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Program Report

IN THIS ISSUE

Program Report: Economics of Education	1
Research Summaries:	
Realized Return Volatility ...	7
Firms in International Trade	11
Economics of the Pharmaceutical Industry	14
Exchange-Rate Models	17
NBER Profiles	20
Conferences	22
NBER News	32
Program and Working Group Meetings	33
Bureau Books	41

Economics of Education

Caroline M. Hoxby*

Over the past few years, the number of Working Papers issued by NBER's Economics of Education Program has grown rapidly, with about five new papers added each month. To cope with the large number of excellent submissions, a spring program meeting has been added to each year's events, which already included a fall meeting, a Summer Institute program, and programs dedicated to special issues. This is all to say that education continues to be an extremely productive and exciting area of research in economics. I attribute this to three phenomena. First, policymakers are actively experimenting with education-related policies, and this creates a great deal of useful variation for researchers to analyze. Indeed, there is a virtuous circle between economic analysis and policy innovation because economics is the inspiration for, or intertwined with, many policies: school choice, accountability, savings and aid plans for college, incentive pay for teachers, reducing the barriers of entry into teaching, and so on. Second, the education program draws upon the talents of economists who come from a variety of fields, and this makes for an exciting dynamic owing to the opportunities for arbitrage of ideas and methods across fields. Third, and by no means least important, is the continued, rapid rise in the quantity and quality of data available to researchers. Researchers may differ on the substantive effects of state accountability laws and the federal No Child Left Behind Act, but no researcher would deny that these laws have created a deluge of data, much of which is longitudinal. Because of coincidence, imitation, and similar causes, researchers' access to rich data on colleges and foreign schools has also risen dramatically. A few states have even created "K-20" databases that allow us to track a student's

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Hoxby directs the NBER's Program on Education and is the Harvard College and Allie S. Freed Professor of Economics at Harvard University. In this article, the numbers in parentheses refer to NBER Working Papers.

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progress from his pre-kindergarten or kindergarten entry to his final college course. The promise of such data is immense. Although program members continue to focus most of their research on the United States, they are increasingly taking advantage of foreign countries' data and willingness to conduct policy experiments. As a result, many of the methodological advances that are launched on U.S. data spread quickly to research around the world.

All program reviews are necessarily selective and this one is no exception. Three major themes in recent work deserve special mention: the effects of teachers, peer effects, and the complexity of college students' choices. Toward the end of this review, I describe other themes that are currently receiving less attention but are likely to emerge as absorbing topics soon.

Teachers

It is a commonplace that teachers *matter*, perhaps because nearly everyone can remember a teacher or teachers who strongly influenced his life. Thus, economists' inability to find consistent empirical evidence to support the idea that teachers matter has been a substantial puzzle. For years, most studies of teachers' effects depended on regressing students' achievement on the characteristics of their teachers: experience, highest degree, certification, and so on. Such studies often suffered from a selection problem — essentially, more qualified teachers had a tendency to gravitate to schools that served students from more privileged backgrounds. (Below, I shall have more to say on this tendency.) The selection problem caused researchers to *overestimate* the effect of teachers' credentials on achievement, yet still there was no consensus among studies that teachers' characteristics affected students.

This puzzle has been largely resolved in the past couple of years, owing to studies that directly estimate teachers' effects on achievement using longitudinal data. With a generous amount of data, the method is fairly straightforward: students' achievement is divided, statistically, into student fixed effects, grade fixed effects, year fixed effects, and teacher fixed effects. Jonah E. Rockoff has done seminal work on this topic.¹ While statistical decisions do arise, most authors uncover fairly large differences in the effects of teachers who teach the same grade in the same school, use the same materials, and draw students fairly randomly from the same population. For instance, estimates often suggest that the best teacher may

raise achievement by as much as half a standard deviation more per year than the worst teacher who operates in identical circumstances. In other words, we are not wrong to recall that “teacher X” raised our achievement.

