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Differences Between Rural and Nonrural Secondary Science Teachers: Evidence From the Longitudinal Study of American Youth

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This paper describes rural/nonrural differences in the secondary science teaching work force, using data from the Longitudinal Study of American Youth. Relative to their nonrural colleagues, rural teachers are less experienced, more likely to have taught subjects other than science, more likely to have majored in education, less likely to have majored in a science, and less likely to have a graduate degree. Rural teachers report having taken fewer science courses and fewer science methods courses, at both the undergraduate and graduate levels. We explore the interaction of ruralness, educational training, and state certification requirements on teachers using multivariate analysis. Some, but not all, of the rural/nonrural difference is attributable to state-by-state differences in teacher certification requirements. For example, rural teachers report having taken fewer subject-matter courses than their nonrural colleagues, a difference that persists when the effects of undergraduate major, graduate training, and state differences in certification policy are removed. Our analysis uses a 1988 national sample of 456 teachers from 93 schools, part of an ongoing longitudinal study of science and mathematics education.

Introduction

We conducted this analysis to provide background information for two different projects, one a study of educational productivity and the other a study of science teacher misassignment in rural secondary schools. This research is consequently guided by both an interest in the predictive utility of school-level variables in educational production functions and by a sensitivity to the challenges that rural schools face in recruiting and retaining science teachers.

Recent research on teacher subject-matter knowledge in science suggests that teacher knowledge has important consequences for the ways in which classrooms and curricula are organized. For example, subject-matter deficiences may prevent teachers from implementing a conceptual change model of teaching (Hollon, Roth, & Anderson, 1991), a widely-taught science teaching strategy. Subject-matter knowledge appears to affect the ways in which science teachers plan activities, manage classroom conversations, and question students (Carlsen, 1991). To date, however, explorations of the effects of teacher knowledge on science teaching have been largely restricted to intensive studies of small numbers of teachers, and little is known about the long-term consequences of teacher knowledge on student learning. Educational

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productivity research can use statistical techniques to sort out the relative contributions of teacher knowledge and other variables using large datasets (Monk, 1991). As a tool in policy deliberation, productivity research offers techniques for gauging the relative effects of isolation, school size, teacher attributes, and other factors on the achievement of rural students.

Methods

Our analysis uses teacher data from the Longitudinal Study of American Youth (LSAY), a National Science Foundation-funded study centered at the Public Opinion Laboratory at Northern Illinois University (Miller, Suchner, Hoffer, Brown, & Pifer, 1991). The LSAY data are a potentially valuable resource because they provide both fine-grained details on science teachers' educational training (e.g., course counts by science subject-matter area) and the opportunity to trace the effects of these measures on student performance over a multi-year period. We used Release 2 of the teacher data file, made available in 1990. The sample of 456 middle and secondary science teachers from 49 schools is a national probability sample, stratified by region and community type (urban, suburban, rural).

The analysis we report here proceeded in two phases. First, we documented rural/nonrural differences on all LSAY variables that measure teacher education and experience. As we will show, this revealed a consistent pattern of differences. Relative to their nonrural colleagues, rural science teachers were, for example, less experienced, more likely to have taught subjects other than science, less likely to have majored in a science, and less likely to have a graduate degree. We became suspicious that these differences might actually reflect the confounding influence of state variation in teacher certification requirements; this suspicion was supported when, leaving the LSAY data for a moment, we graphed population density for each of the 50 states (Bureau of the Census, 1986) by state provisional teacher certification requirements (Blank, 1988) and found that state population density was a reasonably good predictor of teacher certification requirements (see Figure 1).

We subsequently contacted LSAY and were given the state identifications for each of the schools in the sample, information that is not otherwise included in the data releases. Using Blank's (1988) summary of state certification policies, we added a new variable to the LSAY data file, BIO87CER, a continuous variable (range 0-45 credit hours) that reflected the state's initial teacher certification subject-matter course requirement for biology teachers. This variable functions in our study as a proxy measure of state certification policy. (Obviously, state certification policy includes much more than the number of credit hours required for biology certification. Unlike some other measures, however, it is a continuous variable, yielding a range adequate for regression analysis. Biology as an "indicator subject" has the advantage that almost every state has a biology teaching certificate; some states collapse chemistry and physics into a single physical science certification area, complicating comparison of the requirements in different states.)

