



Canadian Labour Market and Skills Researcher Network

Working Paper No. 35

Estimating Treatment Effects from Contaminated Multi-Period Education Experiments: The Dynamic Impacts of Class Size Reductions

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July 2009

CLSRN is supported by Human Resources and Skills Development Canada (HRSDC) and the Social Sciences and Humanities Research Council of Canada (SSHRC). All opinions are those of the authors and do not reflect the views of HRSDC or the SSHRC.

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October 2008

Keywords: Dynamic treatment effects, contaminated experiments, class size, education production, attrition, non-compliance

JEL Code: I21 and C31.

* We wish to thank seminar participants at Harvard University, McGill University, NBER Economics of Education Fall 2003 meetings, New York University, Carnegie-Mellon University, Penn State University, Queen's University, Simon Fraser University, University of Calgary, University of California - Riverside, University of Florida, Université Laval, Economics and Education Development Conference at the Federal Reserve Bank of Cleveland, ZEW 3rd Conference on Policy Evaluation, 2008 SOLE meetings, 2006 Tar-

get Conference, 2005 CEA meetings and the 2004 NASM of the Econometric Society for comments and suggestions. We are grateful to Petra Todd for helpful discussions and encouragement at the initial stages of this project. Two anonymous referees and a coeditor made suggestions that led to a substantial improvement in the presentation of the paper. We would also like to thank Alan Krueger for generously providing a subset of the data used in the study. Lehrer wishes to thank SSHRC for research support.

Abstract

This paper introduces an empirical strategy to estimate dynamic treatment effects in randomized trials that provide treatment in multiple stages and in which various non-compliance problems arise such as attrition and selective transitions between treatment and control groups. Our approach is applied to the highly influential four year randomized class size study, Project STAR. We find benefits from attending small class in all cognitive subject areas in kindergarten and the first grade. We do not find any statistically significant dynamic benefits from continuous treatment versus never attending small classes following grade one. Finally, statistical tests support accounting for both selective attrition and noncompliance with treatment assignment.

Executive Summary

Over the past decade, many provinces have spent millions of dollars on class size reduction initiatives in the early primary grades. Proponents of these initiatives regularly draw on a subset of the published findings from Tennessee's STAR Project, a randomized intervention conducted in the late 1980s. The STAR project was conducted for a cohort of students in 79 schools over a four-year period from kindergarten through grade 3. Within each participating school, incoming kindergarten students were randomly assigned to one of the three intervention groups: small class (13 to 17 students per teacher), regular class (22 to 25 students per teacher), and regular-with-aide class (22 to 25 students with a fulltime teachers aide). However, violations to the experimental protocol were prevalent. By grade three over 50% of the subjects who participated in kindergarten left the STAR sample and approximately 10% of the remaining subjects switch class type annually.

Our empirical strategy in this paper is to reanalyze data from the STAR Project to fill the empirical gaps left behind from the numerous quantitative problems in the project's original dataset. To date, researchers have not examined the STAR Project's data as a multi period trial or accounted for the multiple violations to the experimental protocol. To accomplish these goals, this paper introduces an empirical strategy to estimate treatment effects in randomized trials that provide a sequence of interventions contaminated by various forms of noncompliance including non-ignorable attrition and selective switching between treatment and control groups at different stages of the trial. Our empirical strategy for policy evaluation of contaminated multi-period experiments creates a direct link between the structural parameters of an underlying economic model of education production, to the dynamic treatment effect estimates. This strategy can be applied to analyzing data from multi-period experiments in clinical medicine and the social sciences.

We find benefits from small class attendance initially in all cognitive subject areas in kindergarten and grade one. Yet by grade one there does not exist additional statistically significant benefits from attending small classes in both years versus attendance in one of the years. There are no statistically significant dynamic benefits from continuous treatment versus never attending small classes following grade one. Statistical tests support accounting for both selective attrition and noncompliance with treatment assignment. We investigate several potential explanations for the diminishing benefits from small class attendance in higher grades. The evidence is consistent with a story of teaching towards the bottom, in which teachers were able to identify students in the bottom of the math scores distribution and boosted their performance relative to their classmates. The evidence also suggests a trade-off between variation in academic background and class size. Taken together, the results suggest that small classes do not work unconditionally and education policymakers should exhibit caution in implementing large scale class size reductions between kindergarten and grade three.