

Expanding Value-Added Models to Account for Teacher-by-Student Interactions
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Analyses of longitudinal student achievement data attempting to isolate teacher contributions to student learning have become more common as the requisite longitudinal data have become available with increased standardized testing. Longitudinal data can also provide an estimate of how each student would perform regardless of specific teacher assignments. This latent "general achievement" characteristic is often referred to as a student effect in the mixed model formulation for longitudinal data.

In many applications the student effects are nuisance parameters and are used only as a means to distinguish teacher effects from student inputs to learning. However, in this study we use these effects to explore an enhancement to the mixed model formulation of value-added models of teacher effects that allows teacher effects to depend on each student's general achievement level. Our models specify teacher effects using two parameters: one measuring the teacher's effect on a student of average ability, and another measuring how much a teacher effect varies linearly as a function of a student's general achievement level. Thus the model is capable of distinguishing, for example, two teachers who are equally effective with students of average ability, but differ because one teacher is particularly effective with students of below-average ability and the other particularly effective with students of above-average ability.

The main goals of our investigations are to test whether there appears to be non-negligible student-teacher interactions (an issue that has received only limited attention in the value-added literature), to estimate what fraction of the observed variability among teachers in their effects might be due to such interactions, and finally to use this information to quantify to what extent ignoring the interactions might lead to misleading inferences about teachers, taking into account empirical information about to what extent classrooms vary on the average ability levels of their students.

We are carrying out these investigations using two longitudinal achievement datasets. One consists of longitudinal math and reading achievement data from grades one to five for a cohort of about 9,300 students from a large urban school district. The other consists of longitudinal math, reading, science and social studies data from four cohorts of students in a different large urban school district. The comparisons of the two cases are interesting because of the different contexts, different assessments, and different grade levels that have differing degrees of tracking. We are estimating sequences of increasingly complex value-added models on these two datasets, culminating in the most complex model which allows for the student-teacher interactions described above. We are using Bayesian model specifications and using Bayesian model comparison statistics to demonstrate that the models that allow for interactions are more appropriate for the

data than all of the simpler alternatives. We will then summarize variance components and other parameters from the interaction model to carry out the tasks described above.