The second phase of analysis explored the implications of state certification policies for inequities between rural and nonrural schools. To do this analysis, we focused on an illustrative and continuously distributed measure of teacher preparation, TOTSCIMA, the total science/mathematics course counts reported by teachers for both undergraduate and graduate study. Our analysis asked, using regression models, how well do ruralness, graduate degree status, undergraduate major, and state certification policy affect this outcome measure? Are rural/nonrural differences simply an artifact of laxer certification requirements in states that are primarily rural? A regression strategy was adopted in our analysis to help provide background for further work on education production functions (in progress).

Results

In the first phase, we identified a consistent pattern of rural-nonrural differences on a wide variety of science teacher characteristics. We were surprised to find few differences between urban and suburban teachers: On most measures, urban and suburban teachers resembled each other much more than they resembled their rural colleagues. In order to increase statistical power, in the analyses that follow we contrast rural teachers with the combined urban-suburban groups.

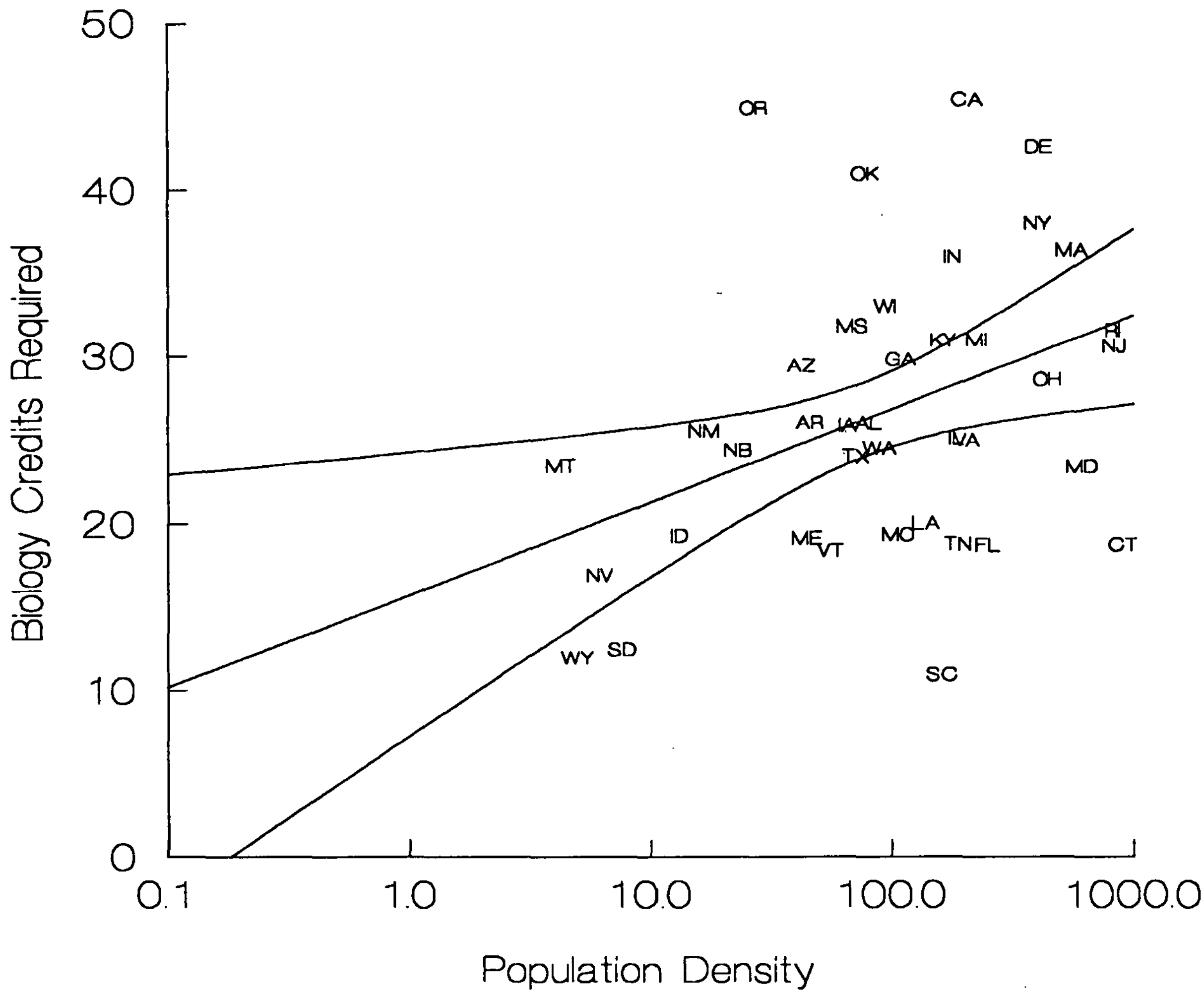

Figure 1: Relationship Between Science Teacher Certification Requirements and Population Density in the Continental United States

Note. Biology Credits Required is the minimum number of science courses required for certification in Biology (data from Blank, 1988). Population Density is defined as the number of people per square mile for the entire state (data from Bureau of the Census, 1986) and is transformed logarithmically. The log of population density is a significant predictor ($p<.01$); the curved lines show 95% confidence intervals. States without minimum coursework requirements are omitted from this graph. Absence of specific standards sometimes reflects minimal requirements, but in other cases, it reflects a state policy of program-by-program review, which may be quite rigorous.

Table 1
Differences Between Rural and Nonrural Secondary Science Teachers

	Rural		Nonrural		
Teacher Characteristic	*M* [a]	(*SD*)	*M* [b]	(*SD*)	Test Statistic[c]
Teaching experience (science only)	11.2 yrs	(8.2)	14.3 yrs	(9.3)	3.25***
Teaching experience (in this district)	10.1 yrs	(7.7)	13.7 yrs	(8.8)	3.91***
