

# Discovery of the Faustmann formula in England and in the German territorial states in 1683–1849

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## Development of forest economic thought: Some motivational aspects

- ▶ Many controversial issues related to contemporary forest management have a strong historical background.
  - the use and non-use of economics and mathematics in forest economics (Löfgren 1990)
  - the friction between land rent theory and forest rent approach (Möhring 2001)
  - the use of an economically unwarranted method for valuing young forests: e.g. Comolli (1981), Yin & Newman (1996, 1997, 1999), Oderwald & Duerr (1990), Yin (1997, 2001), Yin et al. (1998), Yin & Sedjo (2001).
- ▶ Current literature provides somewhat partial picture of the development of economic thought related to optimal use of forest resources.

## Background

- ▶ Conventional conception in forest economics:
  - Martin Faustmann (1849) discovered the “Faustmann formula” and Max Robert Pressler the “Faustmann condition/rule” (e.g. Gane 1968, Samuelson 1976).
- ▶ Similar conception dominates also in the environmental economics literature (e.g. Crocker 1999) and is presented frequently also in various reviews of the development of economic thought.
- ▶ However, Scorgie (1996) has shown that Exonian surveyor and accountant John Richards (1690–1778) applied perpetual annual and periodic series to the valuation of forests and thus discovered the Faustmann formula already in 1730.
- ▶ James (1981) and Scorgie & Kennedy (1996) have pointed out that the celebrated Faustmann condition was already put forward by a well-known English agriculturalist William Marshall (1808).

## Research questions

- ▶ Is it plausible that Richards (1730) and Marshall (1808) discovered the fundamental ideas on forest valuation (capital valuation) and optimal forest rotation?
- ▶ Not necessarily because
  - modern land valuation principles were relatively well-established in the 17th century
  - the English society underwent extensive institutional and political changes in the latter part of the 17th century which lead to a rapid financial and commercial development from the 1690s (“The Financial Revolution”).
- ▶ If not, where did Richards and Marshall derive their ideas?

## Purpose and method of this study

- ▶ Purpose: To trace the discovery of the underlying principles of the Faustmann formula further back and to link their emergence more closely to the general development of economic thought that has been done previously.
- ▶ Method: To delve more deeply into the extensive institutional and political changes that the English society underwent in the latter part of the 17th century.
  - These changes lead to the successful establishment of relatively modern financial markets in England from the 1690s.

## Outline of the presentation

- 1) John Houghton and the opportunity cost of forest capital
- 2) Land and forest valuation in the early 18th century England
- 3) Rediscovery of the Faustmann formula in the “scientific forestry” (in the German territorial states)
- 4) Some discussion

## 1. John Houghton and the opportunity cost of forest capital

- ▶ In the latter part of the 17th century much of the public debate in England was directed at solving the economic problems that the country faced.
- ▶ Significant distress was caused also by the alleged scarcity of domestic wood reserves, especially from economically accessible sites.
- ▶ John Evelyn (1664): *Silva; or a Discourse of Forest-Trees*
  - one of the first comprehensive treatises on forestry
  - written at the request of the commissioners of the navy
  - included calculations on the costs and yields of timber growing
  - great profits related to timber production was propagated.
- ▶ Houghton's (apparently at the time unconventional) arguments:
  - Evelyn's calculations were unwarranted because they did not involve opportunity cost of forest capital,
  - encouraging the growth of wood within twelve miles of navigable rivers would (in contrast to Evelyn's claims) greatly prejudice private and public wealth in England.
- ▶ To support his argument, Houghton provided a numerical example.

## Houghton's numerical example (1683)

- ▶ A landlord was willing to cut his forest and to allocate the land to agricultural production, but was advised by his steward to let it stand for another 13 years.
- ▶ **Option 1:** Continue forestry for 13 years (Evelyn).
  - The value of the standing timber was originally £200 and was expected to increase to £480 in the next 13 years.
- ▶ **Option 2:** The opportunity cost of continuing forestry (Houghton).
  - Account for “the interest of the £200 the landlord might have had”, “the interest on the interest” and “the yearly land rent (£7.5) and its interest” for the 13 years → the steward had prejudiced his lord about £70 by advising him to continue forestry.
- ▶ Although the result is somewhat inaccurate at 6 % interest rate (the correct difference is £97), it is evident that Houghton applied a valid method in comparing the economic rationale of different forms of land use.
- ▶ Implicitly, he also came very close to expounding the underlying principle of the Faustmann condition: harvest timber when its value growth equals (or is less than) the opportunity cost of standing timber and bare land.



