

# Non-life insurance mathematics

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# About the lecturer

- PhD in risk analysis, Institute for Mathematics, University of Oslo
- 12 years experience from insurance
  - Senior Actuary in DNB Skadeforsikring (current position)
  - Actuary in Gjensidige
  - Actuary in KLP
  - Actuarial consultant in Avenir
- 5 years experience from other sectors (energy, research)
  - Quantitative economic risk assessments (consulting, research)
- 2 years pre-graduate experience (teamleader/instructor in military, transport)
- Member of Norwegian Actuarial Association
- nilsfri@math.uio.no

# Overview of this session

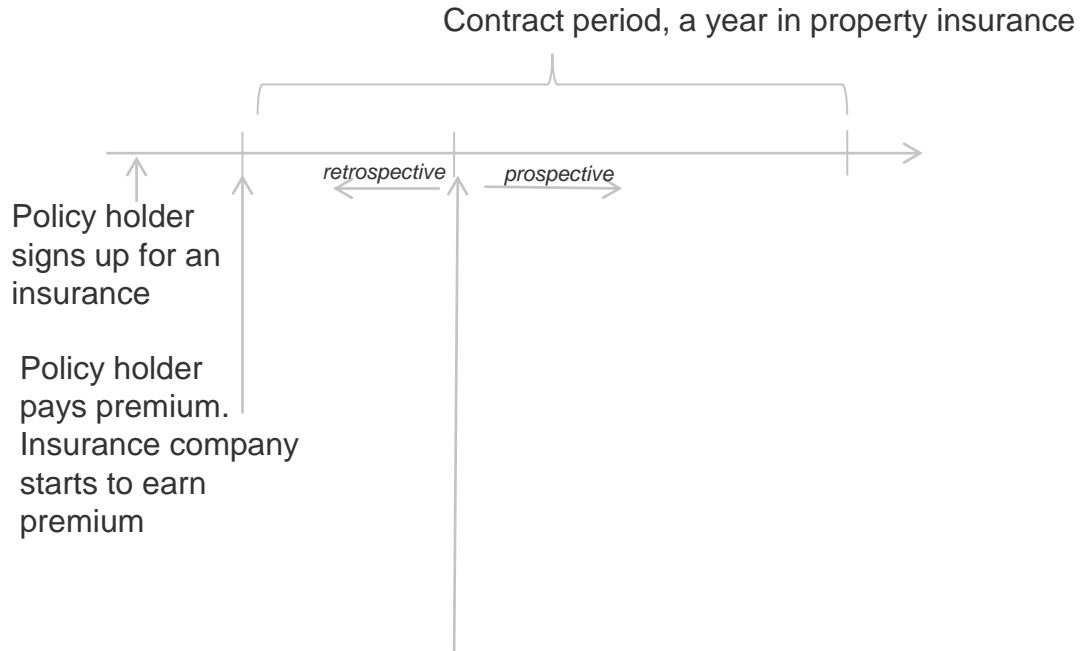
Module	Contents	Part in EB*
Basic concepts	<ul style="list-style-type: none"><li>•Intro</li><li>•Pricing</li><li>•Portfolio and solvency</li><li>•Risk ceding and reinsurance</li><li>•Result elements with risk drivers</li><li>•Risk selection and pricing</li></ul>	<ul style="list-style-type: none"><li>•1.2.1</li><li>•1.2.2</li><li>•1.2.3</li><li>•1.2.4</li></ul>
General insurance: an opening look	<ul style="list-style-type: none"><li>•Intro</li><li>•Enter contracts and their clauses</li><li>•Stochastic modelling</li><li>•Risk diversification</li></ul>	<ul style="list-style-type: none"><li>•3.2.1</li><li>•3.2.2</li><li>•3.2.3</li><li>•3.2.4</li></ul>
How Monte Carlo simulation is put to work	<ul style="list-style-type: none"><li>•How are random variables sampled?</li><li>•Inversion</li><li>•Introduction</li><li>•Computing the reserve</li><li>•When responsibility is limited</li><li>•Dealing with reinsurance</li></ul>	<ul style="list-style-type: none"><li>•2.3.1</li><li>•2.3.2</li><li>•3.3.1</li><li>•3.3.4</li><li>•3.3.5</li><li>•3.3.6</li></ul>
Some important concepts of real life (if time)	<ul style="list-style-type: none"><li>•Loss ratio</li><li>•Costs</li><li>•Combined ratio</li></ul>	

