **n** is the number of years before the existing stand is harvested.

Or we can rewrite the present value relationship using continuous compounding:

$$\text{Present Value} = \frac{HV+L}{e^{in}}$$

Where **i** is the discount rate (the interest rate), **n** is the number of years before the existing stand is harvested, and **e** is the base of the natural logarithms.

To find the stand age that maximizes present value, we set the first derivative of this relationship with respect to stand age equal to zero. If this is done, after simplifying we have:

$$\frac{\frac{dHV}{dn}}{HV+L} = i$$

The left side of the relationship at the bottom of Figure 8 is the change in harvest value with respect to the year of harvest divided by total tract value at the time of harvest – referred to here as **Forest** Value Growth Percent (FVG%). The word **forest** in "forest value growth percent" simply indicates that we're considering the timber value *and* the land value (total forest value) in our comparison with rates of return of similar duration and risk. The second approach to adjusted financial maturity is therefore to manage an existing stand of timber until the forest value growth percent falls below the alternative rate of return (Figure 9).

Figure 9.
Approach 2 to adjusted financial maturity: Compare FVG% to the alternative rate of return.

FVG%	$\gtreqless$	**a.r.r.**	Harvest timber when the **forest** value growth percent falls below the comparable alternative rate of return.

Important points about land value:

What if you plan never to sell your land? Should you still include "L"?

Yes – even if a forest landowner has absolutely no plans to ever sell a specific tract of timberland, that tract has monetary value in other uses, and that value can only be realized after the existing stand of timber is removed.

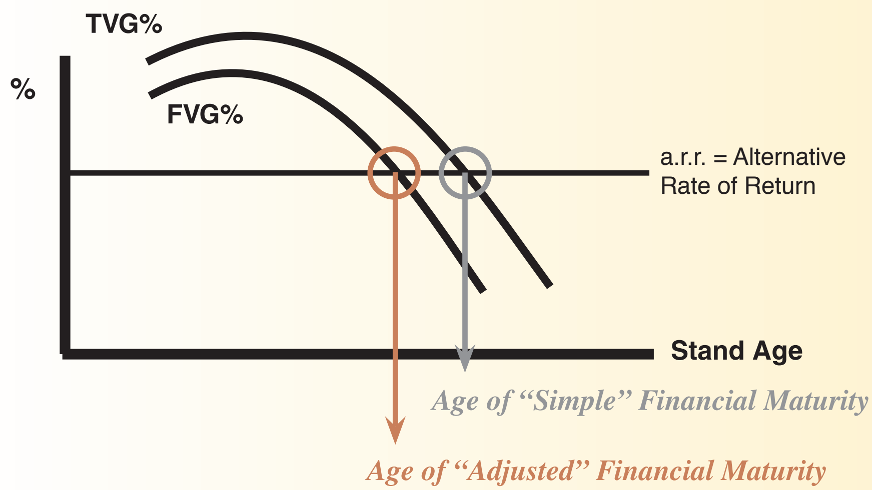
- If the owner plans to keep the land and grow timber, for example, the "L" in **Time-line 2** should be the discounted value of all net income expected from growing timber on the tract after the existing stand is harvested. This calculated value is often referred to as "bare land value," "soil expectation value," or "land expectation value" (Bullard and Straka 1998).

- If you're going to keep the land but use it for an alternative use, "L" should be the value of the land to the owner in that use.

If the landowner would consider selling the land, "L" should be the actual price he or she would expect to receive for the land after harvest of the timber stand. **In general, "L" should represent the appropriate value of the land to the landowner in year "n," the year the existing stand of timber is harvested.**

If we assume that land value is constant over time, forest value growth percent will be less than timber value growth percent at any given stand age. With constant land value, timber is the only part of the timberland asset that is increasing in value over time, so FVG% < TVG%. This is an important result of the adjusted financial maturity model – it implies that using FVG% timber stands will reach the alternative rate of return threshold at an earlier age. As shown in Figure 10, financial maturity will occur at an earlier age using the "adjusted" model.

Figure 10. Diagram of the simple financial maturity model and Approach 2 to adjusted financial maturity.



If the landowner *would* consider selling the land after the timber is harvested, and if the value of land is increasing for development purposes or other "higher and better" uses, one must be careful in using FVG% to determine a stand's age of financial maturity. In cases where the value of land is increasing significantly, FVG% may be relatively high due to the increased value of the land, and the rising land value may mask a relatively poor rate of value growth for the timber.

When land values are rising and the landowner is willing to sell the land after a stand is harvested, it may be useful to calculate separate rates of value increase for timber and for land. Landowners may find it best from a financial standpoint to harvest timber whose rate of value increase is below their alternative rate of return, while holding the cutover land for sale at a later time.

