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Teacher and Student Characteristics as Determinants of Success in High School Economics Classes

I. Introduction

Teaching effectiveness and student achievement have been the subjects of extensive research as well as policies at the federal, state, and local levels. However, identifying and quantifying the factors that underlie high teacher quality and successful educational outcomes has proven to be challenging and has generated divergent results. Moreover, the relative roles of student and teacher characteristics as determinants of student success are not well known and are a source of ongoing debate in the education literature. In this paper, we assess teacher and student characteristics that affect success in high school economics classes, using a value-added approach and fixed- and random- effects statistical procedures. The data are from a special survey of California high school economics teachers conducted by the Federal Reserve Bank of San Francisco ("San Francisco Fed") and outside researchers in 2006, aimed at assessing the effectiveness of a video curriculum program developed by the San Francisco Fed. The survey produced value-added outcome data for nearly 1000 students in 48 matched-pair classes taught by 24 teachers. Our experimental design enables us to explicitly model observed and unobserved teacher effects in addition to observable student and class characteristics, and also to differentiate between two different assessment methods for which we obtained pre- and post-test outcomes: multiple choice questions and an essay question.

We begin with a review of the education literature focusing on determinants of teacher quality, followed by a review of the economic education literature focusing on teacher effects and student effects on learning economics in high schools. After describing our data, we present our methodological framework and results. Our results indicate that student characteristics including own GPA and peer GPA had the largest effects on scores in our value-added models. The impacts of teacher characteristics such as experience teaching economics and formal education in economics were also significant and nearly as large as the impacts of student characteristics, although the effects of formal economics education varied across the different assessment methods.

II. LITERATURE REVIEW

II.A. Education literature

Teacher quality, as defined by the contribution of teachers to student achievement, has been shown in a number of recent studies to play a significant role in student-related outcomes (Hanushek and Rivkin, 2010; Kane et al., 2010.) However, identifying and measuring teacher quality has proved to be challenging, because observable characteristics such as attainment of advanced degrees, years of teaching experience, certification, and ongoing professional development have not consistently explained variations in teacher quality (Rivkin et al., 2005; Rockoff, 2004). Conflicting results on factors affecting teacher quality are often attributed to issues with methodology and data (Kane et al., 2010; Rothstein, 2010).

As discussed by Harris and Sass (2007), findings on the impact of observable teacher characteristics on student achievement are mixed, with some studies showing positive effects for elementary and middle school math but not for reading. At the high school level, a number of studies have found positive effects for teacher training in content-specific areas but not for formal education, including the attainment of advanced degrees. For example, Aaronson, et al. (2007) and Betts et al. (2003) investigated the effects of teachers' college major and find no systematic impact on student achievement in high school. Surprisingly, Harris and Sass (2007) found that teachers with majors in math or math education are less productive in the teaching of high school math than teachers who lack such background. Similarly, in their sample of 9th and 10th grade end-of-course test scores from North Carolina panel data, Clotfelter et al.(2007) found a small positive effect on student outcomes for teachers holding a master's degree and an unexpected and surprisingly large negative effect for teachers with a Ph.D (based on a very small number of teachers who have a Ph.D in their sample.)

In contrast to the ambiguous effects of formal education, one of the most consistent factors affecting teacher quality at both the elementary and high school level is years of teaching experience (Clotfelter et al., 2007; Harris and Sass, 2007; Rivkin et.al. 2005; and Rice, 2010). However, the impact of teaching experience begins to taper off after the first year and by the fourth or fifth year does not appreciably impact teacher quality (Boyd et al., 2008; Clotfelter, et al. 2007; Rice, 2010). Harris and Sass (2007) utilized panel data matching students and teachers to specific classrooms to estimate the effects of teacher education and training, distinguishing between specific types of undergraduate coursework and differentiating between different types of professional development training. Their results indicated generally positive but mixed effects for years of experience but no significant effects for obtaining an advanced degree. These findings corroborate results from a number of other studies (Rice, 2010).

Some studies also find large effects of teacher credentials. For example, Clotfelter, et al. (2007) found in their study utilizing end-of-course test scores, that the effects of teacher credentials are larger than the effects of student characteristics. Similarly, Harris and Sass (2007) found that professional development in the form of content-specific training had a positive effect on student achievement. In another recent study, Subedi et al. (2010) utilized middle school gain scores in mathematics from a single school district to study the effects of teacher experience and training. They found significant positive effects for content certification in mathematics and teaching experience.

