Institute of Insurance Economics

University of St.Gallen

The Impact of Auditing Strategies on Insurers' Profitability

Working Paper by Katja Müller, Hato Schmeiser, and Joël Wagner

August, 2014

About insurance fraud
An Overview

- **Significant economic problem**

  Example: Excess payments due to fraudulent claims added up to an estimated total of $4.8 to $6.8 billion in the auto injury insurance sector in the U.S. during the year 2007*

  Estimations in Switzerland: Up to 25 % of the claims payments

- **Explanation for its occurrence**

  Informational asymmetries between policyholder and the corresponding insurance company may result in misrepresentations of the actual insured loss

  Example: Mutual agreements between policyholders and mechanics to fix already existing damages when repairing the ones which were caused in a current insured event

- **Forms of insurance fraud**
  - Time of occurrence (ex-ante vs. ex-post fraud)
  - Severity of fraud attempt (hard vs. soft fraud)
  - Commiting party (internal vs. policyholder vs. intermediary fraud)

* See Insurance Research Council: ”Fraud and Buildup in Auto Injury Insurance Claims: 2008 Edition”

Model framework
Research goal and main findings

- **Research goal**

  Deriving optimal audit strategies based on policyholder's claiming behavior

  Calculate threshold values indicating whether verification should be performed

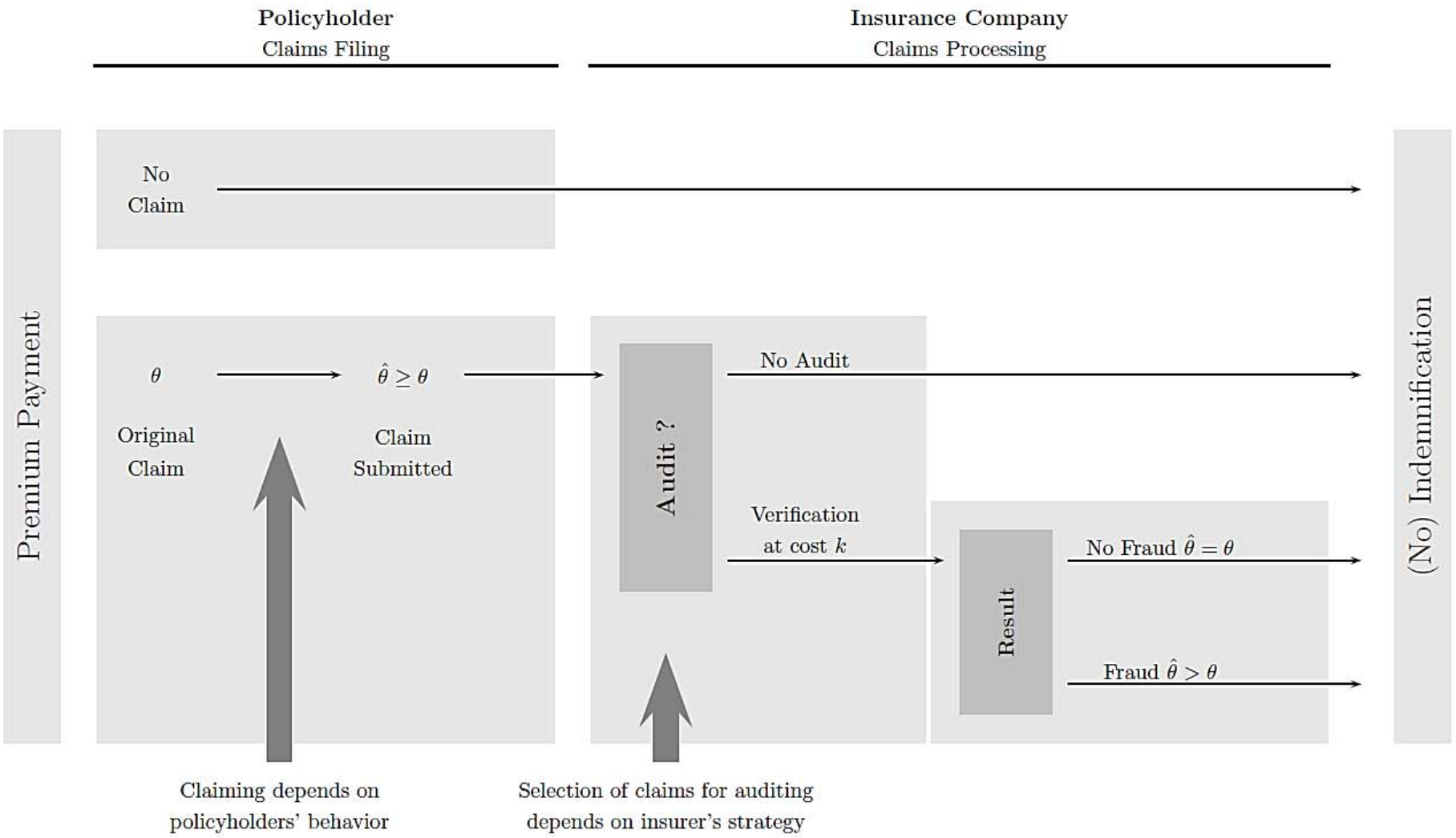
- **Main findings**

  In an cost minimizing environment, the insurance company‘s net present value may increase in the presence of fraud compared to the case where no fraud exists

  There exist situations where – while the possibility to adapt one‘s behavior might be desirable for the insurance company – this option may be disadvantageous from the policyholder perspective

