

## Accepted Manuscript

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PII: S0167-6687(16)30033-6

DOI: <http://dx.doi.org/10.1016/j.insmatheco.2016.05.009>

Reference: INSUMA 2215

To appear in: *Insurance: Mathematics and Economics*

Received date: January 2016

Revised date: April 2016

Accepted date: 18 May 2016



Please cite this article as: He, J., Tang, Q., Zhang, H., Risk reducers in convex order.

*Insurance: Mathematics and Economics* (2016),

<http://dx.doi.org/10.1016/j.insmatheco.2016.05.009>

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# Risk Reducers in Convex Order

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April 3, 2016

## Abstract

Given a risk position  $X$ , a random addition  $Z$  is called a risk reducer for  $X$  if the new position  $X + Z$  is less risky than  $X + E[Z]$  in convex order. We utilize the concept of convex hull to give a structural description of risk reducers in the case of an atomless probability space. Then we study risk reducers that are fully dependent on  $X$ . Applications to multivariate stochastic ordering, index-linked hedging strategies, and optimal reinsurance are proposed.

*Keywords:* convex hull; co/counter-monotonicity; multivariate stochastic ordering; index-linked hedging strategies; optimal reinsurance

*JEL:* C44, G22, C73

## 1 Introduction

In this paper we study when a random addition can reduce the risk of a given risk position, where we mean to reduce the risk in convex order. Interests in stochastic ordering of risks have long been existing. Terminologies closely related to convex order such as second-order stochastic dominance, the Rothschild–Stiglitz increase in risk, majorization, mean preserving spread, and stop-loss order are popular in mathematics, statistics, economics, and decision theory. Pioneering works on these and related concepts include Lehmann (1955), Rothschild and Stiglitz (1970), and Day (1972). See the monographs Ross (1983), Stoyan (1983), Arnold (1987), Mas-Colell et al. (1995), Müller and Stoyan (2002), and Marshall and Olkin (2011) for more extensive discussions. See also Denuit et al. (2005)

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