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Pressler's indicator rate formula as a guide for forest management☆

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ABSTRACT

In this paper, it is shown that Pressler's indicator rate formula is also the optimal condition for the determination of the optimal harvest age under the generalized Faustmann formula. In addition, a modern treatment of the quantity increment, quality increment, and price increment is presented. Pressler's indicator rate formula is then applied to determine the optimal harvest age in a dynamic world of unanticipated changes.

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1. Introduction

In 1860 Max Robert Pressler published his famous indicator rate (*Weiserprozent*) formula, here shown with his then used notations (Pressler, 1860, p. 190):

$$(a+b+c)\frac{k}{k+1}; \quad \text{with}\, k=\frac{h}{g}$$

where a is the rate of quantity increment (*Quantitätszuwachs*), b is the rate of quality increment (*Qualitätszuwachs*) and c is the rate of price increment (*Teuerungszuwachs*), h is the variable timber capital and g is the fixed land capital. The indicator rate formula was published in the journal “Allgemeine Forst- und Jagdzeitung”, the same journal, where Martin Faustmann had published the formula of the land expectation value 11 years before (Faustmann, 1849). Over the years while the quantity, quality, and price increments have been mentioned in various textbook since 1860, they have never been separated satisfactorily both analytically and empirically.

In the premier issue of the Journal of Forest Economics, four seminal papers on the determination of the optimal rotation by Faustmann (1849), Pressler (1860), Ohlin (1921), and Samuelson (1976) were published simultaneously. Among them, the papers by Faustmann, Ohlin, and Samuelson followed essentially the same vein by deriving the classic land expectation value (LEV) formula or its variants. The paper by Pressler, on the other hand, took a different tact by focusing on the increment, which follows the marginal principle in respect to time for determining the rotation ages for forest stand.

However, as Johansson and Löfgren (1985) pointed out, Pressler's indicator rate formula represents the earliest solution to maximizing the classic Faustmann land expectation value to determine the optimal rotation age.

$$\max_{t} \text{LEV} = \frac{V(t)-Ce^{rt}}{e^{rt}-1} \tag{1}$$

where $V(t)$ is the stumpage value of a t-year-old stand, C is the regeneration cost, and r is the interest rate. To maximize such value requires that

$$V'(t) = rV(t) + r\text{LEV} \tag{2}$$

where $V'(t) = dV(t)/dt$ represents the current annual increment in value and all others are as defined earlier.

In other words, intertemporal maximization and marginal (stepwise) comparison of alternatives are two different techniques of the same maximizing principle. However the second technique of Eq. (2) has some advantages for more general applications as we will show in this paper.

Eq. (2) can also be written as Pressler's indicator rate (*Weiserprozent*) formula:

$$\left[\frac{V'(t)}{V(t)}\right]\left(\frac{k}{k+1}\right) = r \tag{3}$$

where $k = V(t)/\text{LEV}$.

This well-established solution to the optimal rotation age is possible with the help of some very stringent assumptions as mentioned in Johansson and Löfgren (1985, pp. 74–75): Among them, the same stumpage prices will repeat themselves rotation after rotation. Successive stands would produce exactly the same yield rotation after rotation. The same regeneration cost will repeat itself rotation after rotation. Finally, the same interest rate will be available rotation after rotation. Although this heroic model-world provides deep insight into how forestry works in a market economy, it has less to do with the world in which we live. Therefore the relevant question for the forest stand management is: Can the Pressler's indicator rate formula be used fruitfully under the generalized Faustmann formula when stumpage price, stand volume, regeneration cost, and interest rate can vary from one rotation to the next?

In this paper we will show that Pressler's indicator rate formula is applicable under the more general conditions. We will show first that Pressler's indicator rate formula not only represents the first order condition for the maximization of the classic Faustmann land expectation value formula under the stringent assumptions mentioned above. It also represents the optimal condition for the