Integrating risks in forest planning

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Agenda

- The concept of „risk“
- Risks in forestry
- Integrating risks in forest models
- Optimizing under consideration of risk

Risk as a concept

- Decisions and their outcome are subject to risk
- Various (and ambiguous) definitions of risk
- e.g. Knight (1921): risk implies known probabilities; uncertainty occurs without known probabilities;
- Planning processes should consider risk

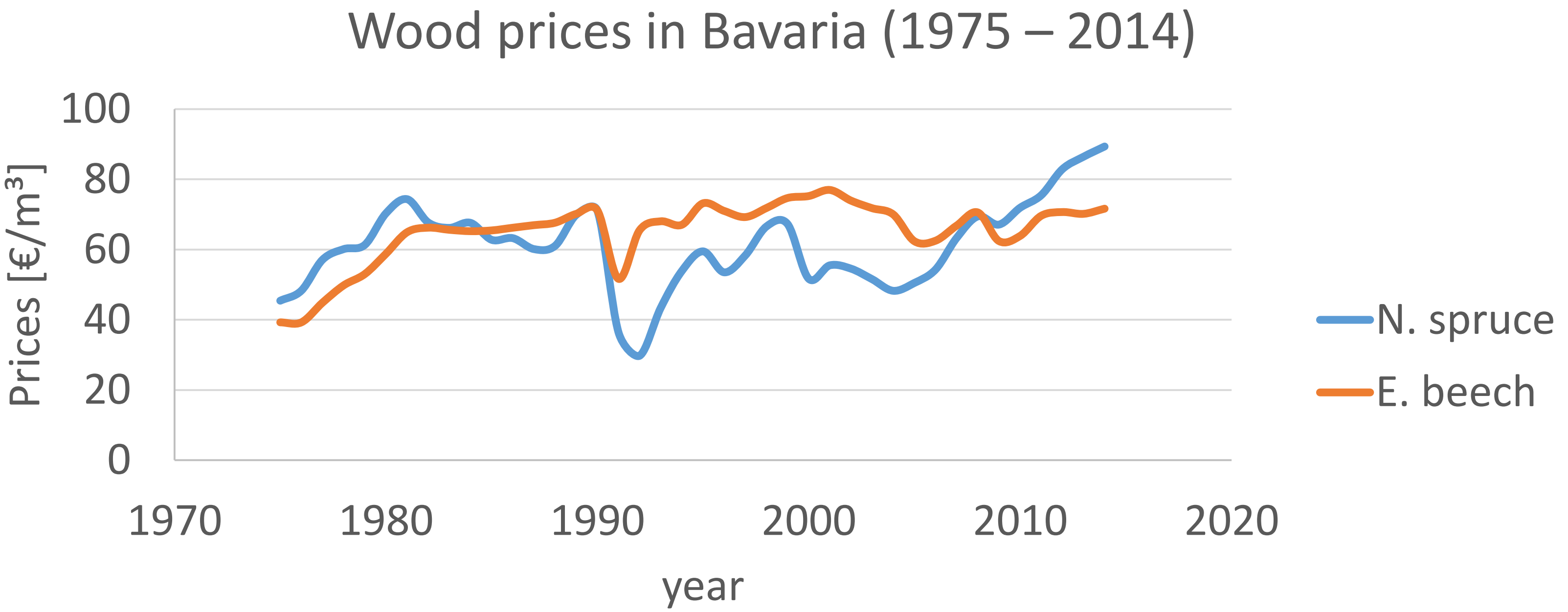
References:
Eyvindson, K., Cheng, Z., 2016. Implementing the conditional value at risk approach for even-flow forest management planning. Can. J. For. Res. 46 (5), 637–644. 10.1139/cjfr-2015-0270.
Detten, R. von, Hanewinkel, M., 2017. Strategies of Handling Risk and Uncertainty in Forest Management in Central Europe. Curr Forestry Rep. 10.1007/s40725-017-0050-7.
Wynne, B., 1992. Uncertainty and environmental learning: Reconceiving science and policy in the preventive paradigm. Global Environmental Change 2 (2), 111–127. 10.1016/0959-3780(92)90017-2.