# Overview

Result elements
The balance sheet
Premium Income
Losses
Loss ratio
Costs

Non-life insurance from a financial perspective:

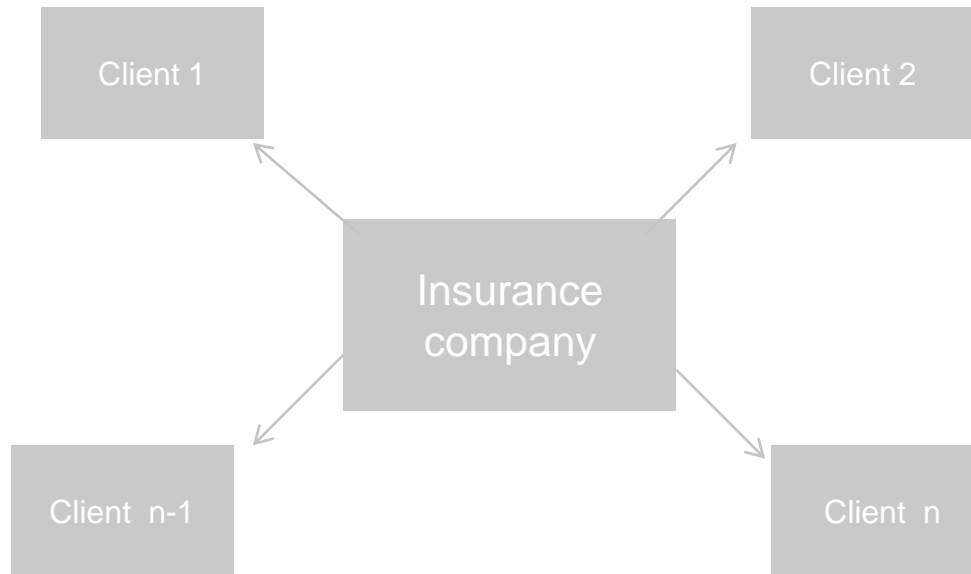
for a premium an insurance company commits itself to pay a sum if an event has occurred



During the duration of the policy, some of the premium is earned, some is unearned

- How much premium is earned?
- How much premium is unearned?
- Is the premium sufficient to cover incurred (retrospective) and future losses (prospective)?

# Why does it work??

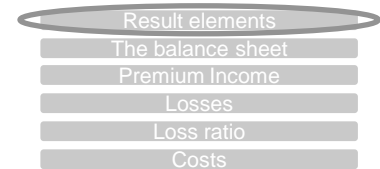


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- Economic risk is transferred from the policyholder to the insurer
- Due to the law of large numbers (many almost independent clients), the loss of the insurance company is much more predictable than that of an individual
- Therefore the premium should be based on the expected loss that is transferred from the policyholder to the insurer

Much of the course is about computing this expected loss  
...but first some insurance economics

# How can the result of an insurance company be decomposed?



Insurance economics in its most basic form:

<b>Result elements:</b>
+ Insurance premium paid by the clients
+ financial income generated by the premium from the clients
- claims paid to the clients
- operational costs of the Insurance company
= result to be distributed among the owners and the authorities

# Insurance mathematics is fundamental in insurance economics

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## The result drivers of insurance economics:

Result elements:	Result drivers:
+ Insurance premium	Risk based pricing, reinsurance
+ financial income	International economy for example interest rate level, risk profile for example stocks/no stocks
- claims	risk reducing measures (for example installing burglar alarm), risk selection (client behaviour), change in legislation, weather phenomena, demographic factors, reinsurance
- operational costs	measures to increase operational efficiency, IT-systems, wage development
= result to be distributed among the owners and the	Tax politics

# Insurance economics

Result elements

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- Risk selection: Object risk



.....which house is most likely to burn down??



# Insurance economics

Result elements

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- Risk selection: subject risk



....."sloppy" client who is always unlucky....