II.B. Economic education literature

The economic education literature investigates teacher effects, student effects, and other effects related to schools, materials, curriculum and policies that affect achievement in high school economics classes. Watts (2005) summarized much of the existing empirical research on pre-college economic education, focusing on studies published since 1990. His major conclusions, as reiterated in Watts and Walstad (2011), are that there are three key factors influencing student learning of economics in high schools:

1. Students who take a separate class in economics and therefore spend more time on economics learn more than students who study economics infused into other subjects.

2. Teacher knowledge of economics and teacher training in economics affect student learning of economics. Unfortunately, many precollege economics teachers lack formal training in economics.

3. Instructional materials with good economics content and presented with interesting instructional methods are important for student learning of economics. However, no consistent evidence favors specific materials or teaching methods.

To determine why some teachers are more effective than others, in a 1990 study Bosshardt and Watts investigated teacher effects on student learning in high school economics classes using fixed- and random-effects models. The teacher effects they examined included college credits in economics, non-credit workshops in economics, years of teaching experience, and how much economics the teacher was teaching. They found that the most effective teachers were those who had completed more courses in economics. Other significant factors included a proxy for student IQ and school characteristics.

Walstad (2001) also found that teachers who take more courses in economics are more effective in teaching economics and identified five to six courses as a critical threshold level.

Overall, teacher characteristics other than coursework in economics show inconsistent or insignificant results on student learning in various studies. These include completion of non-credit workshops, years of teaching experience, years since the last economics course was taken, and percentage of teaching load that is economics (Walstad 1992.)

With respect to student effects, higher student aptitude or intelligence is consistently found to be correlated with greater learning in economics (Watts 2005.) Related to this, prior knowledge or ability captured by a pretest score is often the single most important variable in explaining student achievement. Students in higher level courses such as Advanced Placement (AP) courses outperform students in non-AP courses (Butters and Asarta, forthcoming.) Other student characteristics often related to economics knowledge and learning in high schools include student gender and race or ethnicity, with males outperforming females and whites outperforming other races. The gender effect is generally larger and more often significant than race or ethnicity. Further, teacher attitudes toward economics are found to affect student attitudes and student attitudes are found to affect student learning, although the direction of causality between student attitudes and student learning is not definitive (Watts 2005.)

III. DATA

The data used in this paper were collected as part of a project to assess the effectiveness of a video curriculum program developed by the Federal Reserve Bank of San Francisco for use in high schools. *Open and Operating: the Federal Reserve Responds to September 11* is a video designed to inform the public about the role the central bank can play in responding to a crisis. The title refers to the Fed's press release of September 11, 2001 following the terrorist attacks: "The Federal Reserve is open and operating. The discount window is available to meet liquidity needs." The 16-minute video describes the background and functions of the Federal Reserve System, monetary policy, how the central bank's responsibilities have evolved over time, and how the Fed responded to the September 11 crisis. The Public Information Department of the San Francisco Fed also designed an accompanying curriculum guide for use in high schools. The guide provides a detailed lesson plan that is divided into three sections: an introduction with visuals, instructions for viewing the video using student handouts, and a follow-up poster activity using graphic organizers. The guide relates the concepts covered in the curriculum to the Voluntary National Content Standards in Economics (NCEE 2000.)

Economics teachers at all (approximately 1000) public high schools in California were invited to take part in the assessment project during spring 2006. California has a large and ethnically diverse student population, and a semester course in economics has been required for high school graduation since 1989. In order to introduce strong controls into the data, we sought teachers who were teaching two economics classes at a similar student ability level (Advanced Placement, honors or college prep, non-college bound, mixed) during fall 2006. One class would serve as the experimental class using the *Open and Operating* (O&O) curriculum and the other as the control class. In the control class, teachers would teach about monetary policy and the central bank in their traditional manner, allocating equal amounts of time to the topics in both classes. Teachers were asked to administer pre- and post-tests for 20 multiple choice questions and an essay question, along with student questionnaires, and to complete a teacher questionnaire. If all materials were returned, teachers would receive a $250 consulting fee for their participation.

Sixty-two teachers responded that they were scheduled to teach two similar economics classes during fall 2006 and that they were willing to participate in the study. Materials were sent in early September and teachers were instructed to randomly assign one class to be the experimental class and one class to be the control class. Forty-three teachers returned some materials and 24 returned the complete sets of materials used in this study.[1] Between 1047 - 1290 students of the 24 teachers returned some information, with 982 returning complete information used in the regression analysis of multiple choice scores and 963 for the essay scores. **Table I** reports definitions of variables and descriptive statistics. Post-test multiple choice and essay scores serve as dependent variables in the regression analysis, controlling for pre-test scores. Student characteristics, class characteristics, and teacher characteristics are also included.

