

## Accepted Manuscript

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PII: S0377-0427(18)30320-0  
DOI: <https://doi.org/10.1016/j.cam.2018.05.043>  
Reference: CAM 11708

To appear in: *Journal of Computational and Applied Mathematics*

Received date: 5 May 2017  
Revised date: 9 May 2018

Please cite this article as: K.-A. Fu, C. Yu, On a two-dimensional risk model with time-dependent claim sizes and risky investments, *Journal of Computational and Applied Mathematics* (2018), <https://doi.org/10.1016/j.cam.2018.05.043>

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# On a two-dimensional risk model with time-dependent claim sizes and risky investments\*

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**Abstract:** Consider a two-dimensional risk model, in which two insurance companies divide between them the claims in some specified proportions. Suppose that the claim sizes and inter-arrival times form a sequence of independent and identically distributed random pairs, with each pair obeying a dependence structure, and the surpluses of the two companies are invested into portfolios whose returns follow two different geometric Lévy processes. When the claim-size distribution is extended-regularly-varying tailed, asymptotic expressions for the ruin probability of this two-dimensional risk model is exhibited. Some numerical results are also presented to illustrate the accuracy of our asymptotic formulae.

**Keywords:** Extended regular variation; Lévy process; Ruin probability; Time-dependent risk model

**AMS Mathematics Subject Classification:** 62P05; 60F99

## 1. Introduction

In this paper, we consider a particular two-dimensional risk model, in which two insurance companies (or two branches of the same company) split the amount they pay out of each claim in positive proportions  $\delta_1$  and  $\delta_2$ , respectively, where  $\delta_1 + \delta_2 = 1$ . The surplus of the  $i$ -th ( $i = 1, 2$ ) company up to time  $t \geq 0$  is given by

$$U_i(t) = e^{R_i(t)} \left( x_i + c_i \int_0^t e^{-R_i(s)} ds - \delta_i \sum_{k=1}^{N(t)} X_k e^{-R_i(\tau_k)} \right), \quad i = 1, 2, \quad (1.1)$$

where  $(R_1(t), R_2(t))$  is the vector of investment return processes,  $\vec{x} = (x_1, x_2)$  is the initial surplus vector,  $(c_1, c_2)$  is the vector of rate of premium payments, and  $\{X_i; i \geq 1\}$  is the sequence of claim sizes whose common arrival times  $\tau_1, \tau_2, \dots$  constitute a renewal claim-number process  $\{N(t); t \geq 0\}$  with finite renewal function  $\lambda_t = \mathbb{E}N(t) = \sum_{i=1}^{\infty} \mathbb{P}(\tau_i \leq t)$ . Note that a similar risk model was first

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