- **Related literature** (please cf. working paper)

Model framework
Illustration of procedure



Model framework
Costly state verfication environment

- **Insurance company perspective**

  Contribution margin of single contract

$$CM(P,k,\hat{\theta},\mathcal{A},\mathcal{F}) = \begin{cases} P & \text{, no loss occurred, i.e., } \hat{\theta}=0 \\ P-\hat{\theta} & \text{, no auditing, i.e., } \hat{\theta}\in\mathcal{A}^c \\ P-\hat{\theta}-k & \text{, auditing, but no fraud, i.e., } \hat{\theta}\in\mathcal{A}\cap\mathcal{F}^c \\ P-k & \text{, auditing, fraud detected, i.e., } \hat{\theta}\in\mathcal{A}\cap\mathcal{F} \end{cases}$$

  Net present value

$$NPV = NPV(P,k,\hat{\theta},\mathcal{A},\mathcal{F}) = \mathbb{E}(CM(P,k,\hat{\theta},\mathcal{A},\mathcal{F}))$$

- **Policyholder perspective**

  Without insurance coverage

$$U(W_1^N) = \mathbb{E}(W-\pi\theta) - \frac{a}{2}\mathrm{Var}(W-\pi\theta)$$

  With insurance coverage

$$U(W_1^I) = \mathbb{E}\left(W-P-\pi\theta+\hat{\theta}\left[1-\mathbb{1}_{\mathcal{A}\cap\mathcal{F}}(\hat{\theta})\right]\right) - \frac{a}{2}\mathrm{Var}\left(W-P-\pi\theta+\hat{\theta}\left[1-\mathbb{1}_{\mathcal{A}\cap\mathcal{F}}(\hat{\theta})\right]\right)$$

  Gain in Utility

$$\Delta U = U(W_1^I) - U(W_1^N)$$

Model framework
Behavioral strategies

- **Policyholders‘ claiming strategy**
  Source of information: may use third parties (e.g. repair shops) to act as their partners in fraud

$$\hat{\theta} = \hat{\Theta}(\theta, \alpha, \hat{\theta}^*_{\text{ph}}) = \begin{cases} 0 & , \text{ no loss occurred} \\ \theta & , \text{ no fraud or } \theta > \hat{\theta}^*_{\text{ph}} \\ \min\{\alpha\theta, \hat{\theta}^*_{\text{ph}}\} & , \text{ fraud and } \theta < \hat{\theta}^*_{\text{ph}} \end{cases}$$