The pre- and post-tests administered to students were developed for use in this study, since no valid, normed, and reliable instrument such as the *Test of Economic Literacy (TEL)* (Walstad and Rebeck 2001) exists relating to the concepts covered in the O&O curriculum. The resulting pre- and post-tests consist of 20 multiple-choice questions and one free-response essay question. The multiple choice questions were taken from existing instruments such as the *TEL* where appropriate. The essay question asks students to write one or two paragraphs (as if for a newspaper) about how the Federal Reserve System could respond to a situation such as high inflation, unemployment, a banking panic or other crisis.

IV. REGRESSION FRAMEWORK AND RESULTS

IV. A. Regression specification

Our analysis starts from the well-established value-added approach for estimating the contributions of student, teacher, and classroom characteristics to educational outcomes (see e.g.

[1] Teaching assignments for some of the original 62 teachers changed so that they were no longer teaching two similar classes and could no longer participate in the study. Some teachers did not require their students to complete all assessment activities or otherwise returned data that were not usable.

Rivkin et al. 2005, Kane et al. 2010, Rothstein 2010). Pre-tests and post-tests were administered to participating students in our sample of California high school economics courses before and after they completed the unit on monetary policy and central banking, so our experimental design fits well within the value-added framework. Moreover, our matched experimental sample and ability to model individual teacher effects helps us to overcome some common concerns about the influence of unobservables in the estimation of education production functions.

We begin with a value-added equation of the following form:

$$A_{ijk} = \alpha_0 + \alpha_1 A^0_{ijk} + \beta_1 C_j + \beta_2 S_{ijk} + \mu_j + \varepsilon_{ijk} \qquad (1)$$

This equation specifies that the achievement outcome *A* (multiple choice or essay test score) of student *i* in classroom *j* taught by teacher *k* depends on the student's pre-test score A^0 (which represents individual ability and cumulative educational inputs prior to the experiment), plus vectors of classroom instructional characteristics C, individual student characteristics S, and teacher effects μ_j.[2] The α and β terms are coefficients to be estimated, and ε_{ij} is an error term that has zero mean conditional on the right-hand side variables. Equation (1) does not attempt to pin down the sources of the teacher-specific contribution to student achievement, but instead models these effects as unobserved intercept shifts (fixed effects) or as a teacher-specific component of variance in the error term (random effects). After estimating this equation using the fixed-effects and random-effects estimators, we implemented standard tests of the alternative models.

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[2] A common alternative approach estimates determinants of the "gain score" by moving the pre-test score to the left-hand side and using the score change as the dependent variable. This specification is equivalent to restricting the coefficient on the pre-test score in (1) to be equal to 1. This restriction is strongly rejected in our empirical results reported in Tables II and III.

Acceptance of the null hypothesis of random effects implies that the unobserved teacher effects are uncorrelated with the other variables (classroom and student) in the model, implying in turn that we can obtain unbiased estimates of the coefficients on A^r, C, and S along with the coefficients on a set of explicit teacher variables, or *Tj* in equation (2) below:[3]

$$A^s_{ijk} = \lambda_0 + \lambda_1 A^r_{ijk} + \gamma_1 C_j + \gamma_2 S_{ijk} + \gamma_3 T_j + \eta_{ijk} \qquad (2)$$

We estimate equations (1) and (2) and apply specification tests for the multiple choice and essay test outcomes. The multiple choice scores range from 0 to 20, and their distribution has nearly equivalent mean and variance. We investigated use of a Poisson regression model, which often has attractive properties for estimating models based on count data such as our multiple choice test score. Our specification checks indicated that the Poisson and linear models yield similar point estimates, but the linear model is more efficient (generates more precise estimates) in our specific setting. We therefore use the linear model for the analysis of the multiple choice outcomes.[4] The essay question scores range from 0 to 3, lending themselves naturally to an ordered response model; we use an ordered logit model for the results reported in the next sub-section.

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[3] Rejection of the fixed-effects specification in favor of random effects implies that observable characteristics of classrooms and students are assigned randomly among teachers (no sorting). We are unable to account for unobserved student-specific effects (e.g., Rothstein 2010) and hence are unable to test for sorting based on these characteristics, but we are able to incorporate measures of student achievement more generally (GPA) and attitudes towards economics.

[4] Burnett and La Croix (2010) also analyzed a 20-question exam for high school economics students using an OLS model and an alternative model for count data, the negative binomial; their results are nearly identical across the two specifications.

