

# Contrasting identification criteria of average causal effects: Asymptotic variances and semiparametric estimators

Tetiana Gorbach<sup>1</sup>, Xavier de Luna<sup>2</sup>, Juha Karvanen<sup>3</sup>,  
Ingeborg Waernbaum<sup>4</sup>

<sup>1</sup> *Department of Statistics, Umeå University, Sweden, tetiana.gorbach@umu.se*

<sup>2</sup> *Department of Statistics, Umeå University, Sweden, xavier.de.luna@umu.se*

<sup>3</sup> *Department of Mathematics and Statistics, University of Jyväskylä, Finland, juha.t.karvanen@jyu.fi*

<sup>4</sup> *Department of Statistics, Uppsala University, Sweden, ingeborg.waernbaum@statistik.uu.se*

Pre-treatment covariates are commonly used to estimate an average causal effect from observational data under the back-door identification of the effect. The effect can also be estimated using mediators only or mediators and pre-treatment covariates under the front-door or the so-called two-door identification, respectively. When several of these identification assumptions are fulfilled, the choice of the estimation strategy may be based, among others, on estimation efficiency.

In this talk we provide the semiparametric efficiency bounds for regular estimators of the average causal effect under the front-door and the two-door identification assumptions specified using the potential outcome framework. We also derive the efficiency bounds when at least two of the identification assumptions are fulfilled simultaneously. We compare the bounds and show that neither the back-door, the front-door, nor the two-door identification assumptions yield the lowest bound irrespective of the data distribution. We, however, provide sufficient conditions for the variance bound of the estimation using information on the mediators and the pre-treatment covariates to be lower (or higher) than the bound of the estimation using information on the pre-treatment covariates only. Estimators reaching the different bounds are also proposed and studied.