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School Resource and Performance Inequality

Evidence from the Philippines

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Abstract

This paper examines inequality patterns of school and teacher resources as well as student performance in the Philippines. School and teacher resources, measured by pupil classroom and teacher ratios and per-pupil teacher salary, became more unequal over time. Strikingly, a large portion of the variation is attributed to their within-division distributions, especially the non-city areas in each province (rural schools), where pupil classroom and teacher ratios have significantly positive returns in terms of student test scores. Concavity built into the education production function implies that reallocation of teachers and classrooms within a division can potentially increase average test scores. The estimates also imply that it is optimal to deploy young, inexperienced teachers to rural schools and reassign them to urban schools when the teachers are more experienced.

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School Resource and Performance Inequality
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1. Introduction

It has been increasingly recognized that increasing school resources alone is not sufficient to improve learning outcomes (e.g., Hanushek, 1998; Glewwe and Kremer, 2006). Recent studies show the importance of teachers' incentives and a decentralized and autonomous decision making process with the involvement of parents and community (e.g., Duflo, Dupas and Kremer, 2009; Gertler, Patrinos, and Rubio-Codia, 2011; Pradhan, et al., 2011).[4] School resources and governance reform are likely to be mutually complementary.[5] However, teachers' experience has not been analyzed in the quantitative context as a factor that affects students' learning outcomes, though human capital formation of teachers and its implications for student achievement are of great importance in education production.[6] Young teachers might be more motivated to teach in classrooms, but experienced teachers are likely to know a better way to teach from their classroom experiences. School resources and teachers' human capital are equally important.

The allocation of teachers across and within schools is an important and often controversial policy tool for many education systems, especially those that are growing or changing due to demographic or economic factors. In many developing countries, because of rapid rates of rural to urban migration, a scenario of ever more crowded and bigger urban schools contrasts sharply with dwindling rural student populations. Since the issue of where teachers live and work involves a large amount of resources, especially if a policy reform involves changes, the policy debates are often heated.

[4] See Bruns, Filmer, and Patrinos (2011) for an excellent summary.

[5] Recently Yamauchi and Liu (2012) analyzed the impacts of increased school and teaching resources on students' learning outcomes at the time SBM was introduced in the Philippines. Their results show significant impacts of school building construction/renovation, textbooks, and teacher's training but, as the authors noted, these impacts contain the effect of SBM. Skoufias and Shapiro (2006) and Yamauchi (2013) assessed the effect of school grants as part of decentralized school management reforms in Mexico and the Philippines respectively.

[6] In the existing studies that assessed the effect of pupil-teacher ratio (e.g., Angrist and Lavy, 1999; Card and Krueger, 1996; Dustman, Rajah and Soest, 2003; Hoxby, 2000; Krueger, 1999; Lazear, 2001; Yamauchi, 2005, 2011), teachers' experience is not explicitly incorporated.

Given returns to school resources and teachers' human capital (measured by national achievement test scores), the government can determine the optimal allocation of the above education assets across schools. To motivate the analysis, variations of these resources and teachers' human capital are characterized in two years, 2005 and 2010. Moreover, the distributions are decomposed into between and within school divisions (similar to provinces), so as to identify what dimension of the distribution is more important for policy making. The combination of the two sources of information—returns to school resources and teachers' human capital and actual distributions (variations)—between and within divisions (in two separate years) enables us to identify the magnitude of possible sub-optimality of the education resources.

The national school database is used to explore potential inequality of school resources across regions and provinces and its dynamic changes in the period of 2005 to 2010, and their implications for students' achievements. In particular, the analysis focuses on pupil classroom and teacher ratios (PCR and PTR, respectively) and per-pupil teachers' salaries (which increase with principals' and teachers' ranks).[7] PCR represents the amount of school physical facilities (classrooms), while PTR and per-pupil teachers' salary capture teachers' human resources (quantities and qualities, respectively).

Variations of the above mentioned school and teacher resources are decomposed into two dimensions: (i) between divisions and (ii) within divisions. The analysis shows that the within-division variations are larger than the between-division variations, which directly means that inequity in school and teacher resources is largely related to the allocation decision in each division. Different divisions look rather similar if the averages are simply compared. A major portion of the variations is attributed to the within-division resource allocations. This is particularly true in non-city divisions.