## Houghton's second example (1701)

- ▶ “After eighteen years of consideration and hearing all the objections” against his proposition, Houghton made an extended attempt to prove his claim.
- ▶ This time he made explicit use of the numerical examples that Evelyn had presented a few years earlier in the revised editions of *Sylva* (1670, 1679).
- ▶ Example 1: Latimer's wood in Norfolk, 80 acres. All timber had been harvested and the tenant intends to sub and clear the land for pasture or tillage. One of his labourers encourages him to preserve the oak samplings and continue forestry.
- ▶ **Option 1:** Continue forestry (at least) 50 years.
  - Slight harvests after 25 years (timber income £40); after 50 years the oak trees are estimated to be worth £700.
  - To Evelyn, this example demonstrated “great advances of timber growing”.
- ▶ **Option 2:** Lease the bare land at a market rate (Houghton):
  - Annual rent for the bare land is £20 → capitalized value of the 50-year lease amounts to £6835, i.e. considerably more than the capitalized timber income plus the value of standing timber at the end of the time period.
- ▶ Houghton's conclusion was correct in the sense that “there is no comparison” between the two forms of land use in this particular case (if one assumes that the value growth rate of the oak stand will not increase dramatically).

## Houghton's other numerical examples (1701)

- ▶ Postponing final cut by 35 years → the nominal harvest income can be multiplied by 5.6. For Evelyn, the example demonstrated “great improvements of wood”.
- ▶ Again, Houghton presented valid calculations to show that what looks like a very great profit, proves not to be so.
- ▶ He analysed also three other examples from *Sylva* and showed that Evelyn's conclusions were essentially based on assumption that land costs nothing.

## Who was John Houghton (1645–1705)?

- ▶ Born in eastern England (Norfolk), studied in Cambridge (Corpus Christi College) and became a barrister.
- ▶ Was elected as a fellow of the Royal Society in 1680 on the proposition of natural philosopher Robert Hooke (Secretary of the Society).
- ▶ Not a professional scientist, socially of lower standing, shared a wide circle of acquaintance with Hooke.
- ▶ Editor of one of the first regular periodicals in England, *Collection of Letters for the Improvement of Husbandry and Trade*, appearing from 1681 to 1683.
- ▶ Through this position, reviewed numerous books and used them as subjects for his essays which dealt principally with economic and agricultural topics.
- ▶ His second periodical (1692–1703), differed but little in title from the first, was rich in materials related to the financial and commercial revolution in England.
- ▶ For example, provided quite a modern description to the valuation of joint-stocks and derivative contracts (which had been traded in the Amsterdam Stock Exchange already for several decades).

## John Houghton: a summary

- ▶ A London-based editor and book-reviewer John Houghton should be given credit for being perhaps the first who explicitly recognized the role of opportunity cost of both bare land and standing timber.
- ▶ In his writings, published in 1683 and 1701, he compared forestry with other forms of land use with calculations which are in line with modern capital and investment theory.
- ▶ Houghton's contribution seems remarkable considering that as explicitly formulated insights related to the efficient use of forest resources cannot be found in the works of principal economic writers in the same period, such as William Petty, Josiah Child, Nicholas Barbon and John Locke.
- ▶ Only substantially later, similar principles of modern capital and investment theory were diffused to “forest science”, conventionally regarded as having been emerged in the continental Europe, especially in the German territorial states.

## 2. Land and forest valuation in the early eighteenth century England

- ▶ Houghton's anticipation of the insights and methods which have been traditionally regarded as of much later origin should be seen in a larger context.
- ▶ The English society underwent extensive institutional and political changes in the latter part of the 17th century.
  - Glorious Revolution in 1688 → steady increase of Parliament's power → a more settled political situation → Bank of England in 1694 → more credible market on government loans.
  - The new government securities, offered in various forms, became the alternative investment against which the yields and risks of other short- and long-term investments were increasingly judged in the following decades.
  - A novel measure of “risk-free” rate of return.

## Land and forest valuation in England (cont.)

- ▶ The advancements of the fiscal and monetary institutions in England were stimulated by
  - the financial revolution in Holland,
  - continuous war with France which interrupted overseas trade and directed private investments in public funds,
  - the success of government fund raising schemes → also private merchants and entrepreneurs started to use emerging financial markets to raise money for their trade and manufacture projects.
- ▶ ...and resulted in the establishment of relatively modern financial markets:
  - emergence of joint-stock companies,
  - progressive trading of stocks and derivatives first in London “coffee houses”, later in London Stock Exchange,
  - relatively sophisticated methods to the valuation of various securities according to their yield and risk components.