- **Insurer‘s auditing strategy**
  Source of information: revealed fraud may may help improve the existing auditing strategy

$$\hat{\theta}_{\max} = \max\{\hat{\theta} \cdot \mathbb{1}_{\mathcal{A} \cap \mathcal{F}}\}$$

$$\mathcal{A}_{\text{R}} = \mathcal{A}_{\text{R}}(\hat{\theta}^*_{\text{R}}, s, \hat{\theta}_{\max}) = \{\hat{\theta} | \hat{\theta}^*_{\text{R}} \leq \hat{\theta} \leq (1+s) \cdot \hat{\theta}_{\max}\}$$

Model framework
Behavioral strategies

- **Insurer‘s auditing strategy**
  For the first observation period, the auditing strategy is formally defined as

$$\mathcal{A}_{\text{init}} = \mathcal{A}_{\text{init}}(\hat{\theta}^*_{\text{init}}) = \{\hat{\theta} | \hat{\theta}^*_{\text{init}} \leq \hat{\theta}\}$$

The optimal lower bound is derived by maximizing the *NPV*

$$\begin{cases} \max\limits_{\hat{\theta}^*_{\text{R}}} NPV(P, k, \hat{\theta}, \mathcal{F}_{\alpha, \hat{\theta}^*_{\text{ph}}}, \mathcal{A}_{\text{R}}) \\ NPV \geq 0 \\ \Delta U \geq 0. \end{cases}$$