Risks in Forestry

- Price fluctuations
- Natural hazards
- Inventory errors
- Uncertainty in growth models
- Climate change
- Changing preferences of decision maker

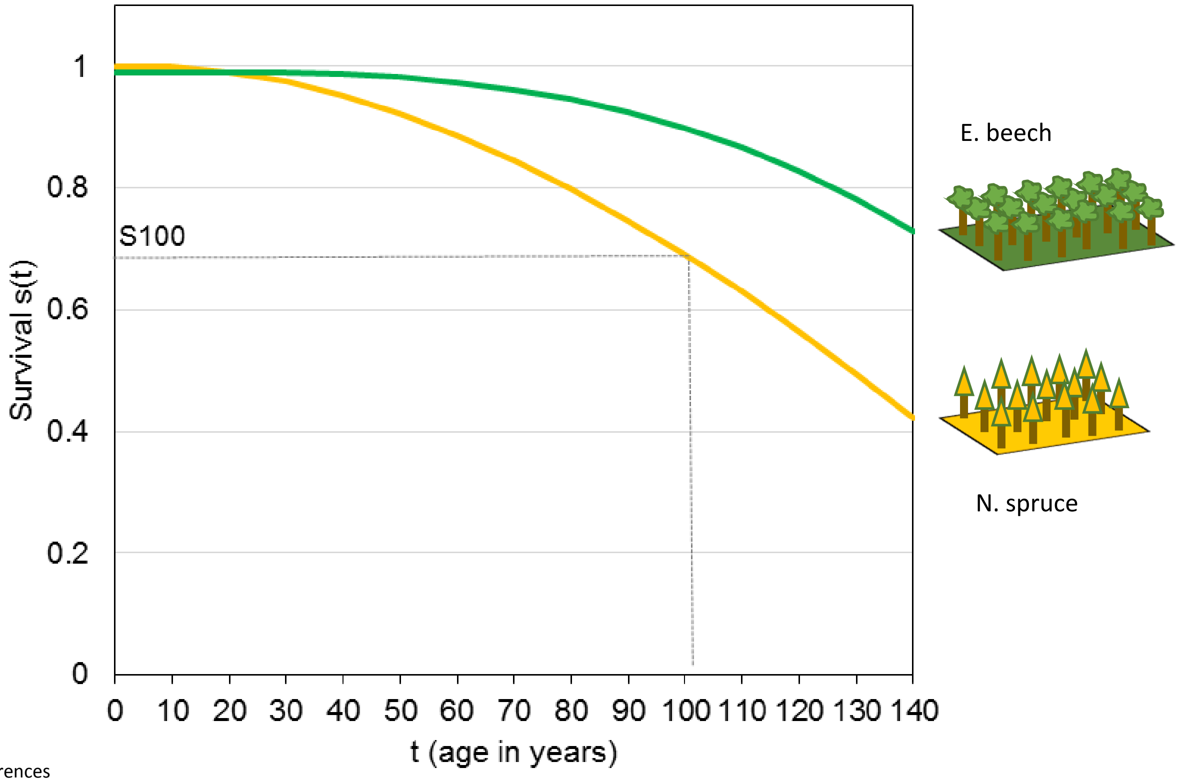
References
Eyvindson, K., Cheng, Z., 2016. Implementing the conditional value at risk approach for even-flow forest management planning. Can. J. For. Res. 46 (5), 637–644. 10.1139/cjfr-2015-0270.
Knoke, T., Moog, M., Plusczyk, N., 2001. On the effect of volatile stumpage prices on the economic attractiveness of a silvicultural transformation strategy.
Forest Policy and Economics 2 (3-4), 229–240. 10.1016/S1389-9341(01)00030-2.
Pasalodos-Tato, M., Mäkinen, A., Garcia-Gonzalo, J., Borges, J.G., Lämås, T., Eriksson, L.O., 2013. Review. Assessing uncertainty and risk in forest planning and decision support systems:
Review of classical methods and introduction of new approaches. Forest Syst 22 (2), 282. 10.5424/fs/2013222-03063.

