The pioneering work of Teivo Pentikäinen on internal models

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Contents

- The career of Teivo Pentikäinen
- Finnish Insurance Company Act 1952 – an early Solvency II
- Other work in the 1950s
- *Risk Theory* book
- The work on stochastic-dynamic models in the 1970s
- Summary

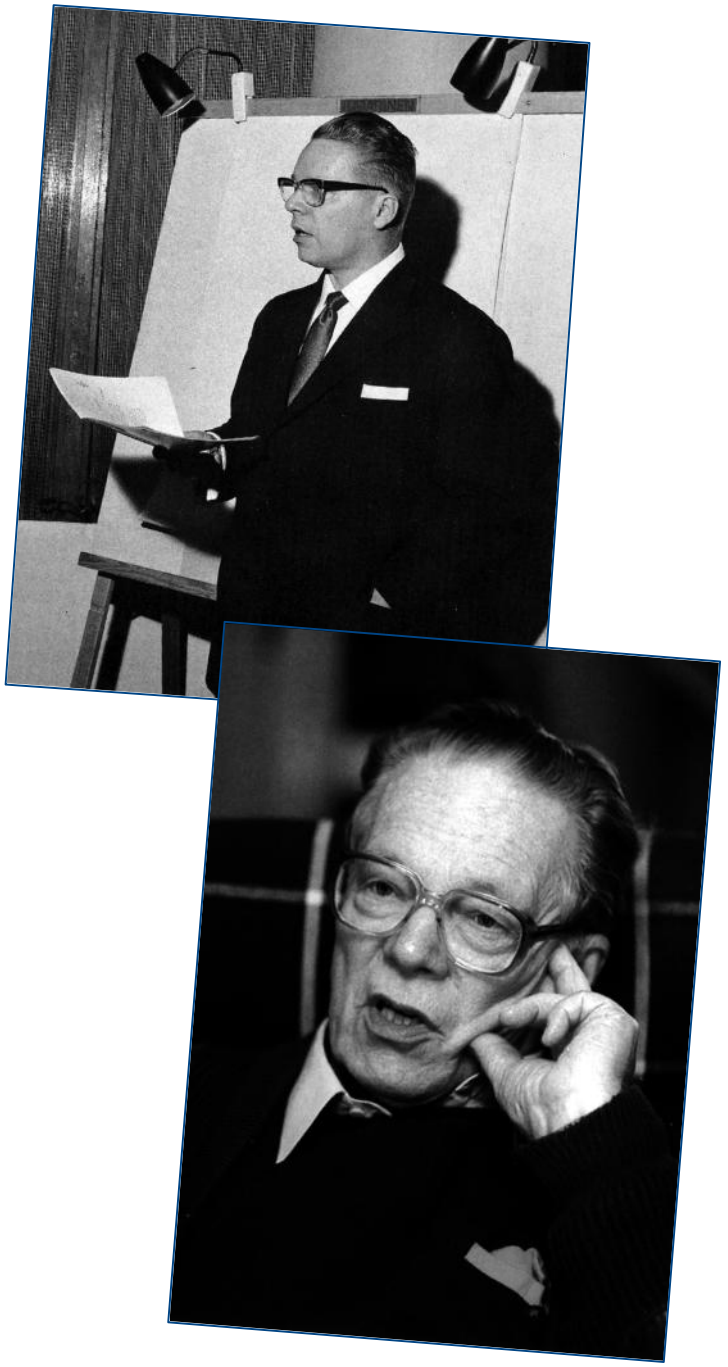
Some milestones of the career of TP

- Born 26 July 1917 in Vyborg (Viipuri), now part of Russia (Karelia)
- Matriculation exam 1936
- Served at the front 1939-1940 and again 1941-1942 (air defence)
- Invited to the Army Ballistic Office 1942

- Graduated in mathematics 1944,University of Helsinki
- Ph.D. in mathematics 1947
  - *Über stetige Funktionssysteme mit einem algebraischen Additionstheorem* (On continuous function systems with an algebric addition theorem)
- Class room teacher training in 1945

Some milestones of the career of TP

- Actuary in the Insurance Department of the Ministry of Social Affairs 1945
- Head of the Department 1948-1962
- In 1962 became CEO of Ilmarinen, a newly established pension insurance company which quickly grew to be the largest in the country
- Retired in 1977, but was engaged actively in the international and national debate, both scientific and insurance/pension politics until 2006
- Died 12 June 2006