Teaching experience (in this building)	8.2 yrs	(6.6)	10.1 yrs	(8.2)	2.31***
Teaching experience (of any kind)	13.7 yrs	(8.2)	16.3 yrs	(8.9)	2.76***
Proportion of teaching experience that is science teaching	0.81	(.26)	0.87	(.27)	1.78*
Time since completing undergraduate degree	17.1 yrs	(8.4)	18.6 yrs	(9.1)	1.43
Teachers having degrees beyond bachelor's	48.2%		64.7%		9.42##
Teachers having degrees beyond bachelor's (teachers with 11-15 years experience)	52.4%		81.1%		6.30##
Teachers having degrees beyond bachelor's (teachers with over 15 years experience)	55.2%		79.1%		7.57##
Teachers reporting undergraduate majors in education	48.0%		36.9%		4.01##
Teachers reporting undergraduate majors in a science	48.0%		57.0%		2.65

[a]n = 108 teachers maximum
[b]n = 348 teachers maximum
[c]t-tests: *p < .05. **p < .01. ***p < .001. Chi-square tests: #p < .05. ##p < .01.

Rural/Nonrural Differences

Table 1 summarizes rural-nonrural differences on a number of variables. For measures that are continuous and normally distributed, significance of rural-nonrural differences is gauged using a t-test of independent groups. For percentage measures, we used a chi-square test.

Teaching experience. Relative to their nonrural colleagues, rural science teachers have significantly less experience (a) teaching science, (b) teaching in their current school district, (c) teaching in their current school building, and (d) teaching any subject anywhere. Rural teachers have a mean of 14.3 years of science teaching experience, for example, 3.1 years less than their nonrural colleagues (p<.001).

Non-science teaching. Despite their relative inexperience, rural teachers report more years of teaching during which they had no science assignment: a mean 2.5 years compared to 2.0 years for nonrural teachers. Proportionally, rural teachers reported a mean 81% of their years of teaching experience included at least one science assignment, compared to 87% for nonrural teachers ($p<.05$).

Advanced degrees. Rural teachers were significantly less likely to have a degree beyond the bachelor's degree. Of the entire sample, 48% of rural teachers and 65% of nonrural teachers reported advanced degrees. Some of this difference is attributable to rural teachers' relative inexperience. However, when our sample is stratified by years of teaching experience, significant rural-nonrural differences are seen only for experienced teachers, those with 11-15 years of teaching experience and those with over 15 years of experience.