[7] Teachers' quality increases with on-the-job and off-the-job training. On-the-job training is closely related to accumulation of actual teaching experience in schools, while off-the-job training requires direct and opportunity costs incurred for knowledge transfer, e.g., attending a workshop and college. Their salary is a function of rank and position, which reflect their performance and accumulated experience.

The division fixed effect estimation shows that returns to school and teachers' resources significantly differ between city and non-city divisions. Impacts of PCR and PTR on NAT scores are significant in non-city divisions, while impacts of per-pupil teacher salary are rather significant in city divisions, implying that it is optimal to assign young (inexperienced) teachers to rural schools, and then reallocate them, once accumulating more experience, to urban schools, which together maximizes the average test score in the country. The results in the Theil decomposition analysis further imply that gains in the test scores from reallocating teachers and classrooms within division are potentially large due to the concavity built into the education production function.

2. Data

Two data sets are used in this study: the Basic Education Information System (BEIS) and the Grade-6 National Achievement Test (NAT) score data. BEIS, a school census collected every school year, has a variety of information on school characteristics and student performance. NAT data cover total and subject-wise test scores (mathematics, English, Filipino, science and hekasi: social sciences). Panel data (2005 and 2010) are constructed with the above two data sources. All elementary schools, located in both city and non-city divisions, are used in the analysis.

From BEIS, we construct school resource and human capital measures: pupil-classroom ratio, pupil-teacher ratio (both quantity) and per-pupil teachers' salary (quality). BEIS has information on the numbers of principals and teachers, differentiated by their categories and ranks. For example, principals are ranked into four levels. Teachers are categorized into master teachers (two levels) and normal teachers (three levels). For each level/category, we have the salary scale, so the total salary payment can be computed. Per-pupil teacher salary is calculated from the total salary payment for principals and teachers, divided by total enrollment. PCR and PTR represent quantities of resources available at the school, while per pupil teachers' salary represents the quality (and experience) of teachers.

3. Theil Decomposition

This section shows Theil inequality measures of the pupil classroom ratio, pupil teacher ratio, per pupil teacher salary and national achievement test scores, decomposed into within-division (district) and between-division (district) variations in both 2005 and 2010.

Table 1a to be inserted

Table 1a shows Theil inequality measures of the above school and teacher resource indicators. Some interesting patterns are revealed in the inequality dynamics. First, in all three indicators, their inequalities increased from 2005 to 2010. That is especially large in the case of pupil teacher ratio. Second, the pupil teacher ratio shows the largest inequalities among the three indicators in both years.

Third, strikingly, the within-division variations are greater than the between-division variations, meaning a larger portion of the inequality comes from within-division distributions. Within-division Theil measures are often twice as large as the between-division measures. On average, the divisions look similar but a major portion of the variations comes from inequalities within each division. More interestingly, when it is decomposed into district levels, within-district and between-district variations are more or less equal. This pattern is confirmed in all three measures of school and teacher resources.

It is probable that the increasing inequality in resource allocation is driven by demographic change that leads to overcrowding in city schools, while dwindling school populations in rural areas do not lead to teachers being redeployed. There is a certain asymmetric 'stickiness' in PTR and PCR. As the year begins, a school has to enroll the children who show up at registration time, hence increasing the PCR or PTR frequently happens rapidly. Reducing the number of teachers because of a downward trend in student population is relatively more difficult to observe.[8]

Table 1b to be inserted

Table 1b shows changes in Theil inequality measures for NAT scores. First, in contrast with school/teacher resources, the inequality of NAT scores declined between 2005 and 2010. Second, similar to Table 1, the within-division inequality is nearly twice as large as the between-division inequality. Third, as confirmed in the school/teacher resource distributions, once decomposed into district levels, the within and between components are almost equal. Though the increasing inequality in resource allocation coupled with a decreasing inequality in student achievement provides an interesting puzzle, this is beyond the scope of this paper.