# Different price elements have different risk drivers

Object



Geography



Subject

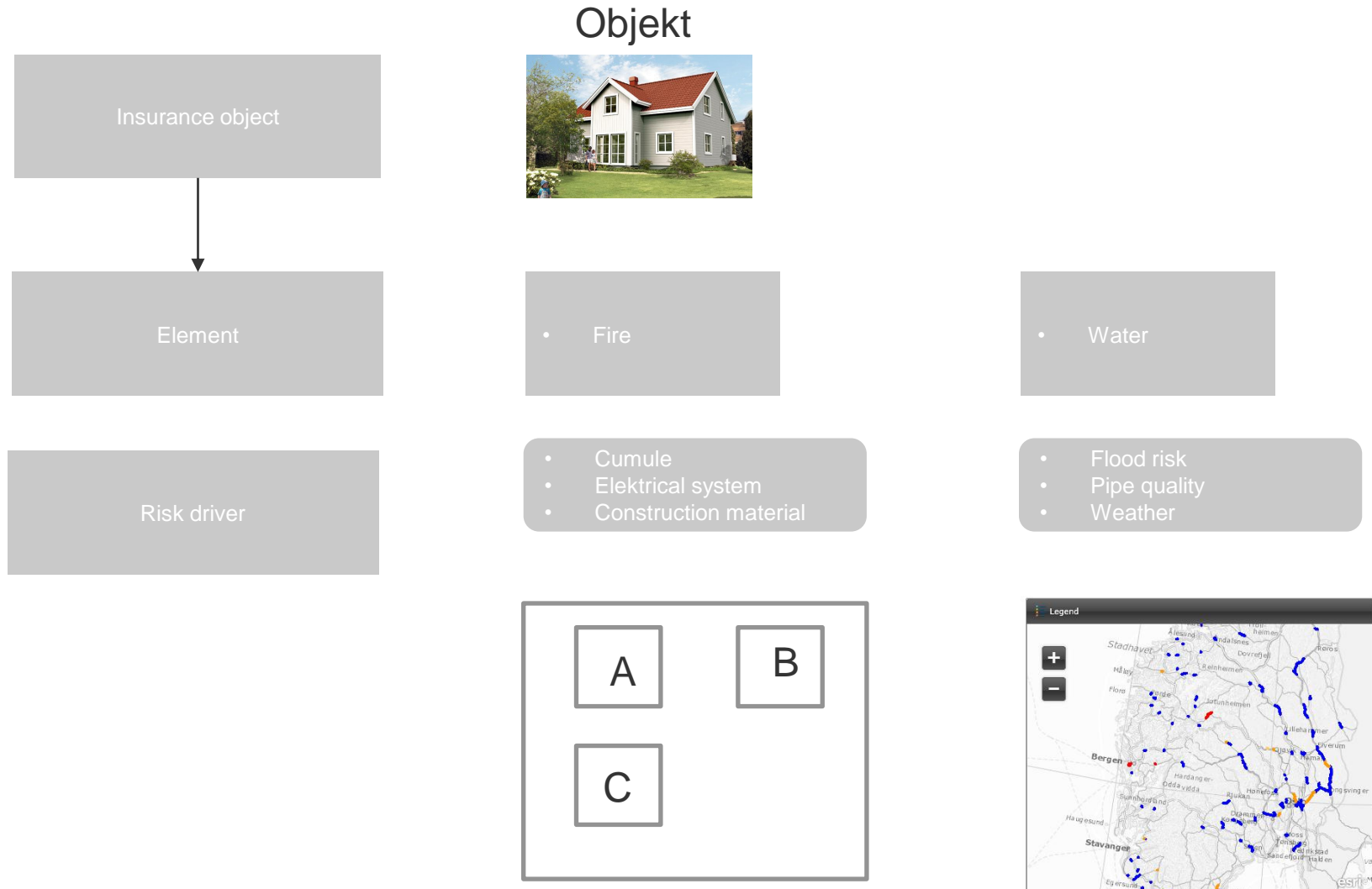


- Standard
  - Electrical system
  - Pipes
  - Roof
- Construction material
- The number of wet rooms and the number of kitchens
- Building year
- Maintenance level in general
- Electrical system reviewed?