Undergraduate major. Rural teachers are significantly more likely to report that they majored in education as undergraduates ($p<.05$). Although fewer rural teachers (48%) than nonrural teachers (57%) report majoring in a science, the difference is not statistically significant using a nonparametric test. Nevertheless, we are fairly confident that the difference is real. For example, when a large number of teachers were removed from the dataset on the grounds that their reported course counts were implausible, both the remaining sample size and the percent of teachers reporting science majors drops. Of the 360 teachers whose course counts were judged plausible and who named an undergraduate major, 42% of rural teachers and 54% of nonrural teachers reported science majors. This difference is significant (chi-square $p<.05$).

Time since completing undergraduate degree. Although the difference was not significant, rural teachers received their bachelor's degrees about 1.5 years more recently than nonrural teachers (mean 17.1 years ago for rural teachers vs. 18.6 years ago for nonrural teachers). Curiously, this difference is about *half* the rural-nonrural difference in teaching experience, suggesting that either rural teachers were more likely to be certified at the master's degree level (implausible, given their reduced likelihood of having a master's degree) or were more likely to take time off from teaching at some point during their career. The latter pattern might occur if, for example, rural teachers were more likely to take time off from teaching to pursue other careers or care for their families. The LSAY data are not suitable for exploring these possibilities, however. The teacher questionnaire, for example, does not ask teachers to report their gender.

Course taking. Table 2 summarizes rural/nonrural differences in teachers' self-reported course-taking. The table uses a subset of 351 teachers in the sample whose reported coursework was judged plausible. The extreme and methodologically problematic decision to drop almost a quarter of our sample reflects a problem in the LSAY dataset that appears to be due to the fact that although teachers were asked to report course counts, many appear to have reported credit hours.[1]

Using this subset of teachers, we found that rural teachers reported significantly fewer undergraduate science courses and significantly fewer undergraduate science methods courses than their nonrural colleagues. Relative to nonrural teachers, rural

[1]This part of the analysis proceeded in two phases. First, we converted quarter-hour courses to semester-hour course equivalents for all teachers using the formula (Semester-hour-equiv = 0.75 x Quarter-hour-count). So, for example, 4 quarter-hour courses would be recoded as 3 semester-hour courses for a given teacher. Using that somewhat-arbitrary conversion factor, mean course counts for teachers who reported semester-hour courses were found to be very similar to mean counts for teachers who reported quarter-hour courses.

Inspection of the resulting course counts showed that a large number of teachers reported implausible patterns of undergraduate courses. Unfortunately, there is no unbiased way to make judgements about which teachers reported credit hours and which reported course counts. Some filtering out of suspect cases seemed essential, however, because otherwise mean course counts clearly would be inflated. Therefore, we developed a set of decision rules to flag (and subsequently remove from the course count analysis) teachers whose course counts could be consistently identified as implausible. Rather than convert reports to course counts (e.g., by dividing them by 3 or 4), we simply dropped these cases from this part of the analysis. This step is obviously methodologically troublesome.

We flagged and removed any teacher who reported (a) more than 40 undergraduate science courses, (b) more than 25 undergraduate science or math methods courses, (c) more than 25 graduate science or math methods courses, (d) fewer than 10 courses in science and mathematics *and* a major in a science, or (e) more than 30 science and mathematics courses *and* more than 20 methods courses.

We should note that the pattern of rural/nonrural differences in course counts that we report here persists even when suspect cases are not filtered out of the dataset. The mean course counts of the whole sample, however, are higher and probably more biased.

Table 2
Differences Between Rural and Nonrural Teachers in Coursework

	Rural		Nonrural		
Teacher Characteristic	*M*[a]	(*SD*)	*M*[b]	(*SD*)	t
Undergraduate science courses	15.0	(7.7)	18.5	(8.6)	3.38***
Undergraduate mathematics courses	2.9	(3.0)	3.4	(3.3)	1.43
Undergraduate science methods courses	0.9	(1.6)	1.6	(2.1)	3.06***
Graduate science courses (teachers with advanced degrees)	7.0	(5.4)	9.0	(6.4)	1.88***
Graduate mathematics courses (teachers with advanced degrees)	0.8	(1.3)	0.7	(1.5)	-.34
Graduate science methods courses (teachers with advanced degrees)	1.6	(2.8)	2.1	(3.6)	.88
Total science and math courses, undergrad and grad (all teachers)	18.9	(10.8)	23.9	(11.8)	3.51***
Total science and math courses, (teachers with advanced degrees)	21.6	(10.6)	25.5	(12.3)	2.07*
Total science methods courses, (teachers with advanced degrees)	2.5	(4.0)	3.2	(4.4)	1.02

