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Documentation for Value Added Scores

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NCTE Value-Added Model

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Overview

This document provides an overview of the process used for estimating a value-added model using NCTE math assessments for the three years of the study (2010-2011, 2011-2012, 2012-2013) and state math and ELA assessments using all available data through the three years of the NCTE study.[1]

Rosters

To create student math rosters for the value-added model, we use verified NCTE rosters for teachers participating in the three years of the NCTE study. We have verified NCTE rosters for both the fall and spring—we only include students in the spring roster period. For ELA rosters, and all other teachers and years, we use district rosters.[2]

District 11 and District 12 only provide one student roster file (near the end of year), but District 13 provides three different rosters, and District 14 provides four different rosters. For District 13 and District 14 we only include students in the final roster period.

Model

Then, using the rosters described above, we estimate the following student-level equation:

$$(1) \qquad a_{i,j,k,t} = A_{i,t-1}\alpha + S_{i,t}\beta + P_{j,k,t}\delta + E_{i,t}\rho + v_{i,j,k,t},$$

$$where\ v_{i,j,k,t} = \mu_k + \theta_{k,t} + \varepsilon_{i,j,k,t},$$

where the outcome of interest, $a_{i,j,k,t}$, is the test score for student *i* a member of class *j* taught by teacher *k* during school year *t*. Two sets of models will be run using the above student level equation:

1. In the first set $a_{i,j,k,t}$ will be a rank-based standardized state assessment (math or ELA) scale score.[3,4,5] The outcome test score is modeled as a function of the

[1] For all districts except District 14, this includes three years of data (2009-10, 2010-11, 2011-12, and 2012-13). For District 14, this includes four years of data (2008-09, 2009-10, 2010-11, 2011-12, and 2012-13). In District 13, for ELA, this includes two years of data (2011-12 and 2012-13).

[2] One consequence of this approach is that a small percentage of students appear to be in classrooms taught by teachers participating in the NCTE study, but they are not included in our NCTE rosters. These students cannot be included in our rosters or in the model.

[3] State test scores are ranked within a school year, test grade, and subject, and then each score is associated with a score derived from the normal distribution based on the rank. This standardization is relative to other

student's prior achievement on the standardized state assessment raw or scale score in the previous school year $A_{i,t-1}$.

2. In the second set $a_{i,j,k,t}$ will be the theta IRT values from the NCTE math assessment. The outcome test score is modeled as a function of the student's prior achievement on theta IRT values from NCTE math assessment in the previous semester $A_{i,t-1}$.[6]

In both sets of models, other observable characteristics of the student $S_{i,t}$ and their peers $P_{j,k,t}$ in class *j* and the school more generally are included for each of the different tests which are used to measure $a_{i,j,k,t}$. Also, fixed effects, $E_{i,t}$, for each of the different tests (in each grade and year) a student took are included. More detailed information is below.

- $A_{i,t-1}$, a vector of information regarding a student *i*'s prior achievement, includes:
    - $a_{i,t-1}$ student *i*'s test score in the same subject the previous school year for state test outcomes and previous semester for the NCTE assessment outcomes.
    - the square and cubic of $a_{i,t-1}$,
    - the interaction of $a_{i,t-1}$ and the grade level of that test, and
    - $a'_{i,t-1}$ student *i*'s test score in a different subject (e.g., reading when predicting math) the previous school year on the state test.[7,8]
- $S_{i,t}$, a vector of other observable characteristics of student *i* during school year *t*, includes indicator variables for:
    - modal, or the most recent year's value, gender,
    - modal, or the most recent year's value, racial or ethnic subgroup,

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students who took the same test within the district and is based on the student's scaled score for District 14 and District 13 and raw score for District 12 and District 11.

[4] In cases of test impropriety, scores are not included.

[5] For instances where students take a test multiple times in a year, we only include the test score of the appropriate test grade and the first instance of test-taking.

[6] In the case of District 14 in year 1, the state standardized state math scale score will be used instead of the first semester theta IRT values from the NCTE math assessment. The NCTE math assessment was not administered in District 14 in the fall of year 1.

[7] If a student is missing data for prior tests in subjects not being predicted, we impute the score as 0, and include an indicator variable to identify such cases.

[8] From data provided by districts, the alternate subject of math is "ELA" for District 12, District 14, and District 11, and is "Reading" for District 13.

- free or reduced price lunch program participation,
- ELL indicator, and
- special education indicator.

- $P_{j,k,t}$, a vector of observable characteristics of student *i*'s peers in class *j* and peers in the same grade-level at the student's school, included separately for class *j* and the school grade-level cohort[9]:
  - the means of the elements of $S_{i,t}$,
  - the means of $a_{i,t-1}$ and $a'_{i,t-1}$,
  - the proportion of peers who are missing test scores for $a_{i,t-1}$ and $a'_{i,t-1}$, and
  - the number of students in class *j* and the number of students in the school grade-level cohort.

Sample

Our analysis sample is constrained by the availability of required data, analytic choices to improve the estimation process, and other choices to aid interpretation of the results. As implied above, sample selection rules will depend on data availability and the intended use of the results. In general, however, we *include* student-by-year observations *i* (and the associated classes *j* and teachers *k*) when:

- $a_{i,j,k,t}$, $a_{i,t-1}$, and all of $S_{i,t}$ are non-missing,
- we can identify *one* class *j* (and *one* teacher *k*) in which the student *i* received instruction in the math or ELA measured on the outcome test $a_{i,j,k,t}$.[10, 11]
- the percentage of students in class *j* missing $a_{i,t-1}$ is less than 50%,
- the class *j* is not composed of more than 50% special education students,
- the test grade of $a_{i,j,k,t}$ is exactly one grade higher than the test grade of $a_{i,t-1}$ for state tests, and the test grade of $a_{i,j,k,t}$ is the same exact grade than the test grade of $a_{i,t-1}$ for NCTE tests, and[12]

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[9] For students who do not have roster grades due to masked data, we utilize their test grades.

[10] In District 13 dosage information is provided and we only include students with only one teacher with a dosage of 50% or greater in the final roster period.

[11] Students in multiple schools or in multiple classrooms are removed from the estimation sample, except in the case where a student is taught by the teacher in multiple classrooms. For these unique cases, we randomly assign the student a classroom. .

- the class *j* includes at least five students for whom the first five bullet points are true.

Estimation

We use Hierarchal Linear Modeling (HLM) (or Linear Mixed Models) to estimate Equation 1 with nested random effects, μ_k and $\theta_{k,t}$, for each teacher *k* in school year *t*. All districts are included at the same time using district fixed effects. For the state assessments, we estimate one model for the full sample (all available years) and also separate models for individual years (where the classroom—or teacher-by-year—random effect is removed). For the NCTE assessments, we also estimate one model for the full sample (2010-11, 2011-12, 2012-13), and a separate model for individual years removing the classroom—or teacher-by-year—random effect.

HLM provides empirical Bayes estimates of the teacher random effects, $\hat{\mu}_k$, that are the best linear unbiased predictions. These empirical Bayes estimates are "shrunken" estimates, which account for differences in the reliability of the estimates from teacher to teacher by shrinking less reliable estimates toward the mean (Raudenbush & Bryk (2002)). This shrinkage reduces random error that is associated with the class- and student-levels, including error due to small samples of students. Besides interpreting the estimates of γ, as discussed above, we can study the relationship between teachers' effects estimates, $\hat{\mu}_k$, and other variables directly.

[12] If students were in the NCTE sample for two years of the study or more, students must also have a test grade for $a_{i,j,k,t}$ exactly one grade higher than their test grade of $a_{i,t-1.}$.