On confidence intervals in regression that utilize uncertain prior information about a vector parameter

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Consider a linear regression model with n-dimensional response vector, p-dimensional regression parameter beta and independent normally distributed errors. Suppose that the parameter of interest is theta = a^T beta where a is a specified vector. Define the s-dimensional parameter vector tau=C^T beta-t where C and t are specified. Also suppose that we have uncertain prior information that tau=0. Part of our evaluation of a frequentist confidence interval for theta is the ratio (expected length of this confidence interval)/(expected length of standard 1-alpha confidence interval), the scaled expected length of this interval. We say that a 1-alpha confidence interval for theta utilizes this uncertain prior information if (a) the scaled expected length of this interval is significantly less than 1 when tau=0, (b) the maximum value of the scaled expected length is not too large and (c) this confidence interval reverts to the standard 1-alpha confidence interval when the data happen to strongly contradict the prior information. Let hat{Theta}=a^T hat{beta} and hat{tau}=C^T hat{beta}-t, where hat{beta} is the least squares estimator of beta. We consider the particular case that that E((hat{tau}-tau)(hat{Theta}-theta))=0, so that hat{Theta} and hat{tau} are independent. We present a new 1-alpha confidence interval for theta that utilizes the uncertain prior informationthat tau=0. The following problem is used to illustrate the application of this new confidence interval. Consider a 2^3 factorial experiment with 1 replicate. Suppose that the parameter of interest theta is a specified linear combination of the main effects. Assume that the three-factorinteraction is zero. Also suppose that we have uncertain prior information that all of the two-factor interactions are zero. Our aim is to find a frequentist 0.95 confidence interval for theta that utilizes this uncertain prior information.

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