Note. The means presented here are for a subset of teachers whose course-taking reports were judged plausible, using rules detailed in Carlsen and Monk (1992). Means for the entire sample of 456 teachers are higher than shown here, but they show the same pattern of rural-nonrural differences.
[a]n = 78 (all teachers) or 32 (teachers with advanced degrees).
[b]n = 273 (all teachers) or 141 (teachers with advanced degrees).
*p < .05 ***p < .001

teachers report significantly less graduate science coursework and less combined undergraduate science and mathematics coursework, a difference that persists even when only individuals with advanced degrees are included in the analysis (eliminating teachers who have taken some graduate courses but have not received a master's degree). In addition, a consistent pattern of non-significant differences occurred for other measures, including undergraduate mathematics, graduate mathematics, and graduate science methods.

We were mildly surprised by the difference in science methods courses, anticipating that, overall, the relative prevalence of the education majors in rural schools would be coupled with lower science course counts but higher science methods course counts. We found the former to be true but not the latter.

Multivariate Models for Assessing the Effects of State Policy

The second phase of our analysis was undertaken to determine to what extent state teacher certification policy accounted for observed rural/nonrural differences in teacher attributes. To do this, we turned to a multiple regression framework, and estimated the relative contributions of three variables to the TOTSCIMA outcome measure (total science/math course counts). Our choice of outcome measure was determined in part by the fact that course counts are a common part of state certification policy and in part by statistical characteristics of the variable in this dataset. TOTSCIMA is a normally-distributed measure with a wide range; as a policy variable, it is more an indicator of overall state certification policy than a comprehensive description.

Our first regression predicted main effects on TOTSCIMA by RURAL (1=rural, 0=nonrural), HAVEMAST (1=has master's degree, 0=no master's degree), and REALSCI (1=undergraduate science major, 0=no undergrad science major). All three dichotomous independent variables contributed significant main effects. We then added BIO87CER, the state certification policy proxy (range 0-45 credit hours of science required for biology teacher certification in 1987). Adding the policy variable had little effect on the regression. RURAL showed a negative influence on the outcome, HAVEMAST and REALSCI showed a positive effect, and BIO87CER had no effect. The first several lines of Table 3 summarize this model, using the subset of non-suspect cases.[2]

We were surprised to find no effect by BIO87CER, given our preliminary finding (Figure 1), which linked state population density and state certification policy. Following the recommendation of Jaccard, Turrisi, and Wan (1990), we divided our sample into three groups (low, medium, and high values of BIO87CER) and constructed separate graphs of the effects of our independent measure on TOTSCIMA for each group. These graphs revealed interactions between BIO87CER and the other independent measures. In response to this, we included first-order interactions in our second regression model (Table 3, Model 2), which improved the overall performance of the model (as seen in the squared multiple R). Unfortunately, it also introduced a multicollinearity problem (reflected in low reported tolerances). We dropped one non-significant interaction term to reduce multicollinearity on the RURAL variable to produce our final model (Table 3, Model 3).

Model 4 shows significant main effects on science/mathematics coursework by HAVEMAST (positive), REALSCI (positive), and BIO87CER (positive), a significant interaction effect for HAVEMAST x BIO87CER, and a significant interaction effect for REALSCI x BIO87CER. (The first interaction effect can be interpreted in this fashion: The positive contribution of a graduate degree on the outcome measure is significantly reduced if a teacher resides in a state with rigorous certification requirements. The second interaction effect shows that the positive contribution of having majored in a science is reduced if a teacher resides in a state with rigorous certification requirements). The model does not perform quite as well for the larger dataset—which includes suspect cases—because of the influence of erroneous course counts. Nevertheless, interaction effects remain significant.

In our judgment, the third model provides the best estimates of the effects of rural location, graduate degree status, undergraduate major, and state certification policy on the TOTSCIMA outcome measure.

Discussion and Policy Implications

Our paper contains four major results. First, there are significant rural/nonrural differences with respect to traditional indicators of teacher educational preparation. For example, we found that, relative to their nonrural colleagues, rural teachers were less likely to have a graduate degree and were less experienced.

