Journal of Forest Economics 16 (2010) 179–193

Contents lists available at ScienceDirect

Journal of Forest Economics

journal homepage: www.elsevier.de/jfe

Integrating neighbourhood effects in the calculation of optimal final tree diameters

Fabian Härtl, Andreas Hahn, Thomas Knoke *

Institute of Forest Management, Center of Life and Food Sciences Weihenstephan, Department of Ecology and Ecosystem Management, Technische Universität München (TUM), Hans-Carl-von-Carlowitz-Platz 2, 85354 Freising, Germany

ARTICLE INFO

Article history:
Received 21 November 2008
Accepted 23 November 2009

JEL classification:
Q23
Q51
Q56
Q57

Keywords:
Economic optimization
Faustmann model
Soil expectation value
Pressler percent
Neighbourhood effects
Single tree approach

ABSTRACT

Modern silvicultural treatments are based on single trees whereas classic forest economics look at the stand level. To accompany each other it is necessary to transfer the established economic models to the single tree level. This paper is an approach to use the Faustmann model and the corresponding marginal rate of return (Pressler percent) to derive value increment rates of single trees taking into account neighbourhood effects due to competition between individual trees. Furthermore, optimal rotation periods and optimal final diameters for future trees will be calculated.

Introduction

Financial mathematics has developed the concept of discount rates to compare payments which are made at different times. This concept refers to a principally free selectable interest rate. Like no other branch forestry is confronted with long terms of production. So it is not surprising that during the 19th century forest economists – almost before common economics – have developed methods to calculate the present value of given or expected pay-outs and pay-ins. Those calculated values

* Corresponding author.
E-mail addresses: fabian.haertl@t-online.de (F. Härtl), andreas.hahn@forst.wzw.tum.de (A. Hahn), knoke@forst.wzw.tum.de (T. Knoke).

1104-6899/$ - see front matter
doi:10.1016/j.jfe.2009.11.003

then were used as a support for economic decisions, normally on company or stand level. Names like *Gottlob König*, *Martin Faustmann* or *Max Robert Pressler* are connected with these more or less intuitively derived calculations which are commonly used in practical forestry in non-German speaking countries, especially in North America, to make decisions about rotation periods and felling seasons (Haight, 1985; Haight and Monserud, 1990; Oderwald and Duerr, 1990; Klemperer, 1996; Chang, 1998; Brazee and Bulte, 2000; Buongiorno, 2001; Möhring et al., 2006). Until now a theoretically grounded and adequately complete transfer of the Faustmann formula to the level of single trees is missing. This paper is an attempt to do this.

Aim and strategy

In many places in Central Europe woodlands are treated as natural production forests (von Teuffel et al., 2005). These treatments often are based on the single tree. This requires a corresponding economic model: The Faustmann model will be expanded by terms describing the competition between the trees, and with that the losses in income due to lower felling values. That will also answer the question if these interactions have relevant consequences for the decisions of the management (compare the hypothesis in "Hypothesis and example"). Other published papers about single tree profitabilities do not consider these effects (e.g. Moog, 1990; Ebert, 1991; Moog and Karberg, 1992; Börner and Roeder, 1994; Knoke, 1997; Beinhofer, 2007).

The soil expectation value as a valuation calculus

Eq. (1) is known in literature as the *soil expectation value*.

$$B_e(T) = \left[A(T)e^{-rT} + \sum_{t=1}^{T} D_t e^{-rt} - c\right] \frac{1}{1-e^{-rT}} - V \tag{1}$$

It was developed in similar ways in 1813 by *Gottlob König* and in 1849 by *Martin Faustmann*. Precisely it is the *soil expectation net value* which is reduced by the net present value of the administration costs v that are assumed to be constant over time. So V is defined as $V := v/r$. A is the felling value of the stand (net-of harvesting costs), r the interest rate, T the rotation period. D_t are the returns from thinning at different times t (net-of harvesting costs) and c the possibly occurring costs for establishing a new stand generation. The soil expectation value describes the benefit – i.e. the net present value – of *durably* stocked woodland (Faustmann, 1849).

The soil expectation value was interpreted by G. König and M. Faustmann as the maximum bid price for (forest) land, for which forest management is just profitable.

The optimization of the rotation period

Eq. (1) is the soil expectation value as a function of the rotation period T. In the next step this equation is used to develop a criterion for the *optimal rotation period*. "Optimal" here means an optimization in a financial view. Forest management can and in many cases has to consider other optimals due to ecologic and social functions (see Touza et al., 2008). The soil expectation value as a function of T has a maximum for a definite rotation period $T = T_0$. A necessary criterion for a maximum of a function, depending on a certain variable, is a zero of the first derivative of this function with respect to that variable:

$$B_e'(T) := \frac{d}{dT} B_e(T) \overset{!}{=} 0$$

Before the derivation $B_e(T)$ will be transformed. As the rotation period will be optimized and not the thinning intervals, and because the times of thinning are not assumed to depend on the exact felling