## Land and forest valuation in England (cont.)

- ▶ Widespread enthusiasm for novel investment opportunities with supposedly great returns drove also land values to very high levels by 1720 (South Sea Bubble, Mississippi Scheme).
- ▶ Some writers pointed out that institutional landowners (e.g. church) applied, for historical reasons, an interest rate of 9–10 percent in valuing land for leases, whereas the market rate for land sales suggested that it should have been much lower, 5 or 6 percent.
- ▶ They were aware that this difference induced a huge income transfer from the institutional owners to the lessees.
- ▶ Also John Richards' (1730) motivation for writing *The Gentleman's Steward and Tenants of Manors Instructed* was the “preposterous” leasing system on copyhold lands that gave the lessees an extremely good bargain.

## Land and forest valuation in England (cont.)

- ▶ Richards' extensive treatise
  - contained virtually all the forms of lease and annuity valuation that had been treated previously in the literature,
  - is perhaps the first work in which the value of a forest is calculated under both intermittent and sustained yield management using discounted cash flow to infinity,
  - received some harsh criticism.
- ▶ This criticism induced Richards to complain in his second book, published in 1739, that many authors had written on the value of leases and annuities but only few had relied on rational deduction and mathematics.
- ▶ He pointed out that his methods and tables were in line with those of Edmond Halley and Abraham de Moivre – two prominent figures of the English scientific community with seminal contributions in using discounted expected values to price various type of life annuities.



### 3. Rediscovery of the opportunity cost of forest capital and the Faustmann formula in the German territorial states

- ▶ The modern economic views that were emerging in England in the turn of the 18th century were overridden in German territorial states by a mercantilist type of state regulation, cameralism.
- ▶ Cameralistic teaching began in Prussian universities in 1727.
- ▶ After the first comprehensive textbooks by Justi (1755) and Sonnenfels (1765), there was a general expansion of teaching cameral science.
- ▶ In essence, *Kameralwissenschaft* was an effort to promote systematic planning of the fiscal management of a kingdom.
- ▶ Because forests provided considerable revenue for various German territorial states and principalities, “scientific forestry” was to emerge as a subdiscipline of this new science of state finances.
  - forest officials were induced to develop exact inventory methods for forest resources and to estimate the value of standing timber and forest land
  - due to various forest enactments that had been issued at least since the fourteenth century, *Nachhaltigkeit*, in the form of even flow of timber, was to form a natural setting for forest valuation.

## “Forest cameralists” and the value of forest

- ▶ Moser (1757):
  - Calculating the value of a forest by assuming it is fully regulated is overly advantageous for the buyer if the initial age-class distribution of the forest is skewed towards old age-classes.
- ▶ Bein and Eyber (1801):
  - A large part of the German forests cannot be considered as fully regulated.
  - How can one determine the average economic return from a forest when the timber income is not constant but instead periodic over time?
  - Calculated forest value over a single rotation period (120 yrs) without accounting for the bare land value.
- ▶ Nördlinger (1805):
  - The value of a forest must be derived solely from its expected utility, i.e., one has to calculate the income (utility) it yields over an infinite series of years.
  - Numerical examples on calculating forest value: constant annual income & infinite time horizon.
- ▶ Hossfeld (1805):
  - Showed how the value of forest can be obtained under both periodic and constant annual income.
  - Numerical examples on this line of calculations.
  - In addition, gave rules for forest valuation under variable, in particular increasing annual timber income.

## Conclusions

- ▶ It seems that John Houghton (1683, 1701) should be given credit for being the first who
  - explicitly recognized the role of opportunity cost of both standing timber and bare land,
  - compared forestry to other forms of land use with valid economic calculations,
  - came very close to expounding the underlying principle of the Faustmann condition.
- ▶ In this sense he anticipated the first German scholars of the discipline by over 100 years, and Faustmann by well over 150 years.
- ▶ Richards anticipated Faustmann by well over 100 years.
- ▶ However, König's (1813,1835) and Faustmann's (1849a,b) works were more extensive and covered a much wider range of issues.
- ▶ Many of the topics Faustmann dealt with constitute – after 160 years – a focal part of research in contemporary forest economics:
  - components of the discount rate
  - uncertainty about future timber prices
  - stand-level vs. forest-level management
  - optimal transition from “intermittent forest management” to “sustainable forestry” (optimal harvesting under multiple age-classes).

## Conclusions (cont.)

- ▶ It remains open how Houghton exactly came to realize the economic principles related to the efficient use of forest resources.
- ▶ His membership in the Royal Society might have been a major contributor in this respect.
- ▶ Through this large intellectual network he was able to relate to the world of London science and assimilate, and perhaps elaborate, the economic insights offered by his fellow-members of whom many were deeply interested in matters of forestry and commerce.
- ▶ Some tentative support for this line of speculation gives the observation that Houghton's first essay on forestry appeared only three years after he had been elected as a fellow in 1680.
- ▶ Collaboration with the prominent figures of the English scientific community at the height of its creativity might have been the essential source of inspiration for preparing the writings which stand out as a landmark in the evolution of modern forest economic thought.