Earnings-related pensions system

- TP considered his contribution to the creation of the Finnish earnings-related pension scheme as his perhaps greatest achievement
- TP chaired the Committee (1956-1960) that planned the system
- Legislation came into force 1962
- Mandatory for employers to provide pension benefits, covered all private sector employees
- Already from the start, the scheme included many modern principles such as short qualifying and vesting periods (initially 6 months, today 0 days), full indexation of accrued benefits and pensions payable etc.
- (Minimum) benefits similar for all employees, independently of employer
- Partly funded partly pay-as-you-go
- Run by private pension insurance companies and pension funds, but:
- Towards the insured the scheme acts like a centralised scheme
  - one pension application, the last institution decides on and pays the whole pension etc.
  - The Finnish Centre for Pensions keeps records of working data and acts as the Clearing House for the money flows (among other things)

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Insurance Company Act 1952, background

- The high post-war inflation had reduced the real value of the capital of Finnish insurance companies, and capital requirements had become outdated
- The new Insurance Company Act was prepared by a committee chaired by TP
- Before and during the committee work, TP published a couple of articles laying the ground for the reform
  - Einige numerische Untersuchungen über das risikotheoretische Verhalten von Sterbekassen, SAT 1947
  - On the net retention and solvency of insurance companies, SAT 1951

Basic ideas and methods

- Problem setting: calculate the required minimum capital
- Runoff approach (Regulators' view)
  - Goal is the short-term safeguarding of policyholders' interests -> lower limits for the capital
- Going concern approach (the management view)
  - Goal is the continuation of the business -> upper limits for tax-free capital and reserves
- Technical tools: the collective risk theory as developed by Ove Lundberg and Harald Cramer, cyclical variations included by variation of basic probabilities à la Hans Ammeter
- Use of Esscher approximation
- Approximations independent of LOB and claims size distribution

Die gesuchte Ruinwahrscheinlichkeit lässt sich mit grosser Genauigkeit durch die folgende von Esscher (SAT 1932) angegebene Funktion approximieren

$$(4) \qquad F(x, K) = e^{-K\psi}\left[A_0(h\sqrt{K\nu_2}) - \frac{\beta}{\sqrt{K}} A_3(h\sqrt{K\nu_2})\right],$$

wo

$$\nu_i = \int_0^\infty z^i e^{hz} p(z)\, dz \,(i = 0, 1, 2, 3);\ \psi = 1 - \nu_0 + \nu_1 h;\ \beta = \frac{\nu_3}{6\sqrt{\nu_2^3}}.$$

A_0 und A_3 sind von Esscher tabulierte Funktionen. h ist eine Hilfsgrösse, die durch die Gleichung $\nu_1 = \varkappa m$ bestimmt wird. Liegt die Risikomasse nur in diskreten Punkten, so werden