Behavioral adaptation
Optimal auditing strategy

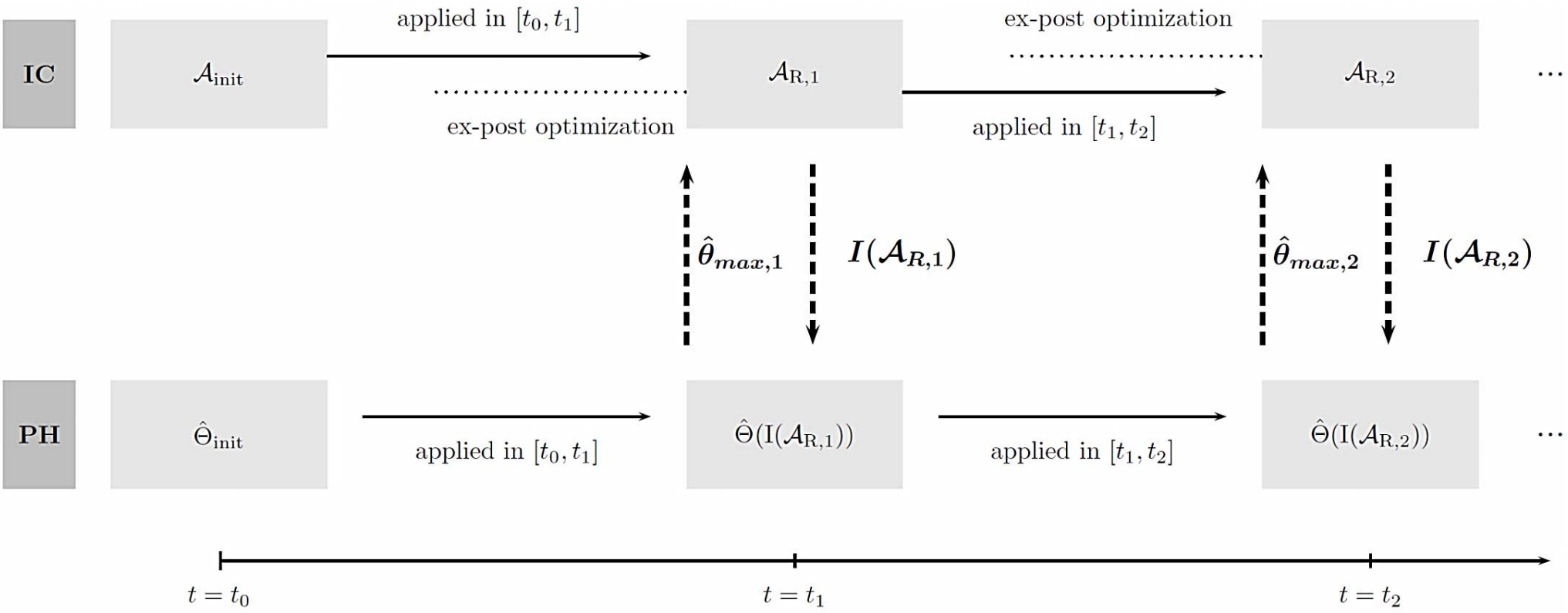


Figure: Interaction between insurance company (IC) and policyholder (PH) over the course of the first two periods in an insurance relationship