Example 1: Wood price fluctuations



Reference: Bayer. Staatsforstverwaltung (1975 – 2005), Bayerische Staatsforsten (2005 – 2014)

Example 2: Forest stand survival



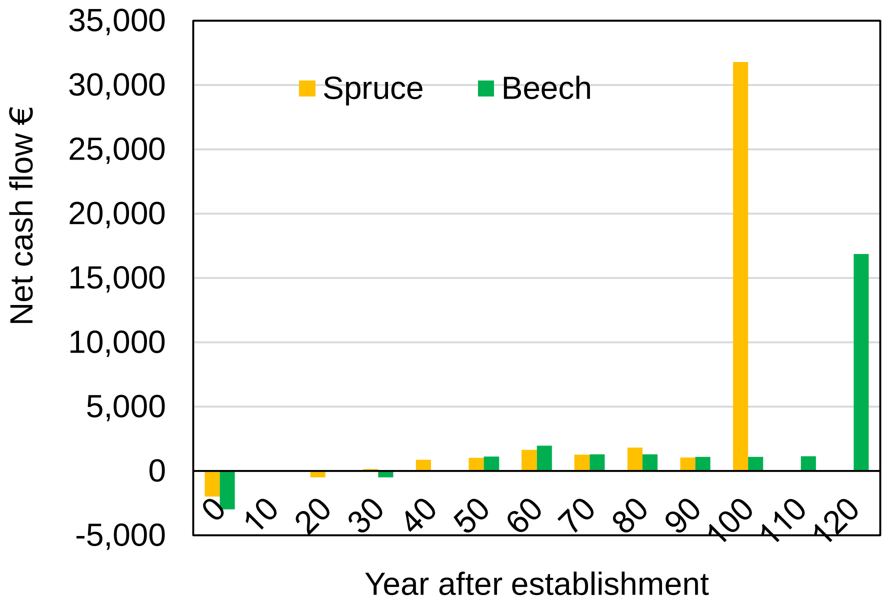
References
Beinhofer, B., 2009. Zur Anwendung der Portfoliotheorie in der Forstwissenschaft – Finanzielle Optimierungsansätze zur Bewertung von Diversifikationseffekten. Dissertation, Freising, 220 pp.

Integrating risks (Example 1 + 2)

- Stepwise stochastic simulation (Monte-Carlo-Simulation)

Integrating risks (Example 1 + 2)

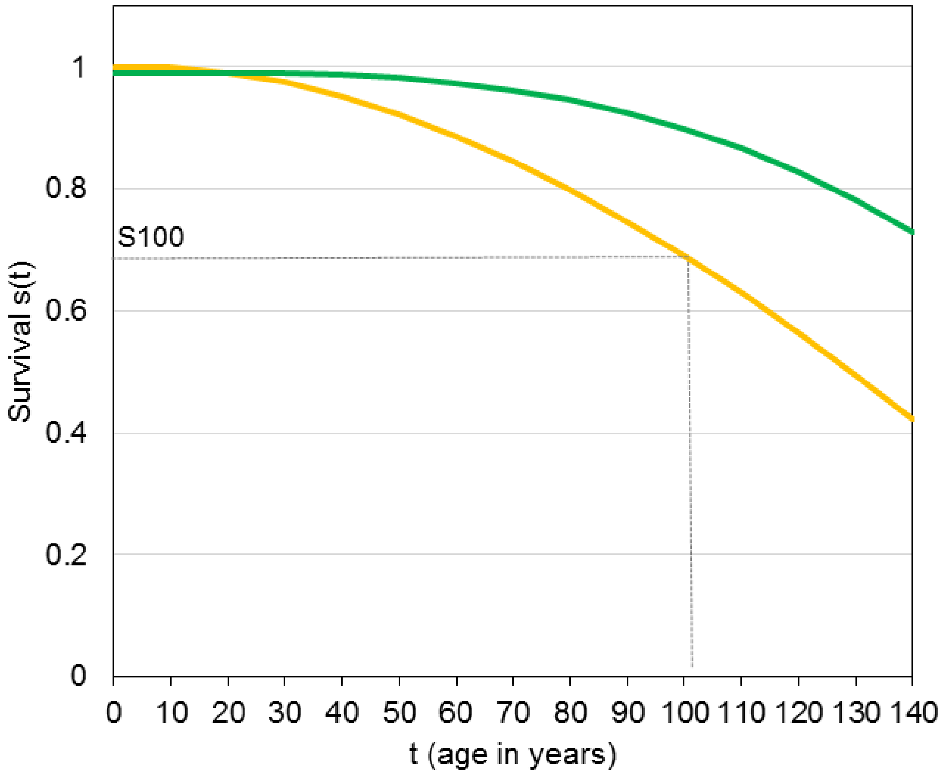
- Data from growth simulation



References:
Clasen, C., Griess, V.C., Knoke, T., 2011. Financial consequences of losing admixed tree species: A new approach to value increased financial risks by ungulate browsing. Forest Policy and Economics 13 (6), 503–511. 10.1016/j.forpol.2011.05.005.