- Weather
- Climate
- Population density
- Infrastructure complexity
- Natural catastrophies
- Demography

- Policy holder
  - Age
  - Profession
  - Risk aversion
  - Personality – structured or carefree?
- The number of inhabitants in building
- Use
  - Inhabited by owner
  - Rental
  - Vacation use (inherited?)

# Find riskodrivars for every price element



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# Loss ratio

- Shows how much of the premium income is spent to cover losses

Amounts in 1 000 000 NOK	2012
Written gross premium	1 450
- ceded reinsurance premium	-270
Change in reserve for unearned gross premium	-110
-change in reinsurance share of unearned premium	25
<b>Net premium income</b>	<b>1 095</b>

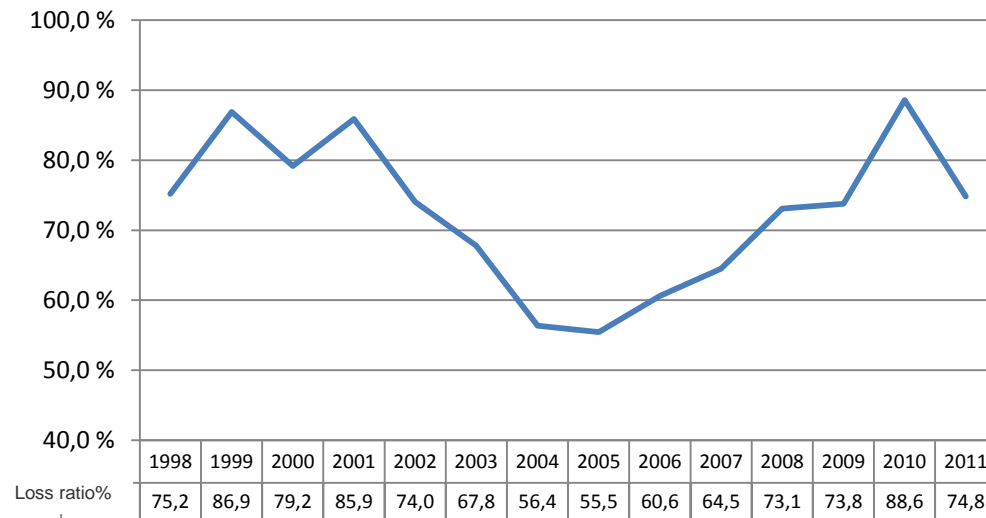
Amounts in 1 000 000 NOK	2012
Paid claims gross	-870
- Reinsurance share of paid claims gross	120
change in gross claims reserve	-200
-change in reinsurance part of gross claims reserve	100
<b>Net claims costs</b>	<b>-850</b>

	Gross	Net
Incurring losses	1070 (-870-200)	850
Earned premium	1340 (1450-110)	1095
Loss ratio	79.9%	77.6%

- What does the difference in loss ratio gross and net tell us?

# Loss ratio

Loss ratio villa, content and cabin 1998-2011



- Difference of 33 pp in 6 years !?!
- Yearly premium of 9 billion

- The graph presents loss ratio for all insurance companies for villa, content and cabin
- The graph illustrates the delay in the price adjustments and the need for reinsurance
- The graph illustrates the effect of claims frequency (frost 2010)
- Source: FNO.no

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# Costs

Amounts in 1 000 000 NOK	2012
Sales costs	-85
Insurance related operational costs	-200
received provision for ceded reinsurance	45
<b>Insurance related operational costs</b>	<b>-240</b>

- Sales costs: Provisions, sales offices, marketing, back-office sale
- Insurance related operation costs: management, accounting, actuary, house rent, HR, IT etc. Up to 2012 also claims settling costs – NB: these were transferred to claims in 2012
- Received provision reinsurance:
  - Normally it constitutes 20% to 25% of ceded premium..
  - NB: "Cost income" in the table – why?
  - Why do the companies receive this provision?

