

Impediments to the estimation of teacher value added

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Estimation and interpretation issues

- Bias introduced by purposeful sorting by families, teachers, and principals
- Test measurement error
- Compensatory behavior by families
- Teacher time allocation and pedagogy decisions

Purposeful sorting by families, teachers, and principals

- Families and teachers choose communities, districts, and schools under constraints
- Principals and others in school match teachers and students in classroom
 - Tracking by student characteristics
 - Compensate weaker teachers with easier students
 - Reward favored teachers with easier students
- Subsequent allocation very different from random classroom assignment across all districts and schools

Empirical Model

Achievement _{$iGcsy$} (student i , grade G ,
classroom c , school s ,
year y)

= student _{iGy} (time varying skill-motivation)

+ family _{iGy} (family inputs)

+ peers _{$Gcsy$} (peer influences)

+ school _{$Gcsy$} (school inputs)

+ teacher _{$Gcsy$} (vector of fixed effects)

+ error _{$iGcsy$} (random component)

Cumulative nature of learning

- Student effect is a function of prior teacher, school, community, and family influences.
 - It is not fixed but rather varies over time
- Measures of lagged achievement account for pre-existing differences in students; might not fully account for “ability”

School and Peer Variables

- Variation across schools but also within schools across grades and classrooms
 - Class size; computers; curriculum
 - Degree of disruption; aspirations; peer pressure
- Fact that peer group and school quality vary at the classroom level complicates efforts to rank teacher value added even within schools

Peer influences

- Limited information with which to account for peer differences
- Unobservable differences likely to be very important and only weakly related to prior achievement
- teachers and classrooms are indistinguishable in many instances

Value added models

- Test score gain model
 - Assumes no knowledge depreciation
 - Violation of this assumption introduces bias if teacher quality in grade G correlated with quality in prior grades even with a student fixed effect
- Lagged achievement model
 - Prior score or scores included as regressors
 - No assumption about knowledge depreciation rate

Estimate of teacher fixed effect

- Teacher effect_c = teacher quality_c +
unobserved: peer quality_c + school quality_c +
random error_c

Assume error components orthogonal to
included variables

Estimate deviates from true value due to bias
and sampling error

Mitigation of influence of errors on variance estimates

- Use of multiple years of data for a teacher
 - Shrinkage estimators
 - Averaging
 - Include only persistent component of teacher fixed effects
 - Variance of teacher quality = variance of teacher fixed effects * year to year correlation of fixed effects for teachers

Remaining issues even with multiple random assignments

- Family efforts to compensate for ineffective teachers
- Teacher time inputs and therefore opportunity costs differ
- Teaching to the test may weaken link between test score and “meaningful” knowledge gains

Summary of Evidence

- Many studies estimate teacher fixed effects and find substantial variation
- Rothstein (2007) illustrates potential difficulty accounting for unobserved peer & student factors
- Rivkin et al (2005) estimates variance in teacher quality from link between cohort achievement differences and teacher turnover within a school
 - Estimate is typically smaller than those produced with classroom level data and teacher fixed effects
 - Consistent with concerns about sorting within schools

Application to large Texas District (Hanushek et al 2008)

- Divide schools on basis of whether students are “randomly” allocated to classrooms
- ANOVA Test for significant differences in pretest scores (Clotfelter et al)
- Chi square test for independent transitions among teachers across 2 grades

Estimation

- Compare estimates between lagged achievement and gains models
 - Score g regressed on score $g-1$
 - Score g minus score $g-1$ as dependent variable
 - Expect estimates of variance of teacher quality with gain model to be smaller in samples with nonrandom sorting that introduces link with prior teacher quality

Estimation

- Teacher by school by year fixed effects
 - Use actual teacher assignments in grade g
 - Alternatively, use teacher assignments in same school in grade $g+1$ as nullification test
- Demean by school-grade-year average fixed effect to estimate within variance
- Compute correlation of fixed effects across years to account for influence of sampling error

Table 1. Estimated Variance in Teacher Quality by type of Value Added Specification and presence of significant differences by classroom in mean pretest scores

Within School-Grade-Year Variation Only	No	No	Yes	Yes
Significant Difference in Mean pre-test Scores	Yes	No	Yes	No
1. Lagged Achievement Model				
variance in fixed effects	0.094	0.148	0.043	0.043
adjacent year correlation	0.426	0.279	0.490	0.297
variance in teacher quality	0.040	0.041	0.021	0.013
2. Test Score Gain Model				
variance in fixed effects	0.116	0.186	0.046	0.053
adjacent year correlation	0.204	0.152	0.371	0.338
variance in teacher quality	0.024	0.028	0.017	0.018
Observations	150k	75k	150k	75k

Table 2. Estimated Variance in Teacher Quality by type of Value Added Specification and presence of significant deviations from random in year to year classroom transitions

Within School-Grade-Year Variation Only	No	No	Yes	Yes
Reject Hypothesis of independent classroom allocation between years	Yes	No	Yes	No
1. Lagged Achievement Model				
variance in fixed effects	0.081	0.131	0.038	0.037
adjacent year correlation	0.431	0.295	0.405	0.293
variance in teacher quality	0.035	0.039	0.015	0.011
2. Test Score Gain Model				
variance in fixed effects	0.084	0.156	0.035	0.038
adjacent year correlation	0.279	0.199	0.270	0.290
variance in teacher quality	0.023	0.031	0.009	0.011
observations	68k	29k	68k	29k

Table 4. Estimated Variance in Teacher Quality for actual and subsequent grade teachers by type of Value Added Specification and presence of significant deviations from random in year to year classroom transitions

teacher timing	actual	next year	actual	next year
Within School-Grade-Year Variation Only	Yes	Yes	Yes	Yes
Reject Hypothesis of independent classroom allocation between years	Yes	Yes	No	No
1. Lagged Achievement Model				
variance in fixed effects	0.047	0.038	0.049	0.026
adjacent year correlation	0.460	0.218	0.326	0.033
variance in teacher quality	0.022	0.008	0.016	0.001