IV.B. Regression Results

Table II lists regression results for four different specifications of the multiple choice model. The listing of control variables is organized into the groups defined in equations (1) and (2). We list the coefficient on the pre-test score first. The first group of variables are all indicator (dummy) variables that capture fixed classroom characteristics, including measures of whether the class received the Fed "Open and Operating" instructional materials ("experimental class"), whether the teacher reported spending more time on the monetary policy material for the experimental class, and three class levels.[5] The next group contains student characteristics including gender, race and ethnicity, self-reported high school grade point average, parents' education, the student's attitude toward studying economics, and the average GPA for all other students in the class. The final group contains teacher characteristics including years of teaching experience, years of experience teaching economics, gender, whether the teacher has an undergraduate major or minor in economics, and whether the teacher has an advanced degree in economics or another area. For both variables measuring years taught, we also incorporate splines that allow for the possibility that early years of experience (five or fewer) are the most valuable in regard to improving student outcomes. These teacher characteristics are only included in Columns 3 and 4, as explained below.

The regressions reported in Table II are based on random effects in columns 1, 3, and 4 and fixed effects in column 2. Each of these accounts for a teacher-specific component to the error structure. The random effects (RE) specification incorporates a teacher-specific random component, which is assumed to be uncorrelated with the other variables in the model. By contrast, the fixed effects (FE) specification is equivalent to a model that includes a dummy

[5] Two teachers reported spending more time on the Fed module in the experimental class than in the control class, despite instructions to spend equal amounts of time.

variable for every teacher and as such accounts for correlation between teacher-specific factors and the other variables in the model (and hence precludes the inclusion of any observable teacher variables).

Columns 1 and 2 are reported primarily for specification testing. Column 1 is the basic RE specification without any teacher variables, to match the FE specification in Column 2. The coefficients are nearly identical across Columns 1 and 2. The formal Hausman test statistic for the null hypothesis of random effects is negative; in conjunction with point estimates that are very similar across the two columns, this implies that the null cannot be rejected at any significance level, hence statistical equivalence of the results across Columns 1 and 2.[6] This equivalence means that we can parameterize the teacher effects directly using observable teacher characteristics, without concern that the other coefficients are biased by unobservable teacher effects.

Column 3 lists the results for the RE specification with a group of explicit teacher variables.[7] We focus here on a subset of key student and teacher characteristics (their relative magnitudes are discussed in the next sub-section). The coefficient on the pre-test score is positive and significant, indicating that students who start from a higher baseline achieve higher final scores. However, this coefficient is substantially smaller than one, indicating that the size of the typical gain declines with the level of the pre-test score (conditional on the other covariates). Students in the experimental classes that received the Fed "Open and Operating"

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[6] The test statistic is -13.9 (d.f.=12). The negative value implies that the underlying assumptions of the Hausman test are not met, because the FE estimator achieves lower variance than does the RE estimator. This can be seen in Table II, where the standard errors are in some cases lower for the FE estimates in column (2) than the RE estimates in column (1).

[7] An alternative approach to the assessment of teacher effects would rely on a regression of the teacher fixed effects (estimated from the column 2 specification) on observable teacher characteristics (see e.g. Bosshardt and Watts 1990). In our data this approach generates point estimates for the teacher variables that are similar to those reported in columns 3 and 4, but with much larger standard errors, indicating that it is a less efficient estimator.

instructional materials recorded higher post-test scores (conditional on pre-test scores) than did the students in the control classes, with an effect that is significant at just under the 5% level (p-value=.061); this largely replicates the key finding of Lopus and Hoff (2009), with slightly lower statistical precision reflecting the expanded set of control variables used here.[8] Several student characteristics also have large and statistically significant effects on post-test scores, most notably their high school GPAs, peer GPA, and self-reported attitude towards economics (which is likely a proxy for their expected performance or studying intensity for the course). These findings are consistent with prior results in economic education (e.g. Watts 2005.) The results for the teacher characteristics indicate that years of experience teaching economics significantly increases achievement gains for the typical student, with a very large effect estimated for the first five years of experience.[9] This is consistent with a number of studies cited earlier (Harris and Sass, 2007; Boyd et al., 2008; Clotfelter, et al. 2007; Rice, 2010) The indicator for whether or not the teacher has an undergraduate major or minor in economics has a positive but insignificant effect on the multiple choice outcome.