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# Cost ratio (percent)

- Shows how much of the premium income is spent to cover operational costs

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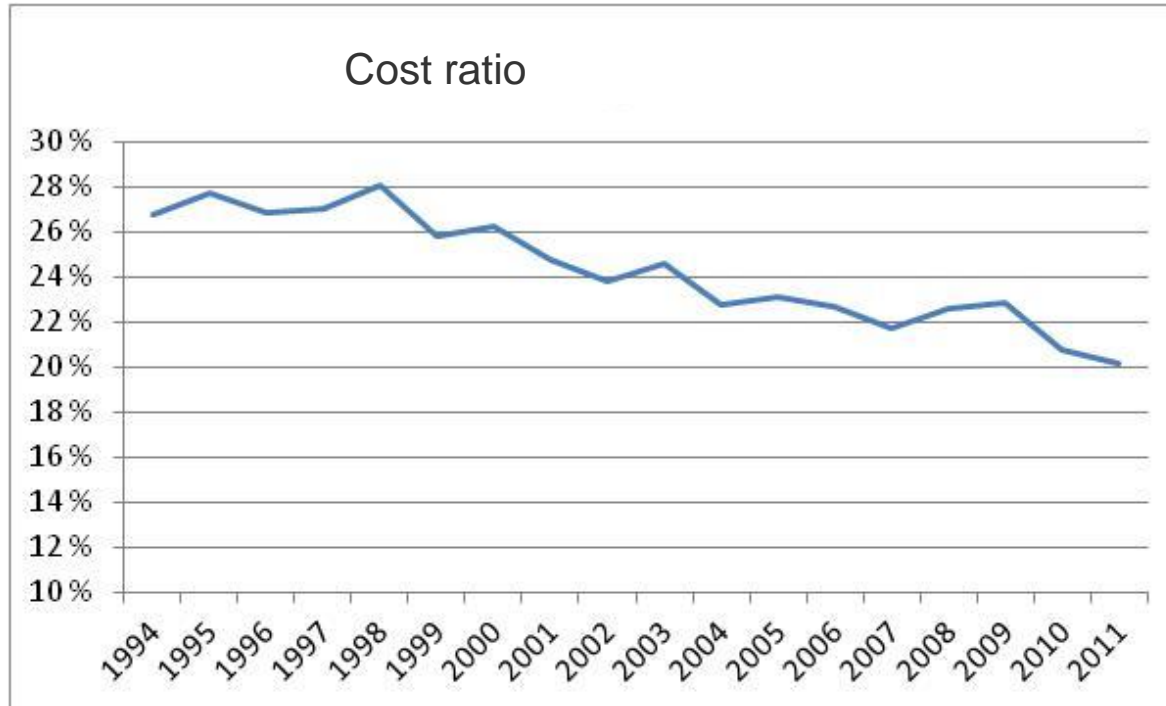
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	Gross	Net
Operational costs	285 (-85-200)	240
Earned premium	1340 (1450-110)	1095
Cost ratio (percent)	21.3%	21.9%

- What does the difference in cost ratio gross and net tell?

# Cost ratio (percent)

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- What is causing the reduction in cost ratio to 20%? Where are the companies heading?
- Source: fno.no – Results in non-life insurance: includes all non-life insurance companies in Norway



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# Combined ratio

- Shows how much of the premium income that is spent to cover claims and operational costs