Sensitivity analysis of ruin probability

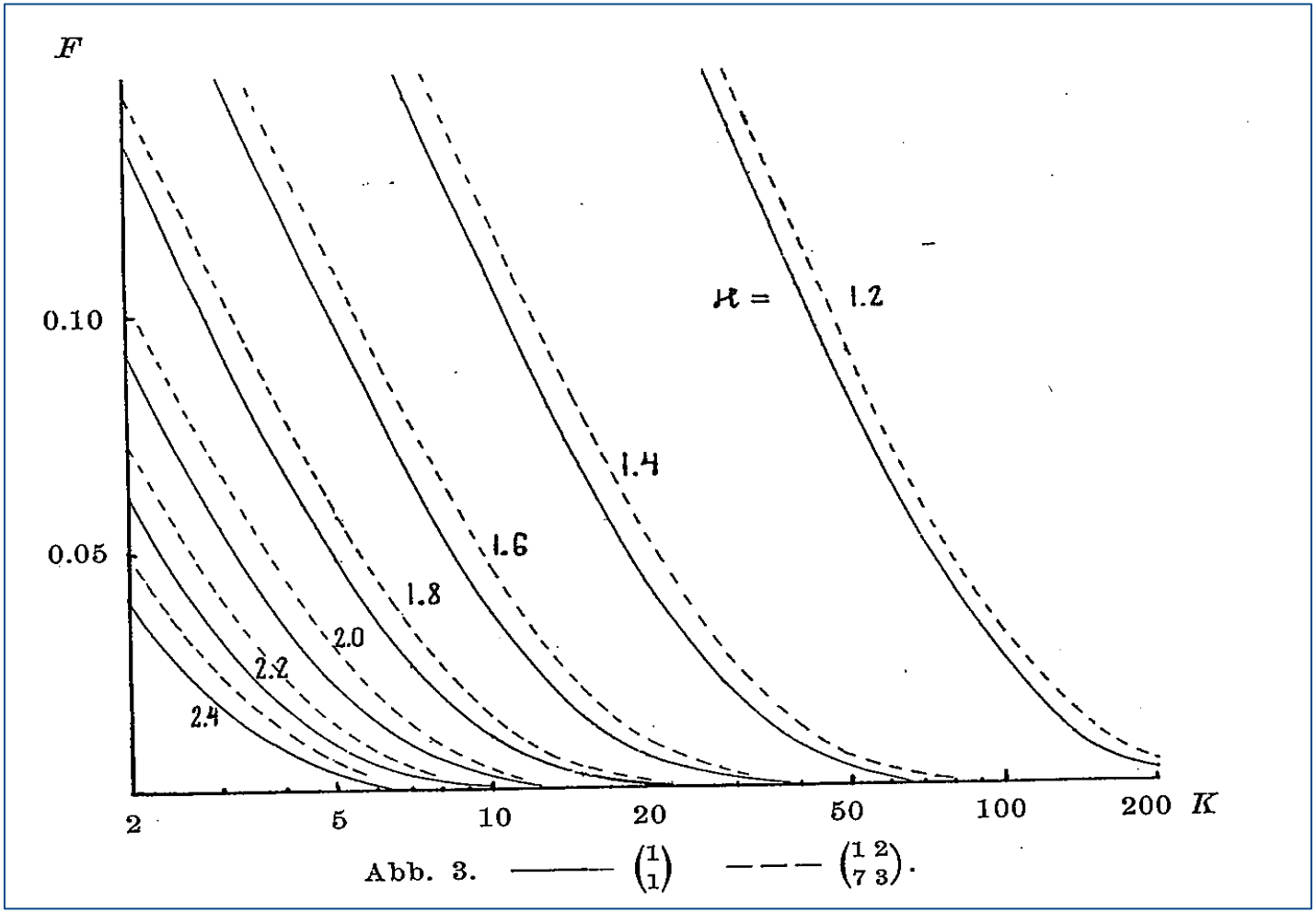


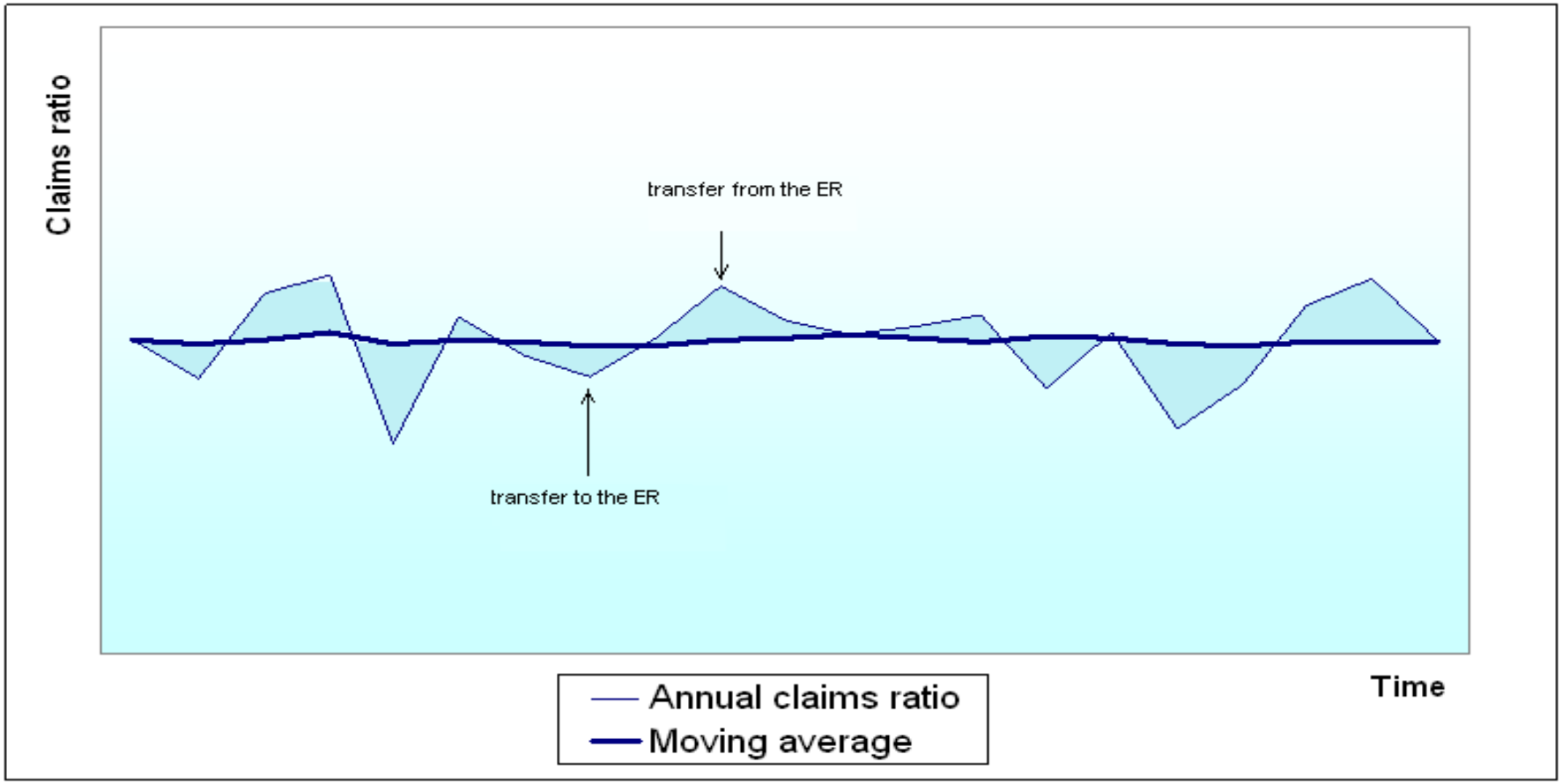
Abb. 3. ——— $\binom{1}{1}$ – – – $\binom{1\ 2}{7\ 3}$.

Solvency rules of the Insurance Company Act 1952

- General formulation in the law text
  - "The insurance company shall through reinsurance or in some other way arrange its operations so that a relation which secures the insured benefits is established between the probable fluctuation in liabilities and the solvency margin."
- Absolute minimum capital requirement
  - Theoretically correct parabola (as a function of the company size) was approximated by a piecewise linear function
- Solvency test, detailed instructions given by the regulator
  - One years' time horizon with 1% ruin probability
- Standard methods for technical reserves
- If the standard methods are not suitable, use your own data and assumptions
- Introduction of the Equalisation Reserve system –tax effective anticyclical device to manage capital needs
  - Lower and upper limits

Introduction of Equalisation Reserve

Idea: to even out the random fluctuation of the claims process as a part of non-taxed technical provisions



Parallels of the 1952 Act to Solvency II

- Risk-based approach employing scientific knowledge
- Solutions developed by using risk-theoretical models with parameters based on empirical evidence
- Quantitative Impact Study
- Principle-based approach accompanied by implementation measures
- Introduction of the absolute minimum capital requirement and risk-based target value (MCR and SCR)
- Standard formula
- If standard formula not applicable, make your own calculations (ORSA)
- Efficient use of capital as a target

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Other work in the 1950s, optimization of the costs of ceded reinsurance 1956

- TP's observation: the actual net retentions of the Finnish non-life companies were much lower than the risk-theoretical considerations would justify
- About 50% of non-life premiums were ceded, mostly abroad
  - Reinsurers' profit margin had to be paid by the policyholders, deteriorated the Finnish currency balance and was harmful for the Finnish economy
- Idea: Collect higher risk buffers, decrease reinsurance ceded -> resulting cost savings enable lower premiums later
- Committee chaired by TP, members from the Parliament, the Bank of Finland, Ministry of Finance
  - Hearings of insurance company CEOs in the House of Parliament
  - Alternative: obligatory reinsurance to a state-owned reinsurance company to be established
- Result: companies decided to implement TP's idea
- The evaluation in 1981 proved that marked savings had been achieved in practice too