Integrating risks (Example 1 + 2)

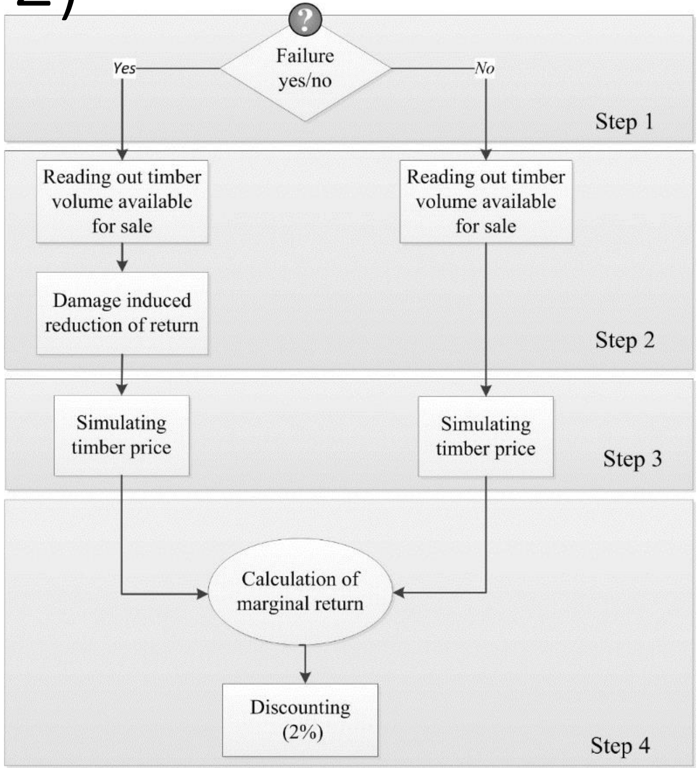
- Data from growth simulation
- Probability distributions of risks



References:
Clasen, C., Griess, V.C., Knoke, T., 2011. Financial consequences of losing admixed tree species: A new approach to value increased financial risks by ungulate browsing. Forest Policy and Economics 13 (6), 503–511. 10.1016/j.forpol.2011.05.005.

Integrating risks (Example 1 + 2)

- Data from growth simulation
- Probability distributions of risks
- Monte-Carlo-Simulation

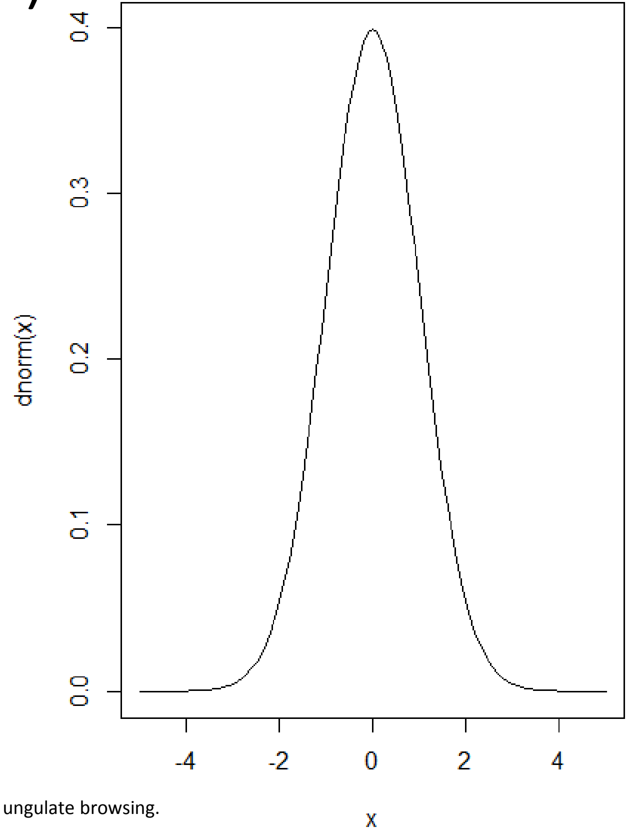


References:
Clasen, C., Griess, V.C., Knoke, T., 2011. Financial consequences of losing admixed tree species: A new approach to value increased financial risks by ungulate browsing. Forest Policy and Economics 13 (6), 503–511. 10.1016/j.forpol.2011.05.005.