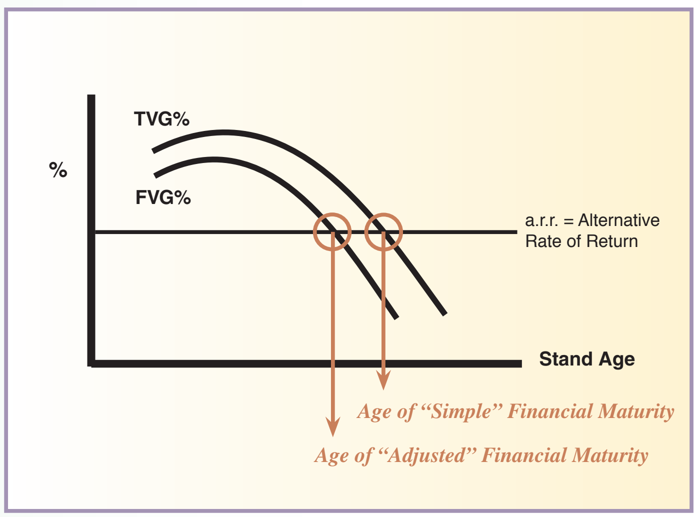
Summary of model development

The basic financial maturity concept is simple – a stand of timber is financially mature when its rate of value increase falls below the rate that can be earned in other investments considering investment duration, risk, liquidity, taxes, and other factors. In practice, however, two basic approaches to applying financial maturity concepts have been developed and applied, as summarized in Figure 11. "Simple" and "adjusted" financial maturity guidelines differ based on whether land value is included in the rate of value increase calculated for a tree or stand.

The second approach to adjusted financial maturity is general and is widely applicable to evaluating harvest plans for existing stands of timber. The three examples that follow are applications of the second approach to adjusted financial maturity.

Figure 11. Simple versus adjusted financial maturity concepts and assumptions.

	"Simple" Financial Maturity	"Adjusted" Financial Maturity
Concept	Harvest when the rate of value increase of **timber** falls below the alternative rate of return. This approach is referred to as "simple" because timber value only is considered.	Harvest timber when the age of value increase of **timber and land** falls below the alternative rate of return. This approach is referred to as "adjusted" because land value is also considered in the timber harvest decision.
Application Guideline	Calculate **T**imber **V**alue **G**rowth percent and compare to the alternative rate of return. Harvest when TVG% < a.r.r. (illustrated below).	Calculate **F**orest **V**alue **G**rowth percent and compare to the alternative rate of return. Harvest when FVG%< a.r.r. (illustrated below).
Time-line Assumption	Results are consistent with maximizing the present value of income from **one** stand of timber.	Results are consistent with maximizing the present value of income from **all** sources – the existing stand of timber as well as value after the existing stand is harvested.
Harvest Age Comparison	Timber will be financially mature at an earlier age using the "adjusted" model. This occurs because we are recognizing the opportunity cost of the underlying land – subsequent income (or value from the land) cannot be obtained until the existing stand of timber is harvested. It's important to include an appropriate land value even in cases where the landowner is not planning to sell the land after the existing stand of timber is harvested (see page 10 for discussion).	



Three Examples

Next we apply the adjusted financial maturity model to three hardwood stands in central Mississippi using data for 1982 and 2000. Our analysis is therefore historical. A forester or landowner faced with the harvest decision for any one of these stands in 2000 could compare the forest value growth percent for each stand over the previous 18 years with an alternative rate of return. As stated previously, however, the value growth rate *projected* for each stand should be considered before making final harvest decisions.

Our three example stands were on bottomland hardwood sites. They varied widely in age, volume, and timber value, but were similar in that during the 18 years between measurements no timber was harvested.

Timber prices and land values

In each example, we used the timber prices and bare land values shown in Figure 12. Prices were obtained from Timber Mart South for Region 1 in Mississippi. Bare land values were obtained from Burak (2000) for 1982 and from Braswell (1998) for 2000.

Figure 12.
Timber prices and bare land values assumed for 1982 and 2000.

	1982	2000
Oak Sawtimber	**55.00**	**271.00**
Mixed Hardwood Sawtimber	**56.00**	**166.75**
Hardwood Pulpwood	**3.80**	**12.22**
Bare Land	**275.00**	**416.00**

Sawimber prices are in dollars per thousand board feet (Doyle), pulpwood prices are in dollars per standard cord, and land values are in dollars per acre. All values are in “nominal” or “current dollar” terms.

