Canadian Labour Market and Skills Researcher Network

Working Paper No. 54

Estimating the Benefit of High School for College-Bound Students

Louis-Philippe Morin
University of Ottawa
IZA

January 2010

CLSRN is supported by Human Resources and Social 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.

Estimating the Benefit of High School for College-Bound Students*

Louis-Philippe Morin†

University of Ottawa and IZA

Abstract

Studies based on instrumental variable techniques suggest that the value of a high school education is large for potential dropouts, yet we know much less about the size of the benefit for students who will go on to post-secondary education. To help fill this gap, I measure the value-added of a year of high-school mathematics for university-bound students using a recent Ontario secondary school reform. The subject specificity of this reform makes it possible to identify the benefit of an extra year of mathematics despite the presence of self-selection: one can use subjects unaffected by the reform to control for potential ability differences between control and treatment groups. Further, the richness of the data allows me to generalize the standard difference-in-differences estimator, correcting for heterogeneity in ability measurement across subjects. The estimated value-added to an extra year of mathematics is small for these students – of the order of 17 percent of a standard deviation in university grades. This evidence helps to explain why the literature finds only modest effects of taking more mathematics in high school on wages, the small monetary gain being due to a lack of subject-specific human capital accumulation. Within- and between-sample comparisons also suggest that the extra year of mathematics benefits lower-ability students more than higher-ability students.

Keywords: Human Capital, High School Curriculum, Education Reform, Mathematics, Factor Model.
JEL Classification: I20, I21, I28.

*A previous version of this paper was entitled "Do College-Bound High School Students Need an Extra Year? Evidence from Ontario's 'Double Cohort'". I would like to thank Victor Aguirregabiria, Joshua Angrist, Michael Baker, Pierre Brochu, Mark Evans, Xavier Fazio, Robert McMillan, Phil Oreopoulos, Silvana Simone, Jeffrey Smith, and especially Aloysius Siow, for helpful comments. I am grateful to George Altmeyer, Khuong Doan, Susan Pfeiffer, Pekka Sinervo, and the Faculty of Arts and Science at the University of Toronto for making this project possible. All remaining errors are mine. Disclaimer: The views, opinions, findings, and conclusions expressed in this paper are strictly those of the author. For confidentiality reasons, the data used in this paper cannot be released by the author. All requests about these data should be directed to the Faculty of Arts and Science at the University of Toronto.

†Contact info: Louis-Philippe Morin, Department of Economics, University of Ottawa, Ottawa, Ontario, Canada, K1N 6N5. Telephone: (613) 562-5800 ext. 4867. Email: lmorin@uottawa.ca.

Executive Summary

Studies based on instrumental variable techniques suggest that the value of a high school education is large for potential dropouts, yet we know much less about the size of the benefit for students who will go on to post-secondary education. To help fill this gap, I measure the value-added of a year of high-school mathematics for university-bound students using a recent Ontario secondary school reform.

In 1997, the government of Ontario announced, starting in 1999, students would now be expected to graduate from high school after four years (after Grade 12) instead of five. As a consequence of the reform, in 2003 the first cohort of students graduating from Grade 12 and the last cohort of Grade-13 graduates entered Ontario universities simultaneously – the so-called ‘double cohort’ – affording a unique and useful comparison that helps shed light on the benefits of high school for university-bound students.

The key feature of the reform (for the purpose of this study) is the way it changed the high school curriculum non-uniformly. Some subjects were drastically affected while others were not. For example, the length of the high school mathematics curriculum for college-bound students went from five years to four while the length of the biology and chemistry curricula for the same students remained unchanged at two years.

This paper uses these non-uniform changes in curriculum to identify the value-added of Grade 13 mathematics. One can use academic performance in subjects that were not affected by the reform to control for potential ability differences between Grade 13 and Grade 12 students due to self-selection. This is especially important since, knowing that 2003 would be a more competitive year for college admissions, some students delayed their university application by a year while others "fast-tracked" high school, graduating a year early to avoid the double cohort.

To estimate the value-added of Grade 13 mathematics, I construct a flexible factor model that has appealing features. First, it takes into account the possibility that Grade 12 and Grade 13 students might differ in academic ability. Second, the model allows for the possibility that subjects do not measure ability in the same way, the identified value-added from the factor model being a generalization of the standard difference-in-differences estimator, correcting for heterogeneity in ability measurement across subjects.

The model is estimated using administrative data from the University of Toronto, the largest university in Canada. The size of the university and its classes make it possible to observe a large number of Grade-12 and Grade-13 graduates with similar backgrounds except for Grade-13 Mathematics, ‘competing’ in same first-year compulsory courses, one of them being a mathematics course.

The main finding of the paper is that, for these high-ability students, the estimated (human capital) benefit to an extra year of high school math is small: students coming

out of Grade 13 have a 2.2 point advantage (on a 100 point scale) over students from Grade 12, representing 17 percent of a standard deviation (σ) in mathematics performance. My within-sample investigation also suggests that the extra year of mathematics benefits lower-ability students more than higher-ability students.

The results are robust to changes in estimation technique or control group:

- All estimation strategies used in this paper (means comparison, differences-in-differences, OLS, or GMM) suggest that the value-added of Grade 13 is modest.

- I obtain very similar results when using chemistry instead of biology as control subject.

- The age difference between Grade 12 and Grade 13 students does not affect the estimate of the value-added of Grade 13.

- Grade 12 students did not drop out from mathematics courses more readily than Grade 13 students.

- Grade 12 students did not avoid mathematics-intensive programs – the program enrolment numbers are very similar.

- Grade 12 students' relative performance across subjects does not suggest any effort substitution.

These results have implications for the previous literature. First, the lack of human capital accumulation found in this paper can explain why previous studies only found modest or no monetary benefits to an extra year of mathematics. Second, the presence of heterogeneity supports the idea that the benefit to an extra year of mathematics could be larger for lower ability students – as suggested by previous studies for schooling in general.

The results also raise questions for public policy. The finding that high-ability students do not gain much from an extra year of mathematics raises an obvious question: why is there so little value-added? It is possible that high school teachers direct most of their effort toward lower-ability students, leaving high-ability students with fewer resources to acquire additional knowledge. Another possibility is that high-ability students, once in university, can make up for the missing year of mathematics ‘effortlessly.’ Understanding why high-ability students do not benefit much from an extra year of mathematics can lead to more informed decisions regarding the allocation of (scarce) high school resources. This issue warrants further investigation.