Second, there are significant rural/nonrural differences in indicators that are receiving attention from policy makers as appropriate gauges of educational quality. New datasets like LSAY make it possible to differentiate among teachers on the basis of detailed information about subject-matter preparation. Taking advantage of these new analytical capabilities, we found significant differences between rural and nonrural teachers in their teacher education programs. Specifically, we found that rural science teachers were less likely to have majored in science and report having taken fewer science and mathematics courses.

Third, significant rural/nonrural differences in teacher preparation persist in the face of controls for other attributes, at both the individual teacher and state

[2]Our strategy is to find the best regression model using the smaller, less suspect dataset. Later, we will apply the model to the original dataset, which includes suspect cases.

Table 3
Multivariate Models Predicting Total Science and Mathematics Coursework (TotSciMa)

Variable	Raw Coefficient	Standardized Coefficient	t
	Model 1: Main Effects Only ($N = 317$, $R^2 = .223$)		
CONSTANT	16.43	0.00	7.27***
RURAL	-3.07	-0.11	-2.12**
HAVEMAST	4.08	0.17	3.28***
REALSCI	9.28	0.40	7.68***
BIO87CER	-0.01	-0.01	-0.15
	Model 2: Add Interactions with State Policy Variable ($N = 317$, $R^2 = .247$)		
CONSTANT	5.76	0.00	1.36
RURAL	0.35	0.01	0.07
HAVEMAST	14.92	0.62	3.36***
REALSCI	16.93	0.72	3.77***
BIO87CER	0.37	0.27	2.53**
RURAL*BIO87CER	-0.12	-0.13	-0.70
HAVEMAST*BIO87CER	-0.37	-0.53	-2.57**
REALSCI*BIO87CER	-0.26	-0.37	-1.79*
	Model 3: Dropped Non-significant Interaction Term ($N = 317$, $R^2 = .245$)		
CONSTANT	6.98	0.00	1.81*
RURAL	-3.18	-0.11	-2.22*
HAVEMAST	14.59	0.60	3.31***
REALSCI	16.42	0.70	3.71***
BIO87CER	0.33	0.24	2.46**
HAVEMAST*BIO87CER	-0.36	-0.51	-2.50**
REALSCI*BIO87CER	-0.24	-0.35	-1.70*
	Model 4: Used Entire Dataset, Including Suspect Cases ($N = 383$, $R^2 = .229$)		
CONSTANT	8.50	0.00	1.62*
RURAL	-2.25	-0.05	-1.16
HAVEMAST	15.46	0.43	2.63**
REALSCI	29.83	0.86	5.05***
BIO87CER	0.34	0.16	1.84*
HAVEMAST*BIO87CER	-0.41	-0.38	-2.10**
REALSCI*BIO87CER	-0.50	-0.48	-2.62**

*$p < .05$ **$p < .01$ ***$p < .001$

levels. These differences remain when controls are included for both teachers' undergraduate major and graduate degree status. A rural effect persists when controls are established for differences among states in the requirements they impose for provisional teacher certification. This means that the rural/nonrural difference in teacher preparation cannot be explained solely in terms of differences among the states in the level of their requirements for licensure.

Fourth, an interaction was found between state certification requirements and teachers' graduate degree status and undergraduate majors. Specifically, in states with relatively strict certification requirements, having a master's degree was less strongly related to the number of math and science courses in a teacher's background than was the case in states with lax certification requirements. One theoretical interpretation of this finding is that at least part of the impact of state certification policy is indirect—a weak independent predictor of teachers' course-taking but a good predictor of teachers' level of educational attainment.

Collectively, these findings indicate that ruralness is negatively related to some key measures of schooling quality. Before turning to the policy implications of this result, several caveats need to be noted. For example, we must be mindful of the fact that teacher characteristics are a very indirect measure of school quality. Our findings would be more compelling if we could show that attributes like teaching experience, degree level, undergraduate major, and science course-taking were dependably linked to subsequent pupil performance. Such work is currently in progress (see Monk, 1991).

We must also be mindful of what we have not been able to control for in our analysis. In particular, we know that in many places, ruralness is associated with poverty. What appears to be a rural effect in this paper may in fact be an economic effect. We have also not tried to disentangle rural effects from school size effects. We have more to say about the size/rural mixing later.