Calculations

To calculate the average annual rate of increase in forest value between 1982 and 2000, we can apply the simple formula for calculating the rate of return earned between year 0 and year n:

$$i = \left[\frac{\text{Value in year n}}{\text{Value in year 0}}\right]^{1/n} - 1$$

The above formula is simply a result of solving the discrete period compound interest formula for calculating future value for “i,” the compound rate of interest (see Bullard and Straka 1998). In the case of adjusted financial maturity, “i” is the calculated rate of forest value growth (FVG%) between year 0 and year n. If a stand of timber is being evaluated that has more than two values, i.e., if intermediate costs and/or revenues result in more than two numbers on the timeline, a computer program such as FORVAL (Bullard et al. 1999) may be used to estimate the historical or projected rate of value increase.

In each of the three example stand calculations that follow, a volume and value summary is presented, followed by the calculation of FVG%. Whether a stand is financially mature, of course, also depends on the alternative rate of return. Alternative rate of return, inflation, and other factors are discussed in the Discussion section.

Stand 1

Stand 1 was 45 years old in 2000. The timber was primarily oak sawtimber, which increased from below 2 MBF (Doyle) in 1982 to nearly 11 MBF in 2000.

Adjusted Financial Maturity Analysis – Stand 1

Volume and Value Summary:

	1982 (Volume) x (Price) = (Value)	2000 (Volume) x (Price) = (Value)
Oak Sawtimber	1.930 MBF x $55.00/MBF = $106.15	10.790 MBF x $271.00/MBF = $2,924.09
Mixed Hardwood Sawtimber	0.07 MBF x $56.00/MBF = $3.92	0.07 MBF x $166.75/MBF = $11.67
Mixed Hardwood Pulpwood	32.3 cds. x $3.80/cd. = $122.74	24.4 cds. x $12.22/cd. = $298.17
	Total Timber Value = $232.81/ac.	**Total Timber Value = $3,233.93/ac.**
	Bare Land Value = $275.00/ac.	**Bare Land Value = $416.00/ac.**
	Total Forest Value = $507.81/ac.	**Total Forest Value = $3,649.93/ac.**

Adjusted Financial Maturity Calculation:

The total values for timber and land for 1982 and 2000 can be used to calculate the forest value growth percent (FVG%) for the stand during the 18-year period:

$$\text{FVG\%} = \left[\frac{\left(\text{Forest Value in 2000}\right)}{\left(\text{Forest Value in 1982}\right)} \right]^{1/18} - 1$$

$$\text{FVG\%} = \left[\frac{\$3{,}649.93}{\$507.81} \right]^{1/18} - 1 = 0.11580\text{, or about } 11.6\%$$

Results:

Stand 1's land and timber (together) increased in value at an average annual rate of increase of about 11.6% between 1982 and 2000. This annual rate of increase is in *nominal* terms on a *before-tax* basis.

Stand 2

Stand 2 was 86 years old in 2000. This high volume stand was oak and mixed hardwood sawtimber. Total sawtimber volume increased from approximately 22 MBF/acre in 1982 to nearly 38 MBF/acre in 2000.

Adjusted Financial Maturity Analysis – Stand 2

Volume and Value Summary:

	1982 (Volume) x (Price) = (Value)	2000 (Volume) x (Price) = (Value)
Oak Sawtimber	9.587 MBF x \$55.00/MBF = \$527.29	10.927 MBF x \$271.00/MBF = \$2,961.22
Mixed Hardwood Sawtimber	20.553 MBF x \$56.00/MBF=\$1,150.97	26.953 MBF x \$166.75/MBF = \$4,494.41
Mixed Hardwood Pulpwood	11.1 cds. x \$3.80/cd. = \$42.18	8.3 cds. x \$12.22/cd. = \$101.43
	Total Timber Value = \$1,720.44/ac.	**Total Timber Value = \$7,557.06/ac.**
	Bare Land Value = \$275.00/ac.	**Bare Land Value = \$416.00/ac.**
	Total Forest Value = \$1,995.44/ac.	**Total Forest Value = \$7,973.06/ac.**

Adjusted Financial Maturity Calculation:

The total values for timber and land for 1982 and 2000 can be used to calculate the forest value growth percent (FVG%) for the stand during the 18-year period:

$$\text{FVG\%} = \left[\frac{\left(\text{Forest Value in 2000}\right)}{\left(\text{Forest Value in 1982}\right)}\right]^{1/18} - 1$$

$$\text{FVG\%} = \left[\frac{\$7{,}973.06}{\$1{,}995.44}\right]^{1/18} - 1 = 0.07999 \text{, or about } 8\%$$

Results:

Stand 2’s land and timber (together) increased in value at an average annual rate of increase of about 8% between 1982 and 2000. This annual rate of increase is in *nominal* terms on a *before-tax* basis.

