

Contract theory in continuous-time models, by Jakša Cvitanić and Jianfeng Zhang,
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This book provides a rigorous mathematical treatment of the *principal-agent problem* in its three main forms:

- Risk sharing under full information.
In this case, the principal and the agent share the same information. This case is also known as the *individual rationality constraint*.
- Contracting under hidden action.
In this case, the principal has less information than the agent. This case is also known as the *case of moral hazard*.
- Contracting under hidden action and hidden type.
In this case, the principal not only has less information than the agent but also lacks full knowledge of key characteristics of the agent.

The principal-agent problem dates back to the work of Kenneth Arrow in the 1960s who studied the topic of the optimal managerial compensation in the presence of information asymmetry (see [1,2]). Since that time, the topic has been of interest mostly in the area of microeconomics, economic theory, and mathematical economics with a plethora of work therein, most of which either covers the principal-agent problem from the economic theory of contracts point of view (see, for instance, [4, 6]) or that of the theory of incentives (see [3]). A first more mathematically rigorous attempt to address this problem can be found in [5].

The book under review provides a complete treatment of the principal-agent problem that covers all cases treated in economic literature (see, for instance [3]), namely those of moral hazard, adverse selection, and non-verifiability. It is the first of its kind in that it provides a fully developed mathematical framework addressing the principal-agent problem with complete proofs and explanations of all mathematical tools used therein. The book addresses the principal-agent problem in models of continuous time. Optimal contracts are also explicitly characterized in cases where it is possible and summarized in the context of specific examples. The book also provides economic interpretations and discussions of specific solutions from an economics point of view.

The book focuses on developing a mathematical framework and, unlike [3], does not discuss how contract theory arises from the theory of incentives. Unlike [3, 4], which draw connections between industrial organization, corporate finance, labor or behavioral economics, and the principal-agent problem, this book gives economic interpretations of mathematical results in very specific economic settings. Some specific applications, however, are also discussed.

The introduction of this book is accessible to a general audience. The mathematical models treated in the introduction and the solutions provided therein are very intuitive and can be grasped at the sophomore level of mathematics. However, further reading of this book requires at least a good knowledge of basic stochastic calculus tools and stochastic differential equations. An intuitive knowledge of these

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mathematical concepts may also be enough to read this book if one is not interested in a thorough understanding of the proofs. A background of microeconomic theory may also be necessary to better understand the economics motivations of certain examples. The last chapter is particularly demanding from the mathematical point of view and provides an introduction to solving forward-backward stochastic differential equations. The key mathematical concepts used throughout the book are those of stochastic maximum principle, dynamic programming, and stochastic calculus of variations.

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