Other work in the 1950s

- Reforms of Workers' Compensation in 1958 and Motor Third Party Liability in 1959
  - Strict liability was introduced
  - Compensation ceilings for bodily injuries were abolished
  - Drivers' own injuries were included in the compulsory MTPL
  - Made complicated voluntary supplementary liability policies redundant
  - Long-term benefits were linked to index, index adjustments were not funded but pooled as joint pay-as-you-go
  - Voluntary mutual pooling of big losses
    - Cheap form of reinsurance
  - Sound statistical bases for premium and reserves calculations
- Insurance text book in 1957
  - General study book intended for all who need a basic knowledge of insurance

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Risk Theory book

- New actuarial examination as impetus
- Insurance Company Act required an actuary in life companies
  - Old qualification: a graduate in mathematics with practical experience of actuarial calculations
  - New Qualification: a graduate in mathematics, passing an examination
- Board, set by the regulator, to organise the examination
- Risk theory was included in the Core Syllabus
- Need for educational material: TP wrote a booklet on risk theory in Finnish in 1955

Risk Theory book

- Inaugural meeting of ASTIN in New York Oct. 1957
  - "Many participants expressed a wish for a concise book … devoted primarily to practical applications"
- Cooperation started with Robert E. Beard and Erkki Pesonen
- "Risk Theory" was published by Methuen in 1969
- 2nd edition 1977, third revised edition 1984 /Chapman & Hall)
- A reviewer named the book as "the Bible of risk theory"
- One of the all-time actuarial best sellers
- Practical Risk Theory for Actuaries (together with Chris Daykin and Martti Pesonen) in 1995

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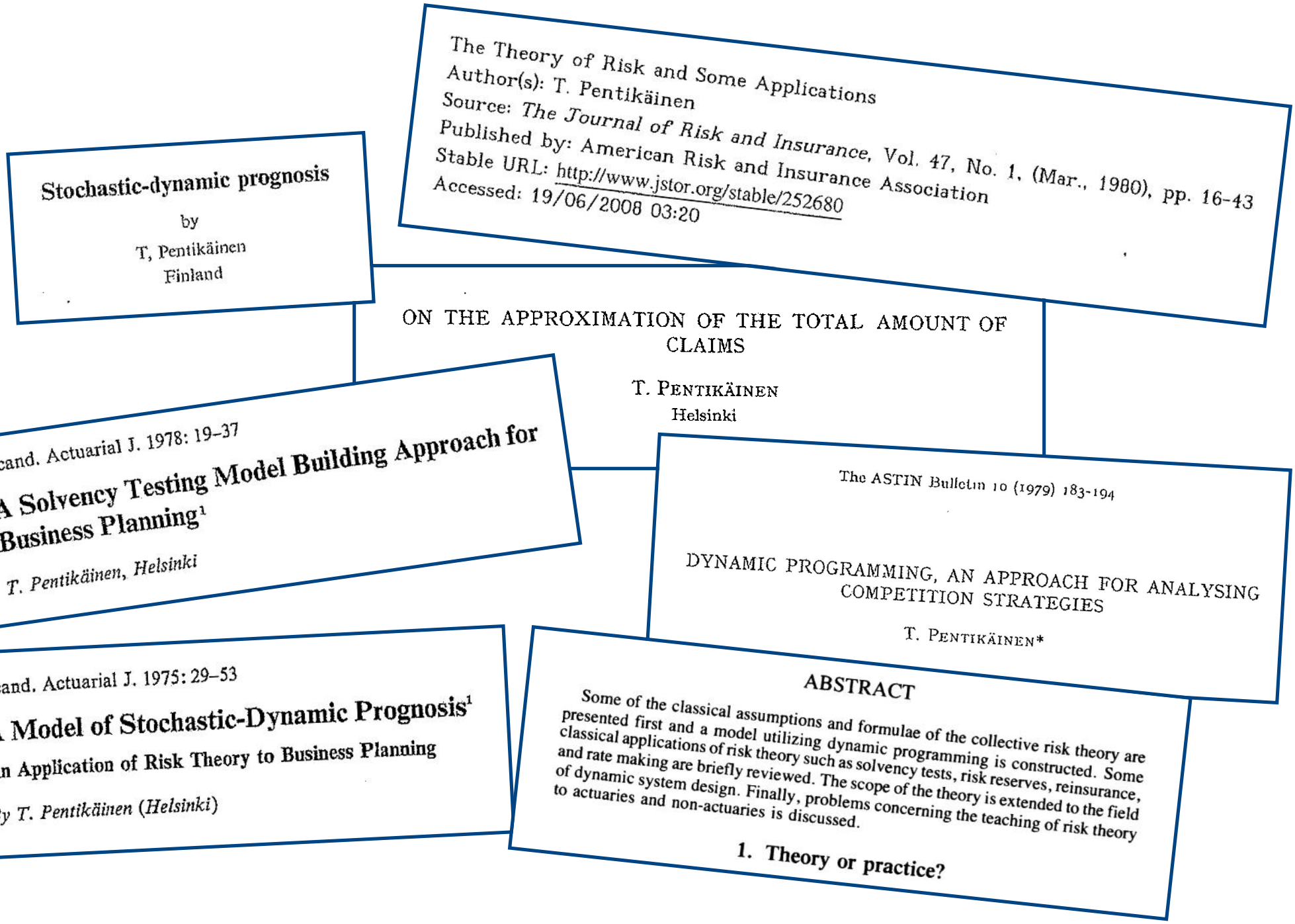
The work on stochastic-dynamic models in the 1970s

