"Choosing Joint Distributions: Theory and Application to Information Design"

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Abstract: In many economic settings, a decision-maker chooses a joint distribution of random variables $(X_1,\ldots,X_n)$ to maximize the expected value of an objective function $V(X_1,\ldots,X_n)$, taking the marginal distributions of the X_i's as given. Problems of the above form arise in optimal transport, where the marginal distributions reflect resource constraints; in multi-product design, where the marginal distributions reflect buyers' valuations for each separate variety of product; and in information design, where the marginal distributions reflect characteristics of receivers.

In models of information design where a sender communicates privately with multiple receivers, the sender's strategic problem is the choice of a joint distribution of signals to the receivers, conditional on each state of the world. In some settings, the sender's problem decouples: the optimal marginal distribution of the signal to each receiver, in each state, depends **only** on that receiver's characteristics, and the optimal joint distribution can then be determined, taking the marginal distributions as given.

The first part of this paper derives three stochastic dominance theorems showing how the solution to a decision-maker's problem of the form above depends on the properties of the objective function and the characteristics of the given marginal distributions. Specifically, it examines the impact of greater "heterogeneity" within the set of marginal distributions, providing three distinct generalizations of the majorization ordering of dispersion to capture heterogeneity among sets of univariate distributions. For each definition of greater heterogeneity of the given marginal distributions, the corresponding stochastic dominance theorem identifies a class of objective functions for which greater heterogeneity is sufficient to guarantee a lower maximized expected payoff for the decision-maker, for **any** objective in that class. Two of the three theorems also demonstrate that greater heterogeneity of the marginals according to the corresponding definition is necessary for the conclusion above.

The second part of the paper applies these stochastic dominance theorems to reformulate a multi-receiver model of private Bayesian persuasion. I derive new characterizations of optimal signal structures and new comparative statics results.