Assessing Teacher Quality in India

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Motivation

- How to improve educational achievement within schools has been a perennial policy debate
  - Class sizes, inputs, incentive-based policies, or teacher quality?
- The importance of teacher quality in determination of student achievement is increasingly realized and incorporated in public policy (e.g. No Child Left Behind in the US)
- Who is good teacher?
  - A good teacher is one who consistently gets higher achievement from students (after controlling for other determinants of student achievement such as family influences or prior teachers) (Hanushek and Rivkin, 2012).

Motivation

- The focus of developing countries, especially India, has been on increasing access to education
- Gradual shift in focus to proving access to quality education
  - The rapid gains in enrolment and attendance is not translating into gains in the cognitive skills as measured by test scores in reading, writing, or math.
  - Two Indian states—Himachal Pradesh and Tamil Nadu—who participated in the extended cycle of 2009 OECD PISA, were able to beat only Kyrgyzstan out of 74 regions
  - Das and Zajonc (2008) used results from standardized math tests based on TIMSS questions from two Indian states—Orissa and Rajasthan—to create indices on mathematics performance similar to those of TIMSS and found these states near the bottom of the global rankings.

Motivation

- Increasing evidence in the US that the teachers play a key role in improvement of student achievement
- How much teacher can increase achievement in a developing country context remains unanswered
  - We are not aware of any work on "Teacher quality/effectiveness-as measured by their ability to raise test scores" for India or for any developing country.
- The paper attempts to provide first evidence from a developing country

Literature

- Mainly from US
  1. Rockoff (2004)- two school districts in New Jersey
  2. Hanushek, Kain, O'Brien, and Rivkin (2005)- one large district in Texas
  3. Aaronson, Barrow and Sander (2007)-Chicago public high school
  4. Rivkin, Hanushek, and Kain (2005)- 3000 schools from Texas
- The US studies find considerable variation in teacher effectiveness
  1. Average standard deviation of 0.13 in teacher effectiveness for reading, highest: 0.18 SD; lowest: 0.07
  2. Average standard deviation of 0.17 in teacher effectiveness for math, highest: 0.27 SD; lowest: 0.11
- Limited literature outside US
  - Slater, Davies, and Burgess (2012) for UK, and Leigh (2010) for Australia

Contributions

- Provides the first estimates of teacher effectiveness in India, or in a developing country
- Only the second paper that we are aware of that examines senior secondary school teachers
- We use grade 12 & grade 10 board exam results to estimate teacher value added (TVA)
  - These are both high stakes tests that students take seriously AND are graded externally.
  - Unlike many other studies that use LEVELS, we estimate the TVA
- Our data is purely administrative data, they are much easier to implement in a more scaled up way
- Corroborates the findings of the US and UK in a developing country context, increasing the confidence in those finding irrespective of the context

Data

- Administrative records provided by a group of linked **private schools** from one of the districts in Uttar Pradesh
- Students who took twelfth-grade (known as Indian School Certificate, ISC) exam between 2006 and 2010 in ten schools.
  - Each of ten schools has multiple sections for twelfth-grade.
  - Twelfth and tenth-grade (known as Indian Certificate of Secondary Education, ICSE) scores in multiple subjects.
  - Each student is matched to the teacher who taught for two years (i.e. during 11th and 12th grade)
- The twelfth-grade exams are typically taken at the age 17-18; the tenth-grade exams are taken at the age of 15-16.
- Both twelfth and tenth-grade exams are nationally set and marked outside the school, and are high stakes exams.

Data

- Information on about 8,319 pupils
- The average number subjects for which twelfth grades scores are reported is 5.8, while the scores are reported for at least four subjects for 99 percent of the twelfth-grade students.
- An observation is a pupil-teacher match, or equivalently a pupil-subject-teacher match as each teacher only teaches one subject.
- 38,265 pupil-subject-teacher (or pupil-teacher) matches.
- 191 teachers; median (average) number of classrooms observed per teacher is 5 (6.8).

Empirical Methodolgy

- Education is a cumulative process, i.e. achievement in grade g involves not only educational inputs in that grade, but also the whole history of inputs that provided the basic knowledge that enters into the summative achievement in grade g.
- Assuming linear form

$$A_{Gi} = \sum_{g=0}^{G} S_{gi}\phi_g + \sum_{g=0}^{G} X_{gi}\gamma_g + \sum_{g=0}^{G} \mu_i + \sum_{g=0}^{G} \epsilon_i$$

- Estimation is almost impossible, as data requirement is too restrictive

Empirical Methodology

- Impose structure on the parameters: a geometrically declining pattern for inputs in the more distant past (indicating that the impact of past inputs depreciates at a constant rate λ over time

$$A_{Gi} = S_{Gi}\phi + X_{Gi} + \mu_i + \epsilon_{Gi} + \epsilon_{Gi}$$
$$+ \sum_{g=0}^{G-1} S_{gi}\phi(1-\lambda)^{G-g} + \sum_{g=0}^{G-1} X_{gi}\gamma(1-\lambda)^{G-g}$$
$$+ \sum_{g=0}^{G-1} \mu_i(1-\lambda)^{G-g} + \sum_{g=0}^{G-1} \epsilon_{gi}(1-\lambda)^{G-g}$$

$$A_{Gi} = S_{Gi}\phi + X_{Gi} + \mu_i + (1-\lambda)A_{(G-1),i} + \epsilon_{Gi} \quad (1)$$

Estimation

- Requires panel data, where student is observed multiple times, and is matched with different teachers

$$Y_{ijkt} = \alpha Y_{i,(t-1)} + \beta X_{it} + \tau T_j + \theta_i + \mu_t + \rho_k + \epsilon_{ijkt}$$

where Y_{ijkt} refers to the achievement of the i^{th} student, taught by teacher j in school k at time t.