Stand 3

Stand 3 was 57 years old in 2000. In this stand the volume of oak sawtimber doubled between 1982 and 2000, but the increase in volume of mixed hardwood sawtimber was not significant.

Adjusted Financial Maturity Analysis – Stand 3

Volume and Value Summary:

	1982 (Volume) x (Price) = (Value)	2000 (Volume) x (Price) = (Value)
Oak Sawtimber	2.535 MBF x $55.00/MBF = $139.43	5.215 MBF x $271.00/MBF = $1,413.27
Mixed Hardwood Sawtimber	4.075 MBF x $56.00/MBF = $228.20	4.980 MBF x $166.75/MBF = $830.42
Mixed Hardwood Pulpwood	29.6 cds. x $3.80/cd. = $112.48	17.0 cds. x $12.22/cd. = $207.74
	Total Timber Value = $480.11/ac.	**Total Timber Value = $2,451.43/ac.**
	Bare Land Value = $275.00/ac.	**Bare Land Value = $416.00/ac.**
	Total Forest Value = $755.11/ac.	**Total Forest Value = $2,867.43/ac.**

Adjusted Financial Maturity Calculation:

The total values for timber and land for 1982 and 2000 can be used to calculate the forest value growth percent (FVG%) for the stand during the 18-year period:

$$\text{FVG\%} = \left[\frac{\left(\text{Forest Value in 2000}\right)}{\left(\text{Forest Value in 1982}\right)}\right]^{1/18} - 1$$

$$\text{FVG\%} = \left[\frac{\$2{,}867.43}{\$755.11}\right]^{1/18} - 1 = 0.07694\text{, or about } 7.7\%$$

Discussion:

Stand 3's land and timber (together) increased in value at an average annual compound rate of about 7.7% between 1982 and 2000. This annual rate of increase is in *nominal* terms on a *before-tax* basis.

Discussion

Are the three example stands financially mature? To address this question, an alternative rate of return must be established – a rate of return that is minimally acceptable to the owner for each specific tract of land. Sometimes referred to as a "hurdle rate," this rate may vary for different tracts. A landowner may, for example, choose to accept a lower monetary rate of return for a specific stand of timber because the stand has high value for wildlife habitat or watershed management.

In all cases, the alternative rate of return should be comparable to the forest value growth percent in terms of taxes, inflation, potential risk, investment liquidity, and in any other way that is important to the decision maker (Bullard 2001). In the three examples of the previous section, inflation was included in the analysis, and the forest value growth percent calculated for each stand is therefore in *nominal* terms. Also, income taxes were not considered, so each rate of return calculated is on a before-tax basis. Whether the rates of return earned by these stands, or projected for these stands, are acceptable is the landowner's decision considering all factors involved.

The expected *duration* of timberland investments should also be considered in choosing a hurdle rate. In Mississippi, for example, nonindustrial private forest landowners specified minimum acceptable rates of return for forestry investments that were significantly higher as the length of the investment increased. On a before-tax, nominal basis, minimum acceptable rates of return averaged 13% for 25-year forestry investments, 11% for 15-year investments, and only 8% for 5-year investments (Bullard et al. 2001).

As stated previously, before determining that harvest of a stand is called for using financial maturity, the *projected* rate of value growth should be considered. Rates of value change are determined by price changes as well as expected timber volumes increases, and it may be that price increases are expected for specific timber product types in a given region; such expected changes may result in relatively high projected forest value growth rates even for stands with relatively low rates of projected volume increase.

Adjusted financial maturity is a very useful tool for helping decide whether to harvest timber. The usefulness of financial maturity comes from its flexibility and simplicity. The approach is flexible because any merchantable stand of timber can be evaluated. In addition, the landowner can choose hurdle rates that are stand-specific, considering risk factors, relative liquidity, and other monetary factors, as well as the non-monetary values associated with a particular property. The approach is also flexible because the forester or landowner can use any method available to project future timber volumes and prices. The approach can be used for evaluating the projected growth and value of timber stands, or it can be used to assess historical rates of value increase. Financial maturity calculations are relatively simple, and the interest rate comparison is easy to understand and apply.

Finally, as demonstrated in this report, adjusted financial maturity can be defended as a valid approach for maximizing the present value of all future net income from a specific forested property. This present value represents landowner wealth from a monetary standpoint, and is the most appropriate criterion to use if the owner's goal is to maximize the financial value of a forested property.

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