Column (4) is identical to column (3) except for the exclusion of peer GPA from the equation. The key results are similar across the columns, except that the impact of the teacher's undergraduate economics training is substantially strengthened in column (4), increasing in size and becoming highly significant, at nearly the 1% level (p-value=.014).[10] This is consistent with

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[8] Students in classes taught by the two teachers who reported spending more time on the monetary policy material in the experimental (Fed materials) class experienced significantly larger increases in their test scores, as reflected by the significant positive coefficient on the "more time" variable. However, this was similar in the experimental and non-experimental classes—the coefficient on the interaction between the "more time" and experimental class indicators is essentially zero—suggesting that these teachers varied their teaching intensity to a similar degree in both classes that they taught.

[9] The full effect of experience for a teacher with fewer than five years of experience is the sum of the coefficients on the "years" and "spline" variables.

[10] The coefficients on the class-level indicators also change substantially between columns 3 and 4, indicating a high correlation between average class GPA and class level.

Walstad's (2001) findings that teacher completion of additional courses in economics improves student performance in economics courses. However, the sensitivity of this result to the inclusion of class GPA is consistent with systematic sorting of high-achieving students into classes based on observable teacher background characteristics (which in turn may reflect unmeasured instructional characteristics); alternatively, this pattern could reflect the influence of bias arising from the small number of teachers and classes in our sample.

Table III lists results for the ordered logit model of essay test scores, with a four-column structure that parallels Table II. RE and FE estimators and a corresponding Hausman test are not feasible for the ordered logit model, so in columns 1 and 2 we list results for the basic model and a similar specification that includes an explicit set of teacher dummies (coefficients not reported). The estimated coefficients are once again very similar across columns 1 and 2, particularly for coefficients estimated with high degrees of precision (e.g., own GPA, parents' education), suggesting that observed and unobserved teacher effects are not significantly correlated with the other variables in the model. The primary exception is the coefficient on peer GPA, which declines substantially in size and statistical precision when teacher dummies are included. As with the multiple choice results in columns 3 and 4 of Table II, this is consistent with a tendency for high-achieving students to be sorted into classrooms taught by teachers with favorable characteristics.

Turning to the full model in column 3, the results are similar to the multiple choice models in regard to the important effects of students' own and peer GPA. In addition, essay scores improve with parents' educational attainment, whereas this variable did not significantly affect the multiple choice scores in Table II. Among teacher characteristics, the number of years teaching economics significantly enhances student achievement, particularly for teachers with five or fewer years of experience, similar to the results for the multiple choice outcomes. The estimated effect of an undergraduate degree in economics is negative and significant, but this is more than offset by a positive and significant effect of a graduate degree in economics. This finding is consistent with the notion that in regard to teaching how to structure a logical argument in the field of economics, advanced training in economics is required (in contrast with the more rote understanding reflected in multiple choice scores). We note that the negative effect of undergraduate economics training (relative to individuals with neither undergraduate nor graduate training in economics) is surprising but is broadly consistent with the finding of Clotfelter et al. (2007) regarding the negative effects of teachers holding a Ph.D for student outcomes in end-of-course tests at the secondary level.[11] Column 4 excludes the peer GPA variable and produces results that are similar to column 3, except that the relative impacts of years teaching economics and possessing a graduate degree in economics both increase.

IV.C. Assessing the magnitudes of class, teacher, and student contributions to learning

The regression results discussed in the previous section identified significant effects for all three categories of inputs in the educational process. In this section, we assess the relative magnitudes of some key effects. Because the variables differ in their dimensions and scale, we translated them into consistent and comparable scales for evaluating the magnitude of their effects. The resulting magnitude calculation is straightforward for the multiple choice models because each coefficient represents the effect of a one-unit change in the variable on the numerical score. For the ordered logit model, the coefficients require a transformation into probability space, which relies on the estimated coefficients in conjunction with the estimated

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[11] These surprising findings for teachers' formal educational attainment raise potentially interesting questions for future research, regarding the level of specialized education that is best-suited for particular content and assessment methods in secondary education.

constants; the latter are different for each outcome category in the model (see Wooldridge 2002, section 15.10.1, for details).

Table IV lists the results, which are based on the estimated coefficients listed in column 3 of Tables II and III; we also report the magnitude estimate for the coefficient on the undergraduate major/minor variable from column 4 in Table III (for which peer GPA is excluded). For each variable listed, we indicate the unit of change assessed (a change of 1 for dummy variables, one standard deviation for other variables) and the calculated effect on the outcome. For the multiple choice models in Panel A, the effect is in terms of the numerical score. For the essay models, the effects in Panel B of Table IV are calculated as the percentage point increase in the probability of receiving a score of 2 rather than 0. These effects on essay scores are most meaningful by comparison with the shares of students who earned those scores: (20.5% scored a 2, and 34.5% scored a 0).