These caveats are important and temper the sweep of the policy implications we can derive based on our available evidence. It is nevertheless useful to consider what the policy implications would be of a finding that ruralness per se is associated with lower levels of school quality for students. In the following discussion, we explore several alternative policy responses, and point out the importance of developing a coherent means of choosing one in preference to another.

1. Provide compensatory assistance based on ruralness. Ruralness in this context is looked at as an indicator or barometer of difficulties in assembling a high quality faculty. Whether ruralness is the *cause* is less important than the presumption that it flags possible difficulty.

In the present context, a useful distinction can be drawn between incumbent and future teachers. For the incumbents, the state might offer incentives for teachers to upgrade their backgrounds in mathematics and science. These incentives might be offered to school districts (e.g., districts could receive additional funds with the expectation that they be used to assist teachers in upgrading their training), or they might go directly to teachers, as summer tuition grants, for example. In either case, there could be some outcome measure to which recipients would be held accountable. For example, if the district received the funds, it could be expected to demonstrate increases in its teachers' credentials.

For future teachers, the state might intervene to increase the minimum requirements for hiring in certain districts. A rural school district might be enjoined from hiring new teachers with certain credentials (e.g., provisionally-certified teachers with minimal subject-matter preparation), for example, unless it could demonstrate that the rest of its faculty was well prepared. Such a regulation would provide an incentive for schools to upgrade the credentials of existing faculties, as well as discourage hiring underprepared teachers to join already-weak faculties. Financial assistance to rural districts might be necessary to make it possible for them to hire teachers with the higher credentials. Nevertheless, targeting stricter teacher preparation requirements to weaker districts would probably cost less in the long run than raising certification requirements for all teachers across the board.

2. Eliminate the source of the rural schools' difficulties. The second policy response is quite different from that sketched above. Instead of trying to remedy whatever deficiencies are found in rural schools, the goal would be to eliminate the effects of the difficulty. Rather than try to correct weak teacher credentials in rural schools, we might eliminate rural schools, or at least eliminate that portion of "ruralness" which gives rise to the problem. Obviously, caught up in this view is a difficulty that stems directly from the "rural" construct. Ruralness can mean many things, and we do not know what it is about ruralness that gives rise to the inequalities we document in this paper.

For example, rural schools are often small. If weaker teacher credentials are in fact related to small size rather than to ruralness, one could use district and school reorganization policies to eliminate the source of the inequalities. Schools would still exist in rural areas, but in a post-reorganization world, inequalities in teacher preparation might eventually disappear. Alternatively, weaker teacher credentials might be more directly related to per-pupil expenditures than ruralness. Broader reforms in school finance or community development might be the only way to ameliorate the inequity. Our analysis does not attempt to disentangle these effects. That would be a fruitful extension of what we do accomplish here, and the results would be quite relevant for policy.

3. *Wait it out.* According to this view, the relatively low levels of teacher preparation that exist in rural schools are either above minimum state requirements (and are therefore not of concern) or result from laxity or lags in enforcement of existing standards. We suspect that much of the effect we have described can be attributed to grandfathering when new certification requirements were put into place by state education departments in the 1970s and 1980s. This explanation would account for the many experienced teachers in our sample who do not have master's degrees and who are teaching in states that now require master's degrees for permanent certification. Eventually, these teachers will retire and be replaced by better-credentialed individuals. Nevertheless, as states continue to change certification requirements, it is worth exploring whether grandfathering clauses have disproportionate effects on rural schools. For example, some grandfathered teachers might elect to continue their higher education if their schools were not located in isolated areas or if courses could be provided using distance learning technologies.

Conclusion

We have presented evidence suggesting that the educational preparation of science teachers in rural schools is more limited than that of teachers working in urban and suburban schools. The increasing attention that teacher preparation is receiving from people concerned with educational productivity underscores the significance of our findings. We have also sketched three—inconsistent—policy remedies and noted that states have yet to devise a principled means of choosing one approach over another.

The inequalities we document in this paper are substantial and potentially alarming. An obvious next step is further work to measure them more precisely and, more importantly, explore their implications for student learning. Further efforts to help states clarify appropriate policy responses is also needed.

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