

# A Continuous-Time Optimal Insurance Design with Costly Monitoring

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October 4, 2012

## Abstract

We provide a theoretical and numerical framework to study optimal insurance properties for players' general utility forms. We consider a continuous-time model where neither the efforts nor the outcome of an insured firm are observable to an insurer. The insured may then cause two interconnected information problems: moral hazard and fraudulent claims. We show that, when costly monitoring is available, an optimal insurance contract distinguishes the one problem from the other. Furthermore, if the insured's downward-risk aversion is weak and if the participation constraint is not too tight, then a higher level of the monitoring technology can mitigate both problems.

Keywords: Insurance, Costly monitoring, Moral hazard, Fraudulent claims.  
JEL Classification: D82, D86, G22, G32.

## 1 Introduction

As it is well known, insurers are often exposed to information problems in corporate insurance practices; see e.g. MacMinn and Garven (2000). Specifically, neither the efforts nor the outcome of insured firms are observable to insurers directly without a cost. The insureds may then cause two information problems: (1) causing losses purposely and (2) filing fraudulent claims. Call the former the problem of moral hazard and the latter the problem of ex-post informational asymmetry.

The ex-post informational asymmetry problem distorts the insured's effort incentives in the moral hazard problem. In standard moral hazard models, it is often assumed that the insurer can observe the insured's outcome ex post; e.g., see Rogerson (1985). The insurer then faces only the incentive problem of inducing the insured to make desired efforts. However, when there exists the ex-post informational asymmetry problem as well, the insured may also exaggerate a claim. The insurer then needs to provide additionally the insured with an incentive to tell the truth ex post. Thus the insurer cannot find directly whether the filed claim is due to the insured's laziness, to the fraud, or neither. Much worse, when the insured has a chance to tell a lie about the ex-post outcome, he may have an incentive to be lazy in order to minimize his effort cost. Since the two information problems are interconnected in such ways, it is very difficult to distinguish the one problem from the other directly without a cost. In practice, to overcome this difficulty, the insurer routinely investigates claims via a costly monitoring technology after they are filed (Harrington and Niehaus (2004)).

The purpose of this paper is to provide a theoretical and numerical framework to study optimal insurance properties when the costly monitoring is available under the problems of moral hazard and ex-post informational asymmetry in an optimal contracting model with two players: an insurer (i.e., insurance company)

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