- In the 1970s, TP restarted the work on practical non-life risk theory models
- He published a series of articles mainly in the SAJ, ASTIN Bulletin and in the Transactions of International Congress of Actuaries
- Move from pure claims process models to more comprehensive stochastic-dynamic company models
  - Company's income statement and balance sheet in a simplified form as the starting point
  - Controlling factors, strategies of the management
- Simulation became the main work tool
  - Analytical methods were still utilized, e.g. to simplify simulation (NP-approximation) and to find ruin probability approximations
- The work culminated in the Finnish Solvency project of 1980-1981



Stochastic-dynamic prognosis

by

T, Pentikäinen

Finland

The Theory of Risk and Some Applications
Author(s): T. Pentikäinen
Source: *The Journal of Risk and Insurance*, Vol. 47, No. 1, (Mar., 1980), pp. 16-43
Published by: American Risk and Insurance Association
Stable URL: http://www.jstor.org/stable/252680
Accessed: 19/06/2008 03:20

ON THE APPROXIMATION OF THE TOTAL AMOUNT OF CLAIMS

T. PENTIKÄINEN

Helsinki

Scand. Actuarial J. 1978: 19–37

A Solvency Testing Model Building Approach for Business Planning[1]

T. Pentikäinen, Helsinki

The ASTIN Bulletin 10 (1979) 183-194

DYNAMIC PROGRAMMING, AN APPROACH FOR ANALYSING COMPETITION STRATEGIES

T. PENTIKÄINEN*

Scand. Actuarial J. 1975: 29–53

A Model of Stochastic-Dynamic Prognosis[1]

An Application of Risk Theory to Business Planning

By T. Pentikäinen (Helsinki)

