Mixed forests and a flexible harvest policy: a problem for conventional risk analysis?

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Abstract

The famous “Faustmann” equation, which allows for identifying the most profitable tree species on a given unstocked piece of land, assumes constant timber prices. In reality, timber prices may fluctuate dramatically. Several authors have proven for monocultures that waiting for an acceptable timber price (reservation price) before harvesting (flexible harvest policy) increases the net present value of forest management. The first part of this paper investigates how efficient a flexible harvest strategy may be applied in mixed forests and whether the optimal species mixture is changed under such harvest policy. Mixtures of the conifer Norway spruce [*Picea abies* (L.) Karst] and the broadleaf European beech (*Fagus sylvatica* L.) were investigated. In order to evaluate mixed forests, the risks and the correlation of risks between tree species as well as the attitude towards risk of the decision-maker (risk-aversion is assumed) were considered according to

the classical theory of optimal portfolio selection. In the second part we took up a recent critique on modern financial theory by Mandelbrot. Whether or not the assumption of normally distributed financial flows, which are supposed to occur under risk, would be appropriate to evaluate the risk of forest management was investigated. Market and hazard risks as well as their correlation were integrated in the evaluation of mixed forests by means of Monte-Carlo simulations (MCS). The risk of the timber price fluctuation was combined with the natural hazard risk, caused mainly by insects, snow and wind. Applying the μ-σ-rule, the mean net present value (NPV) from 1,000 simulations and their standard deviation were used for the optimisation. Given a low-return, risk-free interest rate to assess potential species mixtures of the Norway spruce and European beech, optimal proportions of European beech increased according to the theory of optimum portfolio selection with growing risk aversion from 0 (ignorance of risk) to 60% (great risk-aversion). In relation to a fixed harvest policy, the net present value of both, Norway spruce and European beech, could be increased significantly. Since the hazard risks of European beech were substantially lower compared with the Norway spruce (relation of susceptibility 1:4) beech benefited more from the flexible harvest policy. A comparison of simulated frequency distributions of the NPV with the expected density functions under the assumption of a normal distribution revealed significant differences. Only in the case of European beech was the general shape of the simulated frequency distribution similar to a normal distribution (bell-shaped curve). However, the density of NPV close to the mean was much greater than expected under the assumption of a normal distribution. Consequently, the frequency of a negative NPV for a European beech forest was greatly overestimated when applying the normal distribution. Though the shape of the simulated frequency distribution was rather different from a normal distribution for Norway spruce the simulated part of negative NPV was quite well approximated by the normal distribution. Therefore the simulated and expected frequencies of negative NPV were similar in case of Norway spruce; only a slight underestimation was seen in the assumption of a normal distribution. It can be concluded that actually simulated frequencies of negative NPV seem to be better measures for risk than computed probabilities of negative NPV, which assume normal distribution. As the risk for European beech was greatly overestimated by the conventional assumption of a normal distribution, the optimal proportions of European beech were surely rather underestimated according to the theory of

portfolio. MCS on optimum mixtures derived by the classical portfolio theory seems necessary to test the robustness of such mixtures.

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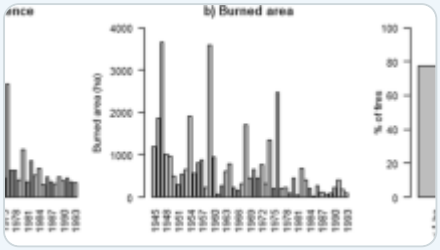

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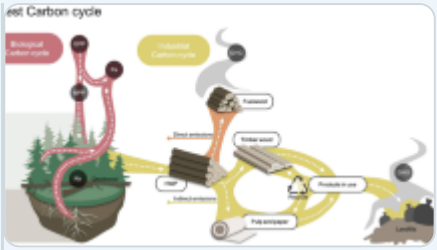

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Notes

1. The NPV is formed by the sum of all appropriately discounted net revenue flows.

2. An earlier exemplary paper has already been written on this topic (see Knoke et al. 2001).

3. For European beech also rotation periods between 101 and 110 years were tested in order to provide identical investment periods.

4. Locally related survival probabilities for forest offices in Baden-Württemberg were published, for example, by Hanewinkel and Holcey (2005).

5. If two rotation periods of different lengths were compared (e.g. 100 and 120 years) considering only one rotation period would be a biased evaluation (see Knoke et al. 2005).

6. Here the NPV was reduced on average by €2,182 per ha, which was the sum of the discounted overhead costs.

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