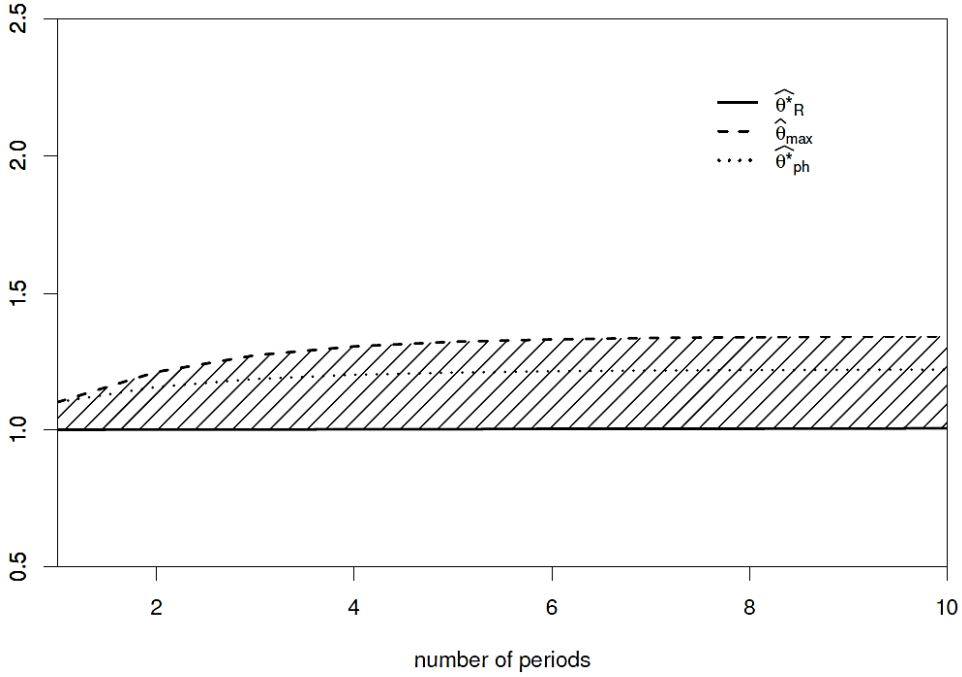
Numerical examples

Choice of parameters in the reference setting

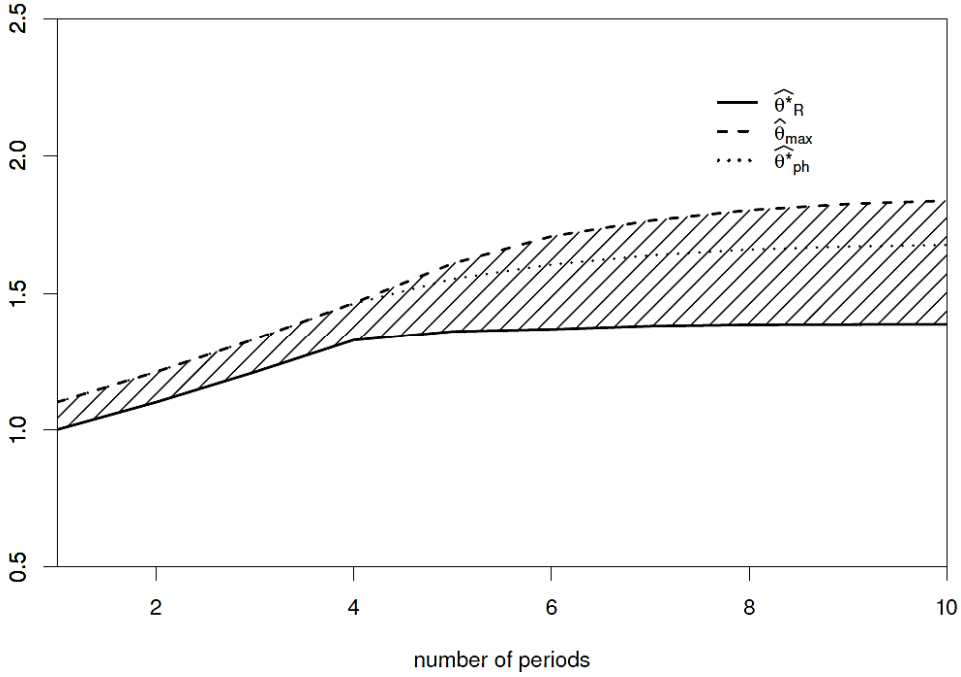
Input parameter		Reference level
Total number of policyholders	M	2'500'000
Number of loss realizations	N	500'000
Loss distribution	θ	$\ln\mathcal{N}(1, 0.4)$
Insurance premium	P	0.3
Fraud probability	p	0.2
Relative fraud amount	α	2
Initial threshold value for auditing	$\hat{\theta}^*_{\mathrm{T}}$	1
Safety margin	s	0.1
Policyholder's initial threshold	$\hat{\theta}^*_{\mathrm{ph},0}$	1.1
Auditing cost	k	0.05
Risk aversion parameter	a	6

Optimal auditing with behavioral adaptation

Simulation results



(a) Optimal auditing range, k=0.05



(b) Optimal auditing range, k=0.3

Figure: Development of optimal auditing range throughout the course of several iterations for two different choices of the cost per audit