ABSTRACT

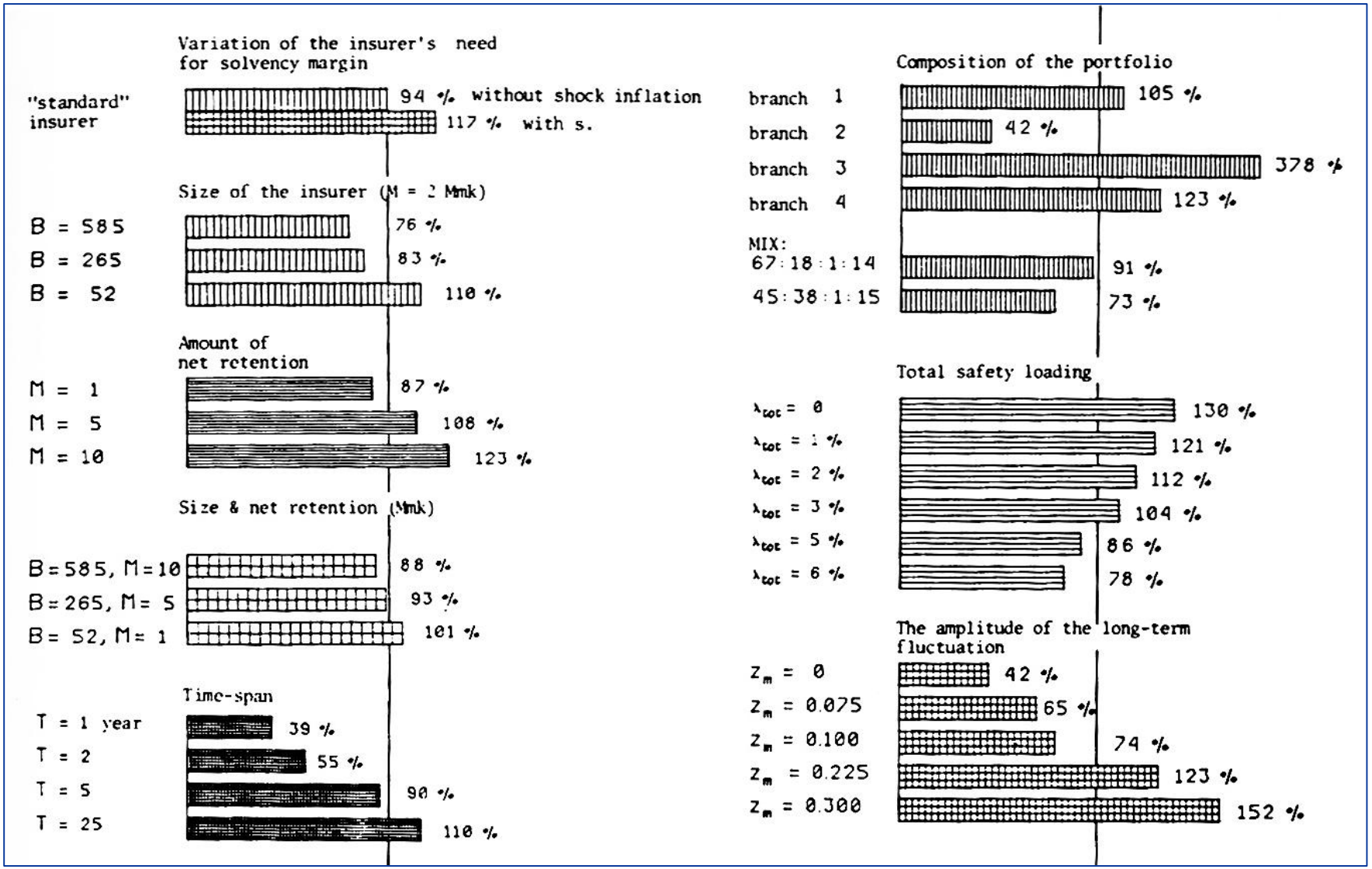
Some of the classical assumptions and formulae of the collective risk theory are presented first and a model utilizing dynamic programming is constructed. Some classical applications of risk theory such as solvency tests, risk reserves, reinsurance, and rate making are briefly reviewed. The scope of the theory is extended to the field of dynamic system design. Finally, problems concerning the teaching of risk theory to actuaries and non-actuaries is discussed.

