# Discussion of "Small Area Estimation: Its Evolution in Five Decades", by Malay Ghosh

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## 1. Introduction

It is my great pleasure to act as an invited discussant of this overview paper on small area estimation (SAE) by Malay Ghosh, based on his 28th Annual Morris Hansen Lecture held on October 30, 2019 in Washington, D.C. I was closely associated with the late Morris Hansen while we were both members of the Statistics Canada Methodology Advisory Committee for several years chaired by Hansen. I greatly benefited from his pioneering contributions to survey sampling theory and practice. Ghosh and I collaborated on a SAE review paper 26 years ago (Ghosh and Rao, 1994), which has received more than 1000 Google citations and partly stimulated much research on SAE over the past 25 years. The greatly increased demand for reliable small area statistics worldwide of course is the primary factor for the explosive growth in the SAE methodology. My joint paper with Ghosh stimulated me to write my 2003 Wiley book on SAE (Rao 2003). Because of the extensive developments in SAE after my 2003 book appeared, I wrote the second edition of my Wiley book in 2015 jointly with Isabel Molina (Rao and Molina 2015). Perhaps, my 2015 book is now obsolete given the rapid new developments in SAE theory and practice over the past 5 years!

Direct area-specific estimates are inadequate for SAE due to small domain or area sample sizes or even zero sample sizes in some small areas. It is therefore necessary to take advantage of the information in related areas through linking models to arrive at reliable model-dependent or indirect small area estimates. Hansen et al. (1983) demonstrated that model-dependent strategies can perform poorly for large samples even under small model misspecification, unlike design-based strategies leading to design-consistent estimators. On the other hand, Hansen et al. (1983) also note that the model-dependent strategies might enjoy substantial advantage in small samples if the model is appropriate and the sampling plan need not be probability based. The latter statement has implications to current focus on non-probability samples. Kalton (2018)

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