Optimal auditing with behavioral adaptation

Simulation results

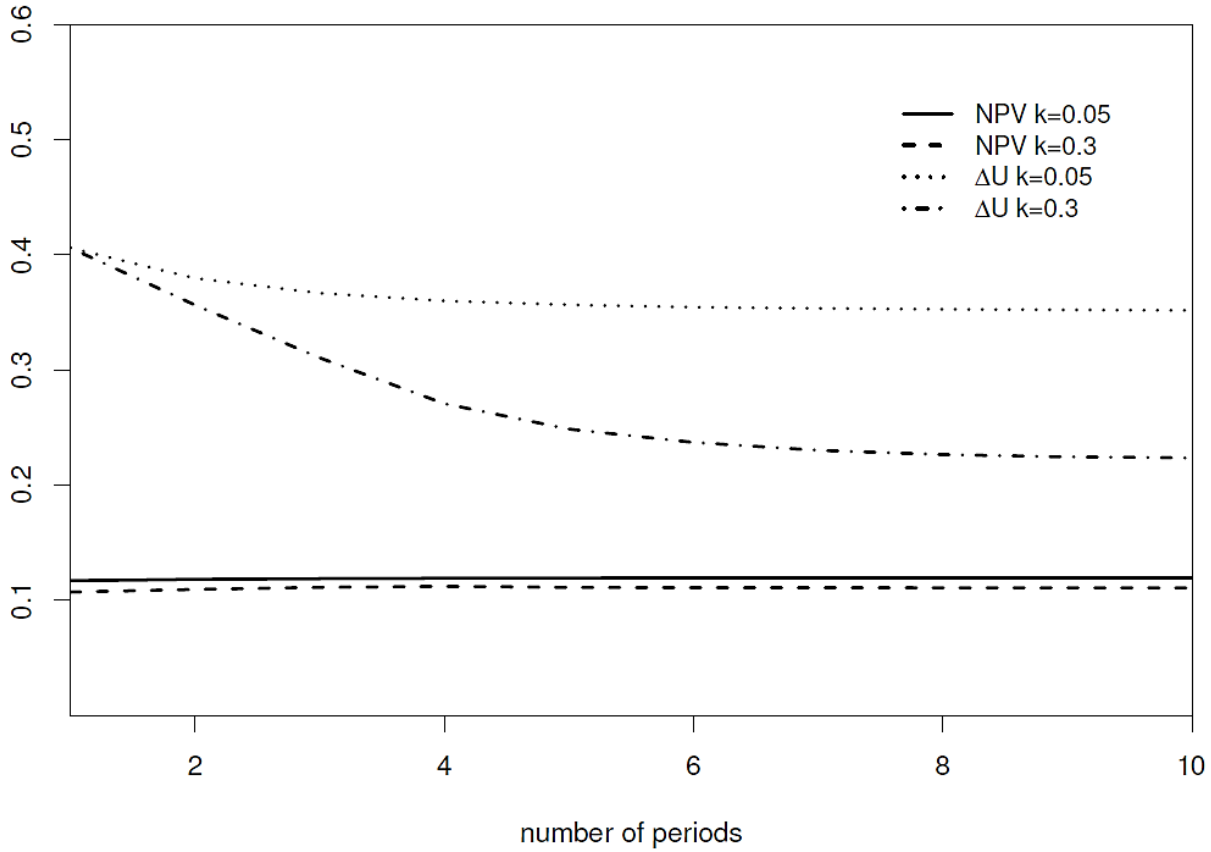


Figure: Development of the insurance company's net present value and the policyholders' gain in utility over the course of several iterations when applying the optimal auditing strategy

Summary and Outlook
Ideas for further research

- **Sensitive analysis**
- **Managerial implementations**
- **Limitations of the aproach**
- **Empirical testing with data from an insurer**

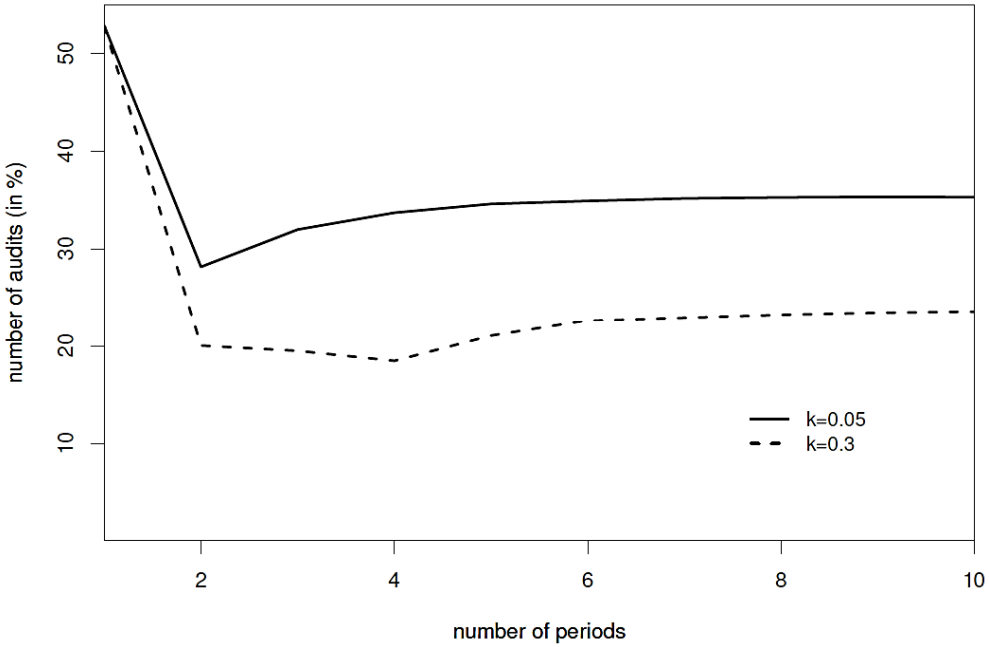
  Analysis of determinants indicating defrauding attempts