1. Theory or practice?

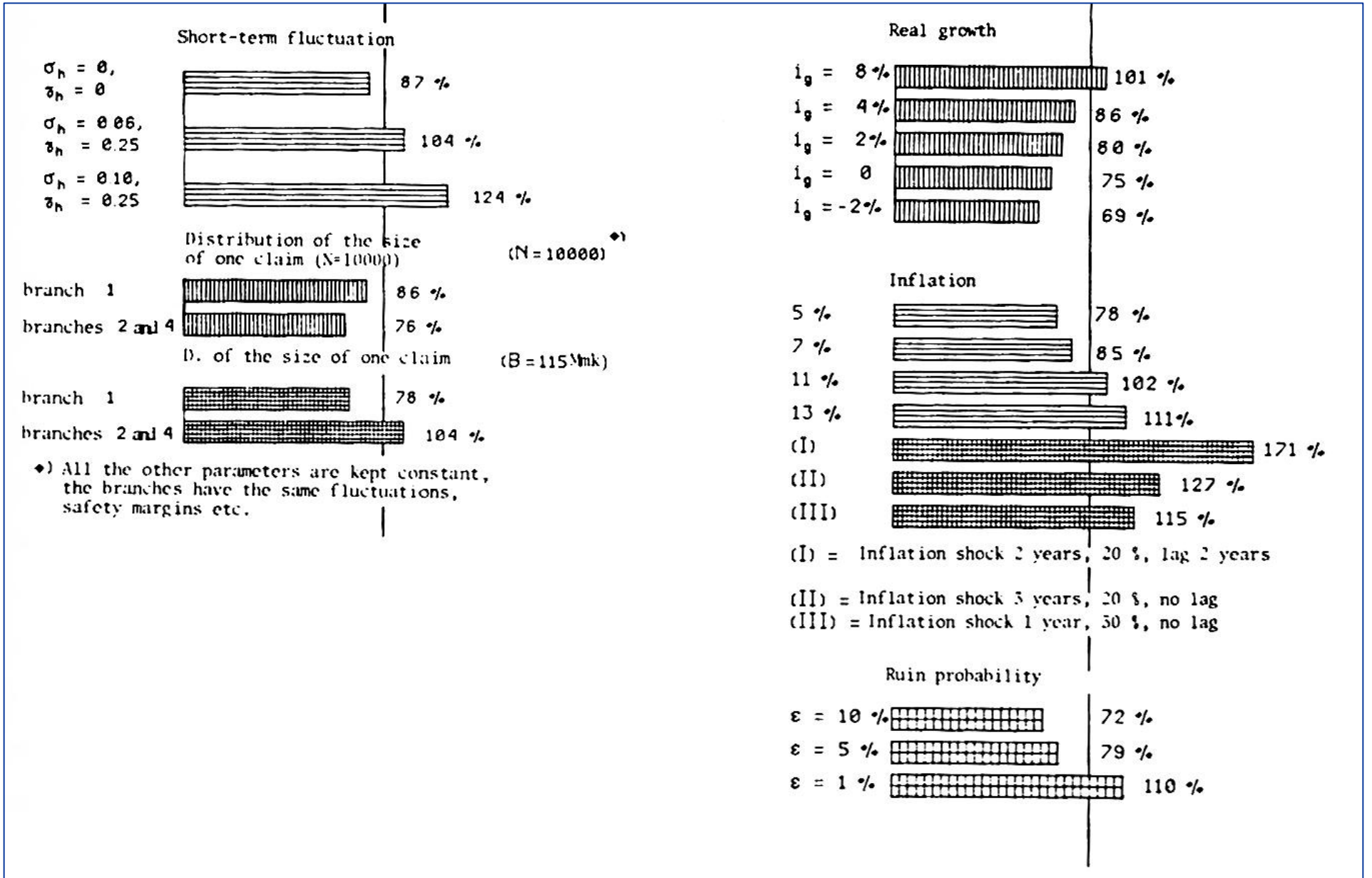
The Finnish insurance solvency project in 1980-1981

- Background: Equalisation reserves of the companies had increased to fairly high levels, which caused criticism in the press and elsewhere – a need to have a fundamental look at the system
- A committee was established with TP as the chair:
  - Solvency policy and general background factors discussed
  - Empirical data was gathered
  - A comprehensive risk-theoretical company model was built
  - The model was run by using varying model specifications and parameter values
  - Discussion of how solvency requirements should be constructed, the main emphasis was on determining the upper limit and a target zone for the ER
  - Analytical formulas were based on the results of the simulation
  - Discussion on how to measure and disclose solvency position
- As a result of the work there were no changes made in the law text, but detailed rules and parameters (given by the regulator) of the Equalisation Reserve system and its lower and upper limits were reformed
- Basic results of the project were published 1982 in English in a two-volume book

Example of sensitivity analysis



Example of sensitivity analysis



Summary of TP's work on non-life internal models

- Always had scientific approach but strongly oriented towards practical application
- The models were fitted to empirical evidence
- Concentrated on the essentials
  - Simplification and approximation of formulas and computations
- Clarity of presentation
- Policy recommendations had marked economic consequences
- Believed that the basic actuarial principles are useful to all management and should be included even in the basic insurance text books (but with an appropriate style of presentation; e.g. the use of figures)
- Never believed that the models alone could give the definite solution
- Active international cooperation
- An outstanding pioneer in the evolution of the internal models of non-life insurance companies