Integrating risks (Example 1 + 2)

- Data from growth simulation
- Probability distributions of risks
- Monte-Carlo-Simulation
- Result: Distribution of returns
- Simulation of different **assets**

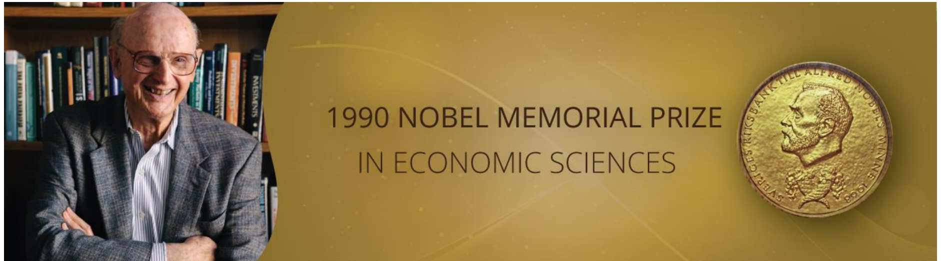
Standard normal distribution



References:
Clasen, C., Griess, V.C., Knoke, T., 2011. Financial consequences of losing admixed tree species: A new approach to value increased financial risks by ungulate browsing. Forest Policy and Economics 13 (6), 503–511. 10.1016/j.forpol.2011.05.005.

Modern portfolio theory

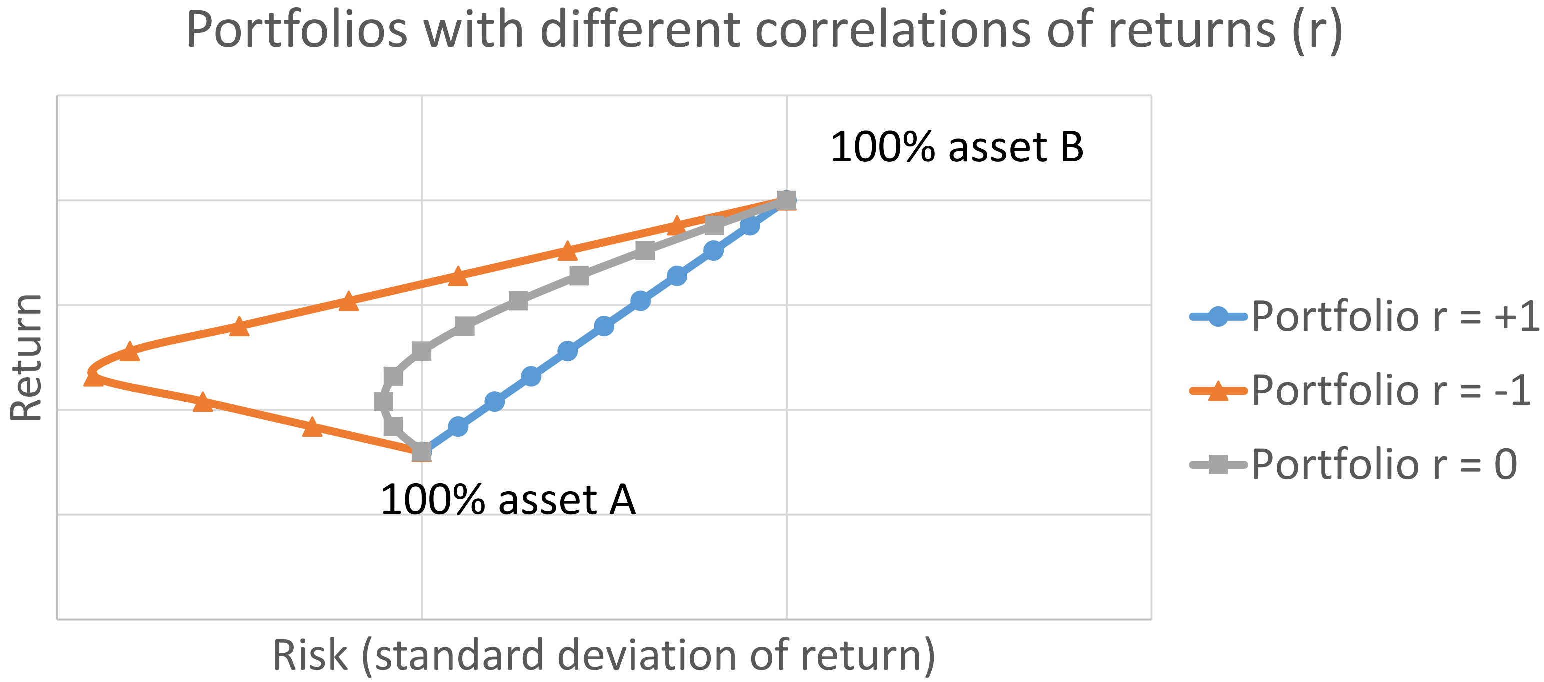
- Harry Markowitz (1952): Portfolio selection
- Basic idea: balance return und risk by investing in independent assets
- Variance of portfolio as measure of risk