  Calibration of the model with data from an insurance company and derivation of their optimal auditing strategy

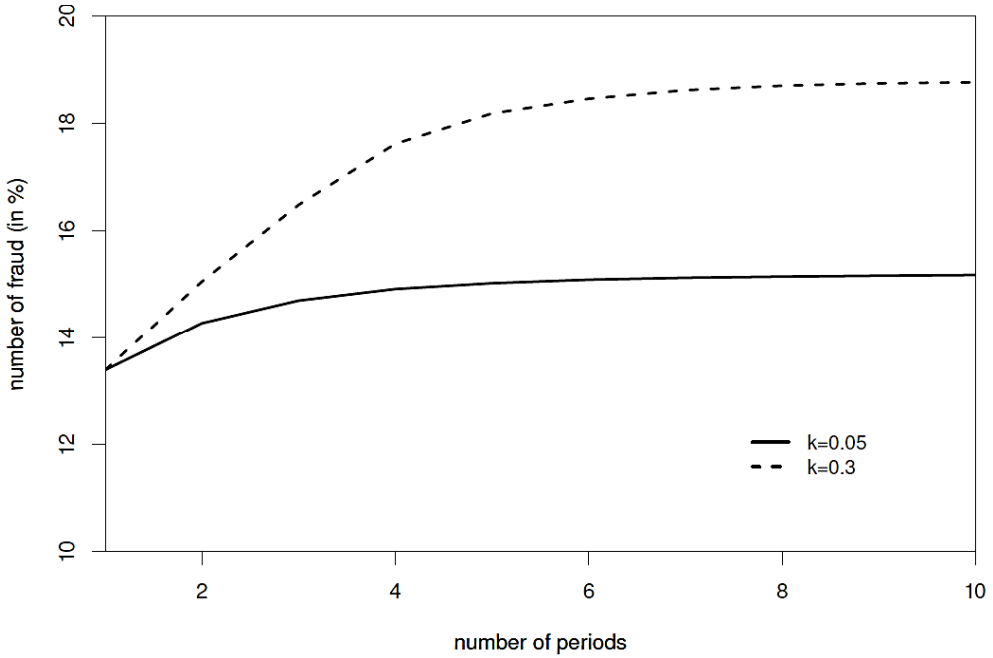
Thank you very much for your attention!