The results in Table IV indicate that students' own and peer GPA have the largest effects on achievement: a one standard deviation increase in either of these measures raises the multiple choice score by nearly a point and raises the probability of receiving an essay score of 2 (rather than 0) by about 9 percentage points; this latter effect is quite large relative to the 20.5 percent sample incidence of this score. The Fed instructional materials raised multiple choice scores by about one-half as much as a standard deviation variation in own or peer GPA. The effects of a standard deviation increase in years teaching economics (about 8 years) are about one-half to three-quarters the size of the effects of the GPA variables.[12] Using the model that excludes peer effects, multiple choice scores are raised almost as much by the teacher holding an undergraduate degree in economics as by a standard deviation variation in the GPA variables.

[12] We did not include the spline for fewer than five years for this calculation, because only a small share of our sample falls in this category.

Teachers who hold an advanced degree in economics raise essay scores by about the same amount as a standard deviation variation in the GPA variables, but teachers who hold an undergraduate degree in economics generate lower test scores than do teachers who do not hold an economics degree.

V. CONCLUSIONS

Using results of a special survey that was administered in 2006 to about 1000 high school economics students in California, we investigated the factors that contributed to outcome improvement on multiple-choice and essay tests, relying on a standard value-added framework. We focused primarily on the contributions of student characteristics such as GPA and teacher qualifications such as years teaching economics and specialized education in economics. Our results suggested that teacher and student characteristics are generally uncorrelated in our sample, indicating that we can obtain unbiased estimates of the effects of the full range of student and teacher characteristics in our data. The primary exception is peer GPA, which appears to be systematically related to observed and unobserved teacher characteristics, which suggests sorting of high-ability students into classes taught by teachers with favorable characteristics. Students' own and peer GPA had the largest effects on scores in our value-added models. Teacher characteristics such as years teaching economics and specialized education had somewhat smaller but still substantial effects, with their contribution varying across specifications and outcomes: holding an undergraduate degree in economics raises multiple choice scores in a model that excludes peer effects, and holding a graduate degree in economics substantially raises essay scores. This latter result suggests that advanced education may provide important knowledge that is particularly valuable for imparting reasoning skills rather than enhancing rote learning.

Our results are based on a relatively small sample of classrooms and teachers and are restricted to instruction in economics. As such, they may not generalize beyond our limited sample. However, the apparent value of specialized teacher experience and targeted teacher training for specialized or advanced material is a topic that is worthy of further research in other settings, particularly at the high school level.

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Table I: Variable Definitions and Descriptive Statistics
(multiple choice sample; 982 students, 24 teachers)

Variable	Definition	Mean or sample share	Standard deviation
Test scores:			
Pre-test multiple choice	Number correct on multiple choice pretest (0-20, max. 15)	8.05	2.58
Post-test multiple choice	Number correct on multiple choice post-test (0-20, max. 20)	12.92	3.38
Pre-test essay	Score on essay pretest (0-3, max. 3)	0.21	0.49
Post-test essay	Score on essay post-test (0-3, max. 3)	1.05	0.96
Student characteristics:			
Female	Indicator that student is female	0.49	0.50
Race/ethnicity: White	Non-hispanic white	0.43	0.49
Asian	Asian or Pacific Islander	0.16	0.36
Black	Black/African American	0.04	0.20
Hispanic	Latin American/Hispanic/Chicano	0.20	0.40
Mixed race/ethnicity	Native American/other non-white	0.18	0.38
High school GPA (own)	High school GPA (self-reported)	3.11	0.59
Average GPA (peers)	Average GPA of peers (same class, in regression sample)	3.11	0.31
Parents' education	Education of parent with highest attainment (6 categories: <HS, HS deg, some college, 2-yr deg, 4-yr deg, grad deg)	3.87	1.62
Attitude toward econ: Excited	Econ likely to be a favorite subject	0.06	--
Indifferent	OK but not likely to be favorite subject	0.67	--
Don't like	Expect to be among least favorite subjects	0.27	--
Class characteristics			
Experimental class	Indicator for experimental class (used O&O curriculum)	0.5	--
More time in exp class	Indicator that teacher reported spending more time on Fed and monetary policy in the experimental class	0.08	--

(continued)

Table I (continued)