Once researchers have calculated teachers’ empirical effects, these become a powerful dependent variable that can be used to explore the effects of policy on the teaching workforce. One of the first things researchers did with the computed teachers’ effects was investigate whether they were closely related to the teacher credentials upon which achievement was traditionally regressed. The answer was generally no: credentials do not explain teacher effects for the most part. (The exception is that very inexperienced teachers have worse effects, but even the effects of increased experience plateau after four to five years.) This brings us to the most recent work, which examines policy changes designed to affect teachers. Donald Boyd, Pamela Grossman, Hamilton Lankford, Susanna Loeb, and James Wyckoff (11844) and Thomas J. Kane, Rockoff, and Douglas O. Staiger (12155) investigate New York City’s recent decision to allow people from a wider variety of backgrounds to teach: not just people who attain certification through regular channels, but also people with alternative forms of certification or temporary teaching licenses (“Teaching Fellows,” Teach for America, international exchange programs, and so on). Both studies conclude that differences in certification explain only a small fraction (if any) of the variation in achievement: differences among teachers with the same certification dwarf the differences associated with certification. The rather striking implication of the evidence is that it may make sense for schools to focus their energy on ex post selection — that is, retaining teachers who empirically demonstrate good effects in their first few years, and not retaining others. Kane, Rockoff, and Staiger conclude that, even after one takes account of the effects that an ex post selection policy would have on teacher turnover (and, therefore, on inexperience), the evidence “suggests that selecting high quality teachers at the time of hire may be difficult ... The large observable differences in teacher effectiveness ex post suggest that

districts should use performance on the job, rather than initial certification status to improve average teacher effectiveness.”

The estimation of teacher effects and the subsequent finding that they are largely unrelated to credentials reconciles a good deal of other evidence and allows a relatively clear picture to emerge. For instance, I mentioned earlier that regressions of student achievement on teacher credentials produce inconsistent evidence. In retrospect, it is easier to see that the studies that suggested that credentials affected achievement substantially were those that did a poor job of controlling for teachers’ tendency to gravitate toward more advantaged students. Recent working papers lay out increasingly rich evidence of this tendency. Eric A. Hanushek, John F. Kain, Daniel M. O’Brien, and Steven G. Rivkin (11154) and Charles T. Clotfelter, Helen F. Ladd, and Jacob L. Vigdor (11936) demonstrate that, perhaps because they experience only trivial wage changes when they switch schools, teachers who are able to make voluntary switches move to schools where students are more affluent, higher achieving, and less likely to be minorities. Boyd, Lankford, and Loeb (9953) show that teachers strongly prefer to teach where they live. This makes sense if the reduction in child care costs and the increase in neighborly amenities associated with proximity outweigh the (usually small) wage gains associated with teaching in a distant school, especially one located in a difficult neighborhood.

Suppose that a state were, rather, to implement a policy whereby a teacher would earn a bonus if she taught in a school that served disadvantaged students. Would anyone respond? Clotfelter, Elizabeth Glennie, Ladd, and Vigdor (12285) examine a North Carolina program that offered a modest bonus of \$1,800 to certified math, science, and special education teachers who chose to work in high-poverty or academically failing secondary schools. Their findings suggest that teachers do respond, primarily because they leave at a slower than expected rate. Andrew Leigh (“Teacher Pay and Teacher Aptitude”, Spring 2006 program meeting) offers further evidence that teachers respond to higher pay. Using data on the test scores of everyone admitted to

Australian universities between 1989 and 2003, he shows that a single percent rise in starting-teacher salaries boosts the average aptitude of students entering teacher education courses by 0.6 percentile ranks. The North Carolina and Australia studies suggest that pay can be used to change the pool of prospective teachers available to a school, but this may be a far less direct way of improving teacher performance than simply paying teachers more when they raise achievements. Victor Lavy (10622) examines a pay-for-performance program in Israel, exploiting a natural experiment in teachers’ assignment to the program. He demonstrates that teachers who experienced incentive-based pay raised their students’ performance on high school exams. Because Florida is currently implementing a substantial pay-for-performance scheme, we are likely to learn more about this topic in future years.

