SIMEX and variance estimation in semiparametric measurement error models

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Abstract: SIMEX is a general-purpose technique for measurement error correction. There is a substantial literature on the application and theory of SIMEX for purely parametric problems, as well as for purely nonparametric regression problems, but there is neither application nor theory for semiparametric problems. Motivated by an example involving radiation dosimetry, we develop the basic theory for SIMEX in semiparametric problems using kernel-based estimation methods. This includes situations that the mismeasured variable is modeled purely parametrically, purely nonparametrically, or that the mismeasured variable has components that are modeled both parametrically and nonparametrically. Using our asymptotic expansions, easily computed standard error formulae are derived, as are the bias properties of the nonparametric estimator. The standard error method represents a new method in general for semiparametric problems, and we show in our example that it improves dramatically on first order methods. We find that for estimating the parametric part of the model, standard bandwidth choices of order $O(n^{-1/5})$ are sufficient to ensure asymptotic normality, and undersmoothing is not required. We also include results on uniform expansions of nonparametric function estimators. SIMEX has the property that it fits misspecified models, namely ones that ignore the measurement error. Our work thus also more generally describes the behavior of kernel-based methods in misspecified semiparametric problems.