Variable	**Definition**	**Mean or sample share**	**Standard deviation**
Class level indicators: Mixed	Class level is mixed	0.63	--
Non-college	Class level is for non-college bound students	0.04	--
College prep	Class level is college-preparatory	0.25	--
Advanced placement	Class is level Advanced Placement	0.08	--
Teacher characteristics			
Years teaching econ	Number of years experience teaching economics	12.67	7.85
% < 5 years		0.21	0.41
Years teaching	Number of years teaching experience	19.21	10.93
% < 5 years		0.13	0.34
Female	Indicator that sex of teacher is female	0.29	0.46
Undergrad econ major or minor	Indicator that teacher had an undergraduate major or minor in economics	0.33	0.48
Advanced degree (econ)	Indicator that teacher has an advanced degree in economics	0.13	0.34
Advanced degree (other)	Indicator that teacher has an advanced degree other than economics	0.54	0.51

Note: Means calculated for the sample used for the regression analysis of multiple choice outcomes (see Table II); essay test scores based on a slightly smaller sample (963 students). Number of classes is 48 (2 classes per teacher, experimental/non paired at same level).

Table II: Multiple Choice Regression Results (scores = 0 to 20)
(linear regression model)

VARIABLES (by category)	(1) Teacher Random Effects	(2) Teacher Fixed Effects	(3) RE (with teacher variables)	(4) (3) without peer GPA
Pre-test score	0.282**	0.292**	0.249**	0.257**
	(0.0345)	(0.0345)	(0.0372)	(0.0376)
Class characteristics				
Experimental class	0.412*	0.411*	0.345	0.360
	(0.163)	(0.161)	(0.184)	(0.186)
More time in exp class	--	--	1.199*	1.010
			(0.536)	(0.541)
(Exp class) x (more time)	--	--	-0.123	-0.0142
			(0.650)	(0.656)
Class level: non-college	--	--	0.962	-0.0749
			(0.692)	(0.663)
Class level: college prep	--	--	-0.458	0.0650
			(0.257)	(0.234)
Class level: AP	--	--	-0.664	0.726
			(0.539)	(0.455)
Student characteristics				
Female	-0.328*	-0.310	-0.318	-0.347
	(0.165)	(0.163)	(0.180)	(0.181)
Asian	-0.453	-0.472	-0.477	-0.465
	(0.274)	(0.278)	(0.279)	(0.282)
Black	-0.701	-0.636	-1.257**	-1.259**
	(0.432)	(0.432)	(0.463)	(0.468)
Hispanic	-0.943**	-0.860**	-1.538**	-1.727**
	(0.270)	(0.273)	(0.279)	(0.279)
Mixed race/ethnicity	-0.393	-0.398	-0.525*	-0.516*
	(0.238)	(0.237)	(0.254)	(0.256)
High school GPA (own)	1.429**	1.439**	1.368**	1.497**
	(0.164)	(0.165)	(0.178)	(0.178)
Average GPA (peers)	1.976**	2.032**	2.271**	--
	(0.521)	(0.787)	(0.483)	
Parents' education	0.0736	0.0674	0.110	0.130*
(numbered 1-6)	(0.0575)	(0.0571)	(0.0625)	(0.0630)
Attitude toward econ	0.537**	0.504**	0.596**	0.635**
(3 categories, neg. to pos.)	(0.155)	(0.154)	(0.167)	(0.169)

(continued)

Table II (continued)

VARIABLES (by category)	(1) Teacher Random Effects	(2) Teacher Fixed Effects	(3) RE (with teacher variables)	(4) (3) without peer GPA
Teacher characteristics				
Years teaching econ	--	--	0.0723**	0.0812**
			(0.0172)	(0.0173)
Spline (years teach econ<5)			0.346**	0.223*
			(0.0963)	(0.0937)
Years teaching	--	--	-0.0554**	-0.0543**
			(0.0138)	(0.0140)
Spline (years teach<5)			-0.0941	-0.0576
			(0.0993)	(0.100)
Female	--	--	-0.0352	0.131
			(0.243)	(0.243)
Undergrad econ	--	--	0.409	0.681*
(major or minor)			(0.280)	(0.277)
Advanced degree (econ)	--	--	0.00176	0.591
			(0.357)	(0.337)
Advance degree (other)	--	--	-0.0249	0.500
			(0.330)	(0.314)
Constant	-1.174	-1.315	-1.837	3.901**
	(1.684)	(2.561)	(1.422)	(0.738)
Observations	982	982	982	982
Number of teachers	24	24	24	24

Note: Teacher effects treated as random effects (columns 1 and 3-4) or fixed effects (column 2).
Standard errors in parentheses.
** p<0.01, * p<0.05