Peer Effects

Investigation of peer effects, broadly construed, is perhaps the single most active area at present within the economics of education. This is sometimes difficult to explain to policymakers because there are no policies known as peer effect policies. Instead, understanding how peer effects function is crucial to analyzing numerous other policies, including selective college admissions, school tracking, desegregation, school choice, bilingual education, and even school finance. Put another way, peer effects are fundamental parameters that, properly estimated, are needed for numerous other analyses. In the context of education, economists define peer effects broadly: the effect that any student has on any other student, regardless of the channel by which the effect operates. That is, peer effects are not just one student’s teaching another but may include phenomena such as one student’s affecting the way a classroom operates, or a teacher teaches, and thereby influencing his classmates.

Two problems make estimation of peer effects challenging, and program members have made significant progress on both fronts. First, identifying peer effects is difficult because they can be confounded with numerous forms of selection. Most obvi-

ously, students X and Y might be similar and spend a lot of time together. Are they similar because Y influences X, or because similar students become friends, or because an administrator recognized their initial similarity and forced them to spend time together by making them roommates, putting them in the same class, and so on? (There are other identification problems that plague peer effects' estimation, but selection is the main one, in practice.) Second, most policies that turn on peer effects implicitly assume that they are non-linear, yet it is often difficult to find data or methods with the power to identify non-linear effects. Linear peer effects are not terribly interesting for policy because they imply that if one person gains from the reassignment of a peer, there is an equal, offsetting loss for another person. Thus, no amount of rearranging peers, as might occur if policy-makers were to alter desegregation programs or college admissions, could produce an outcome that was unambiguously better for society. In contrast, if peer effects are non-linear, it is possible that some arrangements of peers are better for everyone (or are, at least, much better for many people and only a bit worse for a few people).

Program members have made great progress on identifying peer effects by finding natural and policy experiments that rearrange students. I introduced a method (7867) that exploits natural variation in cohorts within a school; Andreas Ammermueller and Jorn-Steffen Pischke (12180) applied it to data on European primary schools, and Weili Ding and Steven F. Lehrer (12305) applied it to data on Chinese secondary schools. Both studies find evidence of significant peer effects in achievement, and the latter study suggests that they are non-linear (a point to which I will return). Eric D. Gould, Lavy, and M. Daniele Paserman (10844) apply the same method to a particularly interesting problem: the effect of an influx of immigrant students. They examine Israeli schools in which one grade experiences a substantial influx of immigrant students and an adjoining grade does not. Their results suggest that the immigrant students have no or only a slight effect overall but have an adverse effect on non-immigrant

students who come from disadvantaged backgrounds. Two papers make powerful use of the method by applying it to military colleges, which arrange incoming students into very distinct units and strictly control cross-unit fraternization. Scott Carrell, Frederick Malmstrom, and James West (Fall 2005 program meeting) and Carrell, Richard Fullerton, West, and Robert Gilchrist (Summer Institute 2006) find evidence of significant peer effects in academic achievement, athletic performance, and even cheating. Finally, Zeynep Hansen, Hideo Owan, and Jie Pan (12251) use variation in the study groups to which students are assigned in business school courses. They find that male-dominated groups perform worse, both working in groups and in exams taken individually, than do female-dominated or gender-balanced groups.

Other papers exploit policy differences among schools that are otherwise very similar. Philip J. Cook, Robert MacCoun, Clara Muschkin, and Vigdor (12471) exploit differences in whether sixth grade is the top primary school grade or the bottom middle school grade. If the former is the case, then sixth graders are exposed mainly to younger peers. If the latter is true, then sixth graders are exposed mainly to older peers. The authors find that sixth graders exposed to older peers are more likely to have disciplinary incidents and that the differences persist in the seventh and eighth grades, when all of the students are in middle school. Hanushek and Ludger Woessmann (11124) compare students across educational systems that "track" earlier and later. In the latter systems, students' classrooms remain heterogeneous longer.

