it is unconditionally advantageous to use them. This is an example of Brown's phenomenon at the level of loss estimators.

For more general point estimators $\tilde{\delta}$ of the form (3.3.1), the Lemma indicates how one might apply existing work to construct reasonable loss estimators for $(\tilde{\delta} - \alpha)^2$. If one works conditionally on S, as in (3.3.3), then it is plausible that an improvement on the unbiased estimate of loss of $(\tilde{\delta} - \alpha)^2$ will follow as in Section 5 of J and an improvement on the upper bound $\sigma^2 + \sigma^2 \operatorname{tr} S^{-1}$ as in Lu and Berger (1989). Construction of loss estimates corresponding to (3.3.4) and (3.3.5) is less clear, but an interesting problem perhaps deserving further study.

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The fundamental ancillarity paradox introduced by Brown can be observed in many other settings. As an example, we herein extend the results of Brown to the confidence set scenario:

Let X be a p-dimensional normal random variable with mean $\mu \in R^p$ and covariance matrix Σ. Consider the confidence procedure

$$C_\delta(X) = \{\mu\colon (\delta(X) - \mu)'\Sigma^{-1}(\delta(X) - \mu) \le c^2\},$$

where Σ^{-1} is an inverse or generalized inverse of Σ. The coverage probability of C_δ, $P_\mu(C_\delta(X)$ contains $\mu)$, is the usual criterion used for evaluating procedures of a fixed size (determined by c). It is convenient to rephrase this as a decision problem, with $\delta(X)$ being thought of as an estimator and $1 - P_\mu(C(X)$ contains $\mu)$ being the risk function corresponding to the loss function.

$$L_c(\mu, d) = \begin{cases} 1, & \text{if } (d - \mu)'\Sigma^{-1}(d - \mu) \ge c^2, \\ 0, & \text{otherwise.} \end{cases}$$

Brown (1966) and Joshi (1969) independently showed that $\delta_0(X) = X$ is admissible if $p = 1, 2$ and inadmissible if $p \ge 3$. Hwang and Casella (1982, 1984) proved that the positive part James–Stein estimator is an improved estimator under the above loss L_c.