Table III: Essay Test Regression Results (scores = 0 to 3)
(ordered logit model)

VARIABLES (by category)	(1) No teacher effects	(2) Teacher dummies	(3) With teacher variables	(4) (3) without peer GPA
Pre-test score	0.706**	0.583**	0.712**	0.702**
	(0.136)	(0.145)	(0.139)	(0.138)
Class characteristics				
Experimental class	0.116	0.113	0.143	0.140
	(0.123)	(0.127)	(0.130)	(0.129)
More time in exp class			1.221**	0.981**
			(0.374)	(0.370)
(Exp class) x (more time)			-0.0752	-0.0278
			(0.449)	(0.451)
Class level: non-college			0.147	-0.406
			(0.480)	(0.467)
Class level: college prep			0.400*	0.683**
			(0.162)	(0.151)
Class level: AP			0.245	1.206**
			(0.365)	(0.302)
Student characteristics				
Female	-0.175	-0.277*	-0.192	-0.201
	(0.124)	(0.129)	(0.126)	(0.125)
Asian	-0.0771	0.0285	-0.0799	-0.0896
	(0.183)	(0.213)	(0.193)	(0.194)
Black	-0.538	-0.839*	-0.735*	-0.667
	(0.335)	(0.368)	(0.350)	(0.343)
Hispanic	-0.0432	-0.0884	-0.0916	-0.212
	(0.186)	(0.217)	(0.199)	(0.197)
Mixed race/ethnicity	0.124	0.0527	0.0753	0.0688
	(0.172)	(0.184)	(0.176)	(0.175)
High school GPA (own)	0.864**	0.925**	0.866**	0.959**
	(0.124)	(0.132)	(0.127)	(0.126)
Average GPA (peers)	1.722**	1.311*	1.553**	
	(0.233)	(0.603)	(0.329)	
Parents' education	0.0866*	0.0920*	0.110*	0.119**
(numbered 1-6)	(0.0421)	(0.0441)	(0.0434)	(0.0433)
Attitude toward econ	0.299**	0.308*	0.303**	0.323**
(3 categories, neg. to pos.)	(0.116)	(0.121)	(0.118)	(0.117)

(continued)

Table III (continued)

VARIABLES (by category)	(1) No teacher effects	(2) Teacher dummies	(3) With teacher variables	(4) (3) without peer GPA
Teacher characteristics				
Teacher dummies	No	Yes	No	No
Years teaching econ	--	--	0.0331**	0.0469**
			(0.0116)	(0.0113)
Years teaching	--	--	-0.00961	-0.0130
			(0.00957)	(0.00952)
Female	--	--	0.00922	0.120
			(0.164)	(0.162)
Undergrad econ	--	--	-0.473**	-0.455**
(major or minor)			(0.172)	(0.170)
Advanced degree (econ)	--	--	0.506*	0.762**
			(0.226)	(0.218)
Advance degree (other)	--	--	0.0496	0.194
			(0.198)	(0.195)
Constants				
Cut 1	8.328**	6.827**	8.278**	4.174**
	(0.755)	(2.038)	(1.035)	(0.530)
Cut 2	10.15**	8.868**	10.20**	6.070**
	(0.777)	(2.046)	(1.052)	(0.550)
Cut 3	11.84**	10.65**	11.92**	7.749**
	(0.803)	(2.059)	(1.072)	(0.570)
Observations	963	963	963	963
Number of teachers	24	24	24	24

Note: Teacher effects in column 2 estimated using a complete set of teacher dummies (23); coefficients not reported. Standard errors in parentheses.

** p<0.01, * p<0.05

Table IV: Magnitude Assessment, Selected Coefficients

Panel A: Multiple choice scores
(Table II, column 3)

Variable	Unit of change (SD, or 1 for dummies)	Effect on outcome
Experimental class	1	0.345
High school GPA (own)	0.591	0.809
Average GPA (peers)	0.312	0.708
Years teaching econ	7.89	0.570
Undergrad econ (major or minor)	1	0.409
Undergrad econ (major or minor) (from column 4 of Table II)	1	0.681

Panel B: Essay scores
(Table III, column 3)

Variable	Unit of change (SD, or 1 for dummies)	Effect on outcome
High school GPA (own)	0.597	0.091
Average GPA (peers)	0.321	0.087
Parents' education	1.64	0.030
Years teaching econ	7.92	0.045
Undergrad econ (major or minor)	1	-0.077
Advanced degree (econ)	1	0.088

Effect indicates percentage increase in probability of receiving essay score=2 rather than 0 (base sample shares=0.205, 0.345).