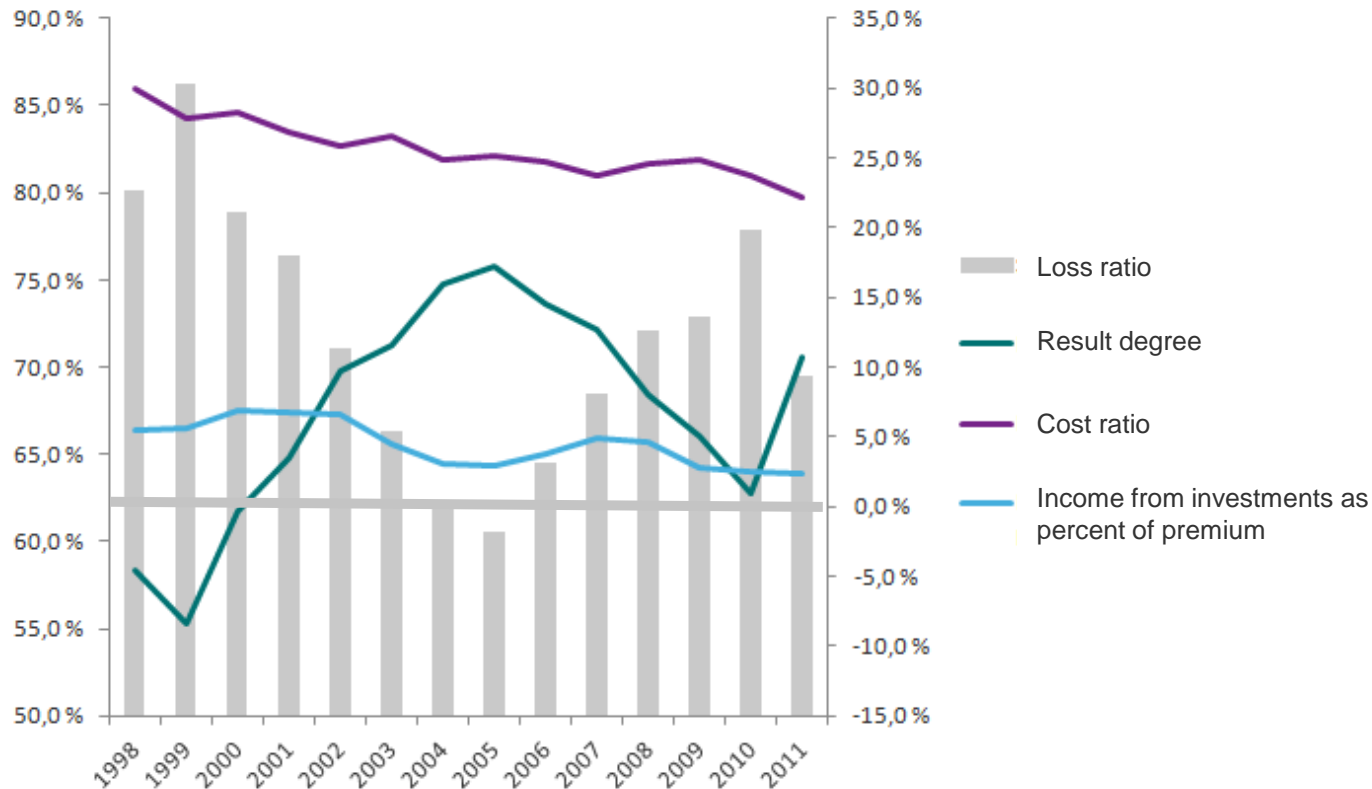
	Gross	Net
Loss ratio	79.9%	77.6%
Cost ratio	21.3%	21.9%
Combined ratio	101.1%	99.5%

- Combined ratio above 100 % implies that the insurance operations are not profitable
- What do the combined ratio gross and net express for the example company?
- Long term CR for insurance companies in Norway are between 90% and 95%
- What key ratio is most problematic for the example company?

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# Key parameters for non-life insurance in Norway

- The graph shows loss ratio (left axis), result degree (total revenue minus total costs, right axis), cost ratio (right axis) and income from investments in percent of premium (right axis) for the period 1998-2011
- The result degree and the loss ratio vary a lot.
- The loss ratio seems to be the most important driver for profitability in non-life insurance
- The cost ratio and income from investments in percent of premium are decreasing during the period.



# Outline of the course

	Models treated	Curriculum	Duration in lectures
Basic concepts and introduction		EB 1.2, 2.3.1, 2.3.2, 3.2, 3.3	1
How is claim frequency modelled?	Poisson, Compound Poisson, Poisson regression, negative binomial model	EB 8.2, 8.3, 8.4	2-3
How is claim reserving modelled?	Delay modelling, chain ladder	EB 8.5, Note	1-2
How is claim size modelled?	Gamma distribution, log-normal distribution, Pareto distribution, Weibull distribution	EB 9	2-3
How is pricing done?		EB 10	1
Solvency		EB 10, Note	1-2
Credibility theory	Buhlmann Straub	EB 10	1
Reinsurance		EB 10	1
Repetition			1

# Course literature

## Curriculum:

Chapter 1.2, 2.3.1, 2.3.2, 2.5, 3.2, 3.3 in EB

Chapter 8,9,10 in EB

Note on Chain Ladder

Lecture notes by NFH

The following book will be used (EB):

Computation and Modelling in Insurance and Finance, Erik  
Bølviken, Cambridge University Press (2013)

- Additions to the list above may occur during the course
- Final curriculum will be posted on the course web site in due time