Optimal auditing with behavioral adaptation

Simulation results / backup



(a) Number of performed audits when applying optimal auditing strategy

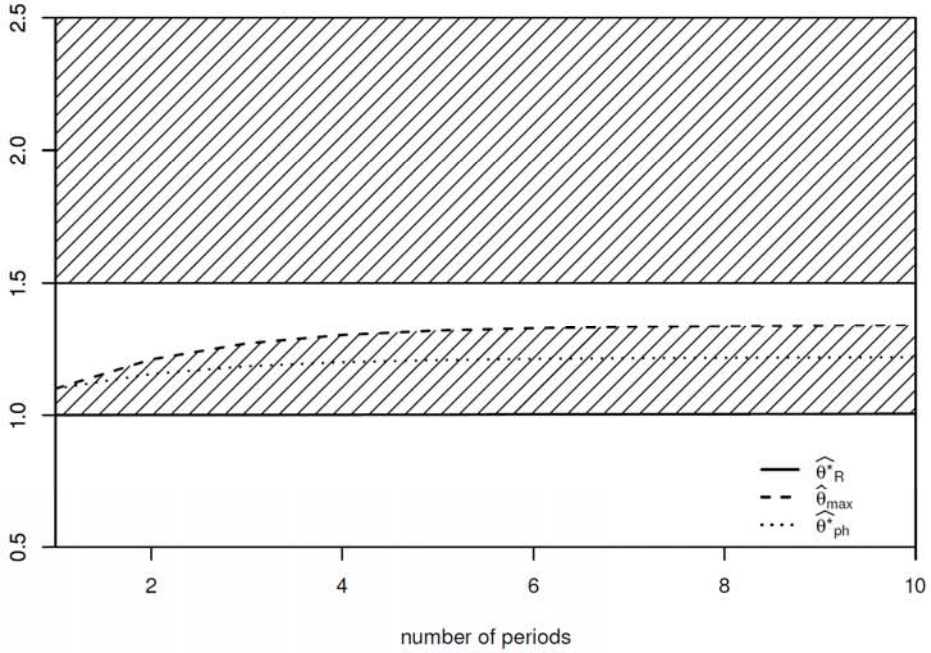


(b) Number of fraudulent claims when optimal auditing strategy is applied

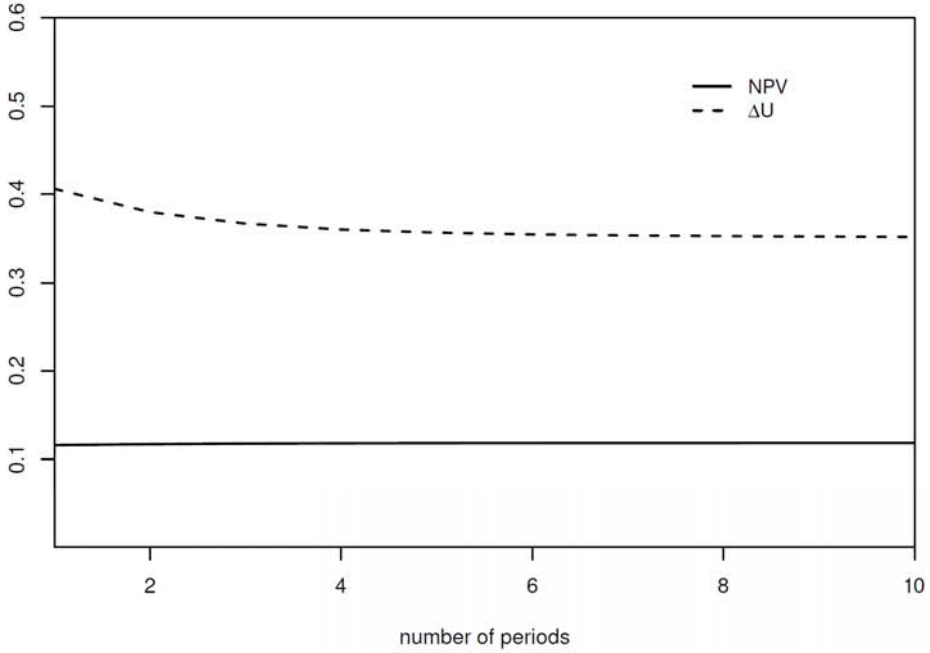
Figure: Development of number of performed audits and number of fraudulent claims over the course of several iterations when applying the optimal auditing strategy

Critical discussion

Introduction of additional threshold / backup



(a) Number of performed audits when applying optimal auditing strategy



(b) Number of fraudulent claims when optimal auditing strategy is applied

Figure: Auditing range including additional auditing threshold and the corresponding objective quantities