Tables 2a and 2b to be inserted

Next, the sample is split into non-city and city divisions. The non-city divisions mainly cover schools in rural areas (though some city municipalities are not independent school divisions). Table 2a shows decomposed Theil index measures. Interestingly, the earlier observation that the within-division variations are greater than the between-division variations holds among non-city divisions. In city divisions, they are more or less of the same magnitude. It is understandable that variations across city divisions are quite large since the number of schools (and areas covered) in each city division is relatively small (though the average size could be larger). The above remark also applies to the NAT score distributions. For further analysis, we examine city and non-city divisions separately.

[8] If better-performing students (from relatively high income families) tend to move to cities, a decrease in PCR or PTR in rural schools does not necessarily increase the average test score.

4. School and Teacher Resources: Returns and Investment Patterns

This section shows estimation results on returns to school and teacher resources and investment patterns. The analysis groups schools separately in non-city and city divisions to see potential differences in the return structures.

Table 3 to be inserted

Table 3 summarizes the estimation results. First, in non-city divisions (rural schools), returns to PTC and PTR are significant, while returns to teachers' human capital are not. The results remain robust with control variables: numbers of principals and teachers distinguished by their positions and ranks. In contrast, city divisions show significant returns to teachers' human capital only (but at the 10% significance level), not to PTC and PTR. The above estimation controls division-specific factors by division fixed effects, so inferences are based on intra-division distributions.

Table 4 to be inserted

Table 4 summarizes the estimation results on investment behavior. The sample is split into non-city and city divisions. The results for both confirm that (i) PTC and PTR tend to converge over time, (ii) NAT scores in 2005 do not affect the dynamics of school and teacher resources, and (iii) a higher level of per-pupil teacher salary in 2005 is related to decreases in PCR and PTR. The above results show dynamic convergence patterns of PCR and PTR, though the explanatory power of these equations is very low, implying that shocks to these measures are relatively large, which may explain increased variations of the above resources over time.

5. Conclusions

This paper showed some striking, but seemingly contradictory results, on dynamic changes in school and teacher resources and students' performance. First, while, on average, a converging pattern of school and teacher resources – PTC, PTR and per-pupil teachers' salaries – is observed in 2005-2010, overall inequalities increased during the same period. This is because, given the initial level of resources, there are substantial variations in their changes (not levels), which seemed to contribute to their increased inequalities. Second, strikingly, a major portion of the variations comes from within-division variation. In this sense, on average, provinces and regions seem to look similar but large variations are hidden within each division (province). This is particularly true in non-city divisions (rural schools).

On the other hand, the analysis showed that returns to school and teacher resources differ between non-city and city divisions. In non-city divisions, returns to PCR and PTR are significant but returns to teachers' human capital are insignificant. In contrast, city divisions show that only teachers' human capital has (weakly) significant returns. Due to concavity built into the education production function, reallocating teachers (and building classrooms) across schools within a division potentially improves average test scores. This is particularly important from policy perspectives since a large portion of (increased) variations in school resources is attributed to their within-division distributions.

Another implication of our findings could be politically controversial: it may be optimal for the government to deploy younger, thus relatively inexperienced teachers to rural schools (non-city divisions), while reassigning them, once they gain experience, to city schools. This message could be counter to the accepted wisdom which holds that rural schools are more difficult teaching environments and hence policy should encourage older, more experienced teachers to teach in rural schools. However, the finding that returns to teachers' experience (quality) are significantly positive only in city schools rather justifies the conventional practice that younger teachers, with relatively less political and social capital, tend to be placed in rural schools.

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Table 1a Theil Decomposition: School and Human Resources

		Division	District
Pupil classroom ratio 2005	Theil	0.04431	
	Within	0.02146	0.02395
	Between	0.01285	0.02037
Pupil classroom ratio 2010	Theil	0.05922	
	Within	0.03774	0.02755
	Between	0.02148	0.03166
Pupil teacher ratio 2005	Theil	0.06142	
	Within	0.04576	0.03286
	Between	0.01565	0.02856
Pupil teacher ratio 2010	Theil	0.10185	
	Within	0.06545	0.04598
	Between	0.03641	0.05586
Per pupil teacher salary 2005	Theil	0.06356	
	Within	0.04364	0.03111
	Between	0.01992	0.03246
Per pupil teacher salary 2010	Theil	0.08261	
	Within	0.05584	0.03988
	Between	0.02677	0.04272

