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Response

Response to Reviewers

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Three thoughtful responses by Prof. Thomas Louis, Dr. Lorenz Rhomberg, and Profs. Dale Hattis and Rob Goble testify to the importance of uncertainty characterization and the willingness of top researchers to apply themselves to the task. I greatly appreciate this opportunity afforded by *Risk Analysis* to nudge the discussion forward.

Rhomberg succinctly captures the main point "that simply taking an existing formula and imposing distributions on each of its variables to 'probabilitize' it is not necessarily a good way to model uncertainty." The covariance singularity is the most telling symptom. Goble and Hattis render this intuitive by saying that two ways of extrapolating from SP to CR, via SR and via CP, must introduce a dependence. That is basically right, but it is a bit more complicated because these are random variables and not simple numbers. The demonstration requires identifying assumptions and working out the covariance matrix.

Simply blocking this singularity would not solve the problems, however. Assuming that a ratio of two random variables is independent of one of its terms, which is entailed in the first step of a probabilized UF method, already raises questions. My article showed that this leads to consequences at variance with our intuitions. A simple example involving height, weight, and body mass index (BMI = weight [kg]/height[m^2]) is illustrative. Distributions for all three quantities for U.S. females older than 20 years from the National Health Statistics Report are summarized below.

All U.S. Females Older Than 20 Years			
	5%	50%	95%
BMI (kg/m^2)	19.4	26.9	41.6
Height (m)	1.507	1.622	1.731
Weight (kg)	50.5	70.4	113.6

Just as with uncertainty factors, we can always write an equation such as:

$$\text{Height}^2 = \text{Weight}/\text{BMI}.$$

Suppose we learn the weight of a U.S. female over 20. Would it make sense to divide this weight by the random variable BMI to obtain the uncertainty in this woman's height? Certainly not. If we measured a weight at the 95th percentile (113.6 kg) and divided by the random variable BMI, we would find that the 95th percentile of height, given weight 113.6 kg, would be $(113.6/19.4)^{1/2} = 2.4198$ m. The tallest man in the world, Bao Xishun of Inner Mongolia, China (2.36 m or 7 ft 9 in. tall) would look up to a woman of 2.4 m. In the general population, 5% of women have BMI < 19.4. If we consider all women with weight 113.6 kg, is there still a 5% chance that in this group, the BMI is <19.4? Might not their BMIs tend to be larger?

Granting for the sake of argument that Goble and Hattis avoid the covariance singularity in the 17 chemicals of their "straw man," this step still warrants careful scrutiny.

In proposing log-linear regression and Bayesian belief nets as two ways forward, I certainly did not intend to "force a choice between … these two extremes" in Louis's words. The latter seems most promising to me, but the conclusion was: "Undoubtedly, more good ideas will emerge, once the inevitability of thorough going reform is recognized." These searching reviews testify that our research community is abundantly capable of generating new ideas.

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