

Monotonicity of optimal contracts without the first-order approach

Chris Ryan, PhD
Associate Professor
Operations Management, University of Chicago

Abstract: We develop a simple sufficient condition for an optimal contract of a moral hazard problem to be monotone in the output signal. Existing results on monotonicity require conditions on the output distribution (namely, the monotone likelihood ratio property (MLRP)) and additional conditions to ensure that agent's decision is approachable via the first-order approach of replacing that problem with its first-order conditions. We know of no positive monotonicity results in the setting where the first-order approach does not apply. Indeed, it is well-documented that when there are finitely many possible outputs, and the first-order approach does not apply, the MLRP alone is insufficient to guarantee monotonicity. However, we show that when there is an interval of possible output signals, the MLRP does suffice to establish monotonicity under additional technical assumptions that do not ensure the validity of the first-order approach. To establish this result we examine necessary optimality conditions for moral hazard problems using a penalty function approach. We then manipulate these conditions and provide sufficient conditions for when they coincide with a simple version of the moral hazard problem with only two constraints. In this two-constraint problem, monotonicity is established directly via a strong characterization of its optimal solutions.

Bio: *Chris Ryan* is an associate professor of operations management at the University of Chicago Booth School of Business where he teaches in the MBA and PhD programs. Chris graduated with a PhD in Management Science from the Operations and Logistics department at the UBC Sauder School of Business. Chris researches the theory of optimization (including infinite-dimensional, discrete and stochastic) with applications to theoretical economics (contract theory, game theory and mechanism design), decision problems in the digital economy (particularly video games and apps), and health care operations.

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