Additional papers make use of explicit randomized experiments. Lisa Sanbonmatsu, Jeffrey R. Kling, Greg J. Duncan, and Jeanne Brooks-Gunn (11909) use data from the Moving to Opportunity experiment, in which some families who apply for housing vouchers are induced to move out of high poverty areas. Compared to children in the control group, the children in the (randomized) treatment group are exposed to peers from higher-income families. The authors "had hypothesized that reading and math test scores would be higher among children in families [who

move out of high poverty neighborhoods, but] ...the results show no significant effects on test scores for any age group among over 5000 children ages 6 to 20 in 2002 who were assessed four to seven years after randomization." This finding—an absence of peer effects—conflicts somewhat with the results of the aforementioned studies, but the Moving to Opportunity experiment alters families' lives on more dimensions than the typical school rearrangement does. Thomas S. Dee (11660) puts the randomization in the Tennessee Star Experiment (which was designed for analyzing class size) to unusual purpose: understanding the peer effects of teachers. Although the application strains the "peer effects" nomenclature and "role model effects" might be more natural, the study nevertheless belongs in this section. In it, Dee finds that students assigned to own-gender teachers have higher achievement, are more engaged, and are more positively perceived in school.

Many, though not all, of the above papers have difficulty identifying non-linear peer effects, primarily because the typical experiment (natural or otherwise) does not rearrange a sufficient number of students in a sufficiently diverse number of ways. In other words, the studies typically lack the power to discover non-linear effects. Ding and Lehrer's paper (12305) is something of an exception. Its authors suggest that students who are initially high achieving benefit more from having high achieving schoolmates than do students who are initially low achieving. However, Gretchen Weingarth Salyer and I (Spring 2006 program meeting) illustrate the most intense testing for non-linearities by examining more than 80,000 students exposed to reassignments in a large North Carolina school district. We test nine models of peer effects and find evidence of substantial non-linearities. For example, we find that students are disproportionately influenced by students who are initially like them. And, if a student who is initially very low achieving is "dropped" into a classroom, his presence most affects other students who were fairly low achieving themselves. Another result is that, while some classroom heterogeneity is fine, excessive heterogeneity reduces all students' achievement: the evidence against

bi-modal or “schizophrenic” classrooms is particularly strong.

College Students and their Choices

It is only a bit of an exaggeration to say that economic research on higher education used to focus on only two questions: what was the return to college education (where “college” was a generic thing) and whether “policy X” made students more likely to attend college? In *College Choices: The Economics of Where to Go, When to Go and How to Pay for It*, I predicted the proximate demise of these two questions owing to the fact that, at least for American students, they are not where the action is.² Most students who are at all interested in college now at least try attending some institution of higher education, but there is enormous variation in the sorts of institutions they attend, the curricula to which they are exposed, whether they persist and earn a degree, and how quickly they earn credits. It is increasingly naive to expect a college-related policy to have its main effects on the attendance margin as opposed to the “which college”, “whether a degree”, or “when a degree” margins. It is also naive to treat all postsecondary education as the same: a year is a year is a year, regardless of the curriculum delivered, the institution’s resources, or the time the student devotes to the effort (full-time or part-time, for instance). Thus, I am not only unsurprised but also glad to see that, by what appears to be a wholly natural evolution, program members are increasingly investigating questions about how a student’s college choices, in all their complexity, affect his outcomes.

Several papers consider persistence to the college degree and achievement in college classes. In practice, these are closely related topics because, once a student starts performing poorly in college, he is likely to stop persisting and may never (or only much later) earn a degree. Failure to persist is particularly common among students from disadvantaged backgrounds, students whose secondary school achievement was poor, and students who enroll in non-selective institutions. This is not to say that any of these factors is *causal*—for instance, being

disadvantaged does not necessarily cause a student to drop out—but they suggest where the investigation should begin. Eric P. Bettinger and Bridget T