Source: http://hmarkowitz.com/

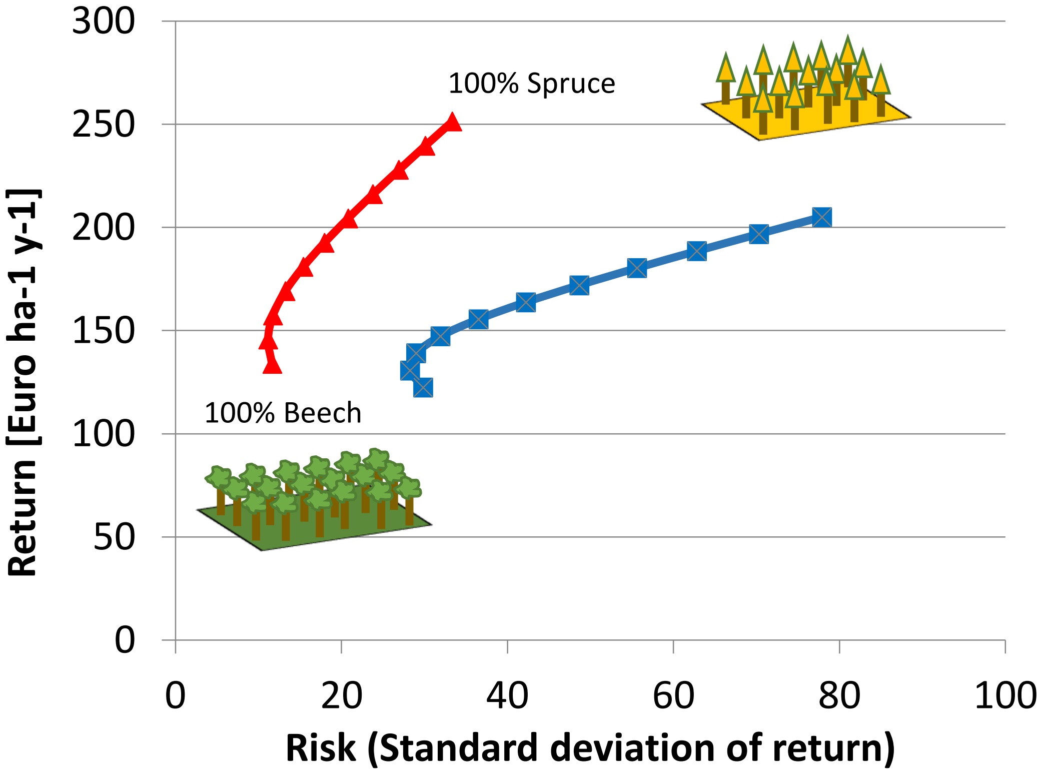
References:
Markowitz, H., 1952. Portfolio Selection. The Journal of Finance 7 (1), 77.

Modern portfolio theory



Effects of diversification with r < 1!

Example: Portfolios considering suvival probabilities



Excluding hazard induced mortality (wood price fluctuation only)

Survival rates by Beinhofer (2009)

Next step: Optimization

- Objectives of minimization or maximization
  - Accepted level of risk with maximum return
  - “Value at Risk” (99%/95% of all returns exceed VaR)
- Constraints (e.g. carbon storage)
- Multi-objective optimization (income, carbon, soil protection, water, social preferences)

Thank you for your attention