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The effects of class size on student grades at a public university

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Abstract

We model how class size affects the grade higher education students earn and we test the model using an ordinal logit with and without fixed effects on over 760,000 undergraduate observations from a northeastern public university. We find that class size negatively affects grades for a variety of specifications and subsets of the data, as well as for the whole data set from this school. The specifications tested hold constant for academic department, peer effects (relative ability in class), student ability, level of student, level of course, gender, minority status, and other factors. Average grade point declines as class size increases, precipitously up to class sizes of twenty, and more gradually but monotonically through larger class sizes. The evidence is that this is not exclusively a small class effect. We conclude that there are diseconomies of scale associated with a deterioration of student outcomes as class sizes grow larger. The cost of this deterioration is not quantifiable with our data, as much of the costs are non-market costs and unobservable. Future studies of economies of scale in higher education need to address the traditional assumption of constant product quality.

JEL classification: I21

Keywords: Economies of scale; Educational economics; Student performance; Logit analysis; Fixed effects models

1. Introduction

This present paper makes a contribution to understanding a major problem of resource allocation in the faculty staffing of classes in higher education. It has been observed that if faculty can teach larger class sizes with no adverse outcomes, then economies of scale may not always be utilized. If student outcomes are adversely affected by larger classes, then perhaps institutions are incurring diseconomies of scale (see Hancock, 1996).[1]

If they exist, economies of scale are a particularly attractive way to reduce costs at schools experiencing increasing demands for education and where

[1]Hancock noted that if the performance outcomes of students in different sized classes was indeed not class size dependent, and if the … learning experience is not demonstrably harmed by significant increases in enrollment caps, then it is certainly harmed by not increasing them. While Hancock admits that outcomes may be a function of size in some disciplines beyond statistics courses (the data Hancock used), he is properly concerned about expending resources in staffing unnecessary sections throughout higher education.

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the quality of the incoming students appears to be rising or steady.[2] Schools often look to spreading the costs of a faculty over more students by increasing class sizes or by increasing workload (number of courses taught per term). This latter method is resisted by faculty senates, unions, and often trustees, leaving the easier option of marginally increasing class size as a way to realize economies of scale. The pressure to achieve class size economies of scale is discussed in Nelson and Hevert (1992), Toth and Montagna (2002) and Moore (2003).

But the questions arises, is the education received in a large class the same as that in a small class? To bring further light on this question, we estimate the influence of class size on student achievement in higher education. We model grades as an output and test this model using a very large dataset from a medium-sized public research university.

Applying a logistic regression with and without a fixed effects model we find that class size is an important negative variable in predicting grades and that the functional form of the relationship is consistent with the theoretical model developed by Glass, Cahen, Smith, and Filby (1982) to explain the negative effect of class size on K-12 student performance. We explore several specifications, additional models, various proxies for a key variable (student ability), and how the effect of class size on grades differs for advance placement, at-risk, underrepresented and female undergraduates. We also test the results by academic department. In all cases we find class size negatively affects student grades. We conclude that any considerations of economies of scale must consider the scale effects on the quality of output. Schools that seek to reduce costs by increasing class sizes may need to take steps to train faculty or otherwise rectify poorer student outcomes and other diseconomies of scale.

2. Background

2.1. K-12 studies

By the 1970s there was near consensus in the educational research community that class size had little effect on student achievement.[3] However, Glass and Smith, in a series of articles beginning in the late 1970s (Glass, McGaw, & Smith, 1981; Glass & Smith, 1979; Smith & Glass, 1980) presented a theoretical model suggesting that the functional form of the relationship between class size and student achievement should be negatively sloped and concave.[4] This model has become a basis for further normative discussion on whether, or how, class sizes should vary.[5] Glass & Smith also presented the results of their own meta-analysis of studies looking at the effect of class size sustaining the negative logarithmic relationship between class size and student performance.[6] Given this apparently beneficial evidence of smaller class sizes, several states designed experiments to replicate Glass et al. (1982) findings.[7] In 2003, a number of

[2]Thus, we find concerns about graduation rates and the average time-to-degree performance of universities [NYS Executive Budget (2005–06),] the increasing use of part-time and non-tenure track faculty (Ehrenberg, 2004) and increasing tuition fees and corporate sponsorship (Rizzo, 2004).

[3]Student/pupil ratios in K-12 schools had been dropping since the 1950s without any marked increased in standardized test scores or other indicators of overall student performance, and the majority of the studies conducted at the classroom level showed either no or very modest affect of class size on student performance. The U.S. Department of Education reports that K-12 student teacher ratios fell from 26.9 in 1955 to 17.2 in 1998. Yet average class sizes remain at about 24. The increase in special education teachers is believed to be the principle reason for this apparent contradiction.

[4]The negative slope suggests that the ideal class size from the point of view of the student's learning is size one. The concavity suggests an optimal tradeoff might exist between the student and the school (society). If concave, the rate of fall off in student outcome decreases slowly at first, and then more rapidly. If the costs of providing student outcomes are typical, it may also decline per student as the numbers of students per class increase, but rapidly at first as the costs of facilities and faculty are distributed over more students, and less rapidly at larger number of students as marginal efficiencies diminish. Hence, there may be a societal optimum, assuming society bears the costs of education and receives its benefits, where the rate of diminution in outcomes equals the rate of diminution in per student costs.

[5]Lipman (1990), Kennedy and Siegfried (1996, 1997).

[6]Heavily weighting studies that they considered more experimental in design, and discounted those they considered non- or quasi-experimental, Glass et al. (1982) argued that the positive effect of smaller class sizes results from attitudinal changes in both teachers and students in that environment.

[7]The most extensive experiment was Tennessee's STAR project (Ritter & Boruch, 1999; Word et al., 1990). The results of the STAR Project showed that students scored better on 3rd grade standardized tests in math and reading if they had attended smaller sized kindergartens (Finn & Achilles, 1990, 1999; Krueger, 1999). Follow up studies showed that those students who continued in small classes beyond kindergarten did better than those that did not (Nye, Hedges, & Konstanopoulos, 1999) and that small classes seem to be most beneficial to those coming from disadvantaged backgrounds (Krueger & Whitmore, 2001; Slavin, 1990). Subsequently, the findings from the STAR program and more modest experiments elsewhere (Tillitski,