- We observe students taking exams in multiple subjects at the same time (for twelfth-grade exam), we modify the above equation

$$Y^{12}_{izjkt} = \alpha Y^{10}_{iz} + \tau T_j + \theta_i + \mu_t + \rho_k + \delta_z + \epsilon_{ijzkt}$$

Issues

$$Y_{izjkt}^{12} = \alpha Y_{iz}^{10} + \tau T_j + \theta_i + \mu_t + \rho_k + \delta_z + \epsilon_{ijzkt}$$

- Inclusion of the pupil fixed effects means, as would be the case in longitudinal studies, that effects of the T variable are estimated within students, i.e., they are based the fact that different subjects are taught by different teachers.
- Subject varying ability? (analogous to fixed ability over time)
  - Prior subject achievement Y_{iz}^{10}
- Not possible to separately identify a pure teacher effect and a school effect
- Variance in the estimated values of τ_j is within-school variation in τ_j, i.e., the variance of $(\tau_j - \bar{\tau}_{j(k)})$.
  - Rivkin, Hanushek, and Kain (2005) shows this is lower bound estimate of teacher effectiveness

What explains the variation in teacher effectiveness

$$\hat{\tau}_j = \pi Z_j + u_j$$

where Z_j is j's teacher's characteristics.

Descriptive Statistics

	Mean	Standard Deviation	Number of Obserations
Dependent variable	-0.004	1.002	38288
Tewlfth-grade Score			
English	78.60	8.95	8319
Chemistry	75.31	12.80	5693
Physics	73.03	14.34	5693
Mathematics	78.46	17.02	5260
Computer Science	86.10	9.33	4497
Enviromental Science	83.84	10.00	3349
Hindi	81.15	9.15	1451
Biology	73.08	13.12	1196
Commerce	65.69	17.29	348
Economics	60.95	19.20	221
Teachers credentials			
Age	41.324	8.445	188
Male	0.511		188
Experience	9.968	6.928	188
Teacher have Master or higher Qualification	0.851		188
Teacher have received B.Ed training	0.590		188

Variability in teacher effectiveness

	Model (1)	Model (2)	Model (3)
Standard Deviation	0.511	0.379	0.379
90-10 gap	1.271	0.934	0.974
90-50 gap	0.685	0.513	0.509
75-50 gap	0.235	0.217	0.219
75-25 gap	0.537	0.456	0.476
50-25 gap	0.302	0.238	0.257
Teacher effects	Yes	Yes	Yes
Subject effects	Yes	Yes	Yes
Year effects	Yes	Yes	Yes
Pupil effects	NO	Yes	Yes
School effects	NO	NO	Yes

Does human capital variables explain teacher effectiveness?

	Model (1)	Model (2)	Model (3)
Age of Teacher	-0.008	-0.006	-0.006
	(0.005)	(0.004)	(0.004)
Sex code as per M=1,	-0.087	-0.016	-0.023
W=0	(0.077)	(0.059)	(0.059)
Teaching experience	0.009	-0.019	-0.019
	(0.018)	(0.013)	(0.013)
Experience Square/100	-0.023	0.067	0.068
	(0.058)	(0.044)	(0.044)
Teacher is MA	0.353***	0.092	0.091
	(0.104)	(0.079)	(0.079)
Tecaher has recieved	0.127	-0.002	-0.003
B.Ed training	(0.079)	(0.060)	(0.060)
Constant	0.059	0.339*	0.348*
	(0.240)	(0.183)	(0.183)
Observations	188	188	188
R-squared	0.107	0.041	0.042

Results

- Teachers matter a great deal
  - Being taught over a two-year course by a high quality teacher (defined as 75th percentile teacher) rather than a low quality teacher (defined as 25th percentile teacher) adds 0.476 of the standard deviation to the score.
- Substantial variation in teacher's quality:
  - SD in TFE 0.379; Slater, Davies, and Burgess (2012) found a SD 0.358 in UK
  - About twice of what reported in US (SD in US is value added of one year, while ours & UK study, it value added for two years)
- Corroborate recent finding of substantial variation in TFE in the US and UK.

Teacher effectiveness in different sub-samples

	Standard error in TFE	No. of teachers
All subjects (8)	0.379	191
Drop Biology	0.376	179
Drop Chemistry	0.380	169
Drop Computer Science	0.419	172
Drop English	0.395	150
Drop Enviromental Science	0.355	167
Drop Hindi	0.384	180
Drop Maths	0.394	168
Drop Physics	0.365	166
Drop Economics	0.380	184
Drop Commerce	0.378	184

Conclusion & Caveats

- Teacher assignment in principle can play an important role in alleviating unequal outcomes across genders or social groups.
  1. As teacher's effectiveness affects the entire class, it will have a greater impact compared with any student based incentives.
  2. Improving teacher quality is less prone to substitution by households when compared to increasing school inputs.
- Teacher progression policies may be rethought as *ex ante* discrimination is hard.

- *Caveats*
  1. Heterogeneity in India
  2. Public schools