Table 1b Theil Decomposition: National Achievement Test Scores

		Division	District
NAT overall score 2005	Theil	0.03010	
	Within	0.02101	0.01478
	Between	0.00908	0.01532
NAT overall score 2010	Theil	0.01810	
	Within	0.01133	0.00796
	Between	0.00677	0.01014

Table 2a Theil Decomposition: School and Human Resources – Non-city and city divisions

		Non-city	City
Pupil classroom ratio 2005	Theil	0.045357	0.0362826
	Within	0.03365	0.02211
	Between	0.01171	0.01418
Pupil classroom ratio 2010	Theil	0.0576679	0.0544786
	Within	0.04026	0.02964
	Between	0.01741	0.02484
Pupil teacher ratio 2005	Theil	0.0636922	0.0498972
	Within	0.04900	0.03132
	Between	0.01469	0.01858
Pupil teacher ratio 2010	Theil	0.0815136	0.1514528
	Within	0.05899	0.08596
	Between	0.02253	0.06550
Per pupil teacher salary 2005	Theil	0.065159	0.0542735
	Within	0.04602	0.03165
	Between	0.01914	0.02262
Per pupil teacher salary 2010	Theil	0.0784213	0.0910964
	Within	0.05693	0.05122
	Between	0.02149	0.03987

Table 2b Theil Decomposition: National Achievement Test Scores – Non-city and city divisions

		Non-city	City
NAT overall score 2005	Theil	0.0297832	0.0313383
	Within	0.02175	0.01806
	Between	0.00804	0.01328
NAT overall score 2010	Theil	0.015639	0.0256354
	Within	0.01056	0.01449
	Between	0.00508	0.01115

Table 3 Determinants of NAT score: Returns to School and Human Resources

Dependent: Change in overall NAT score	(1)	(2)	(3)	(4)
	Non-city		City	
Change in PCR	-0.0452	-0.0486	0.0520	0.0535
	(2.02)	(2.16)	(1.33)	(1.33)
Change in PTR	-0.0323	-0.0434	0.0312	0.0366
	(2.67)	(3.31)	(0.59)	(0.60)
Change in per-pupil personnel expenditure	-0.00061	-0.0019	0.0114	0.0124
	(0.39)	(1.16)	(1.88)	(1.81)
Including changes in numbers of principal, head teachers, master teachers and teachers by ranks	No	Yes	No	Yes
Division fixed effects	Yes	Yes	Yes	Yes
Number of observations	16075	16075	3979	3979
R squared (within)	0.0018	0.0050	0.0089	0.0130

Numbers in parentheses are absolute t values using Huber robust standard errors with division clusters.

Table 4 Resource allocation

Dependent: Change in Sample: Non-city divisions	PCR	PTR	Per pupil teacher salary
Total test score in 2005	0.0126	0.0058	-0.2789
	(1.28)	(0.59)	(0.66)
PCR 2005	-0.4843	0.2120	-4.7227
	(10.99)	(6.02)	(8.00)
PTR 2005	-0.0383	-0.9420	0.9491
	(1.56)	(28.54)	(2.29)
Per pupil teacher salary 2005	-0.0132	-0.0282	-0.0588
	(4.10)	(8.85)	(0.95)
Division fixed effects	yes	yes	yes
Number of observations	4025	4027	4027
Number of divisions	86	86	86
R squared (within)	0.2913	0.5830	0.0442

Dependent: Change in Sample: City divisions	PCR	PTR	Per pupil teacher salary
Total test score in 2005	0.0227	-0.0141	0.3016
	(3.81)	(1.59)	(1.74)
PCR 2005	-0.4762	0.2401	-3.0243
	(13.98)	(6.34)	(6.40)
PTR 2005	0.0123	-0.8433	0.8563
	(0.74)	(22.20)	(2.48)
Per pupil teacher salary 2005	-0.0079	-0.0220	0.1351
	(4.93)	(5.88)	(1.81)
Division fixed effects	yes	yes	yes
Number of observations	16357	16267	16267
Number of divisions	60	60	60
R squared (within)	0.1947	0.4577	0.0337

Numbers in parentheses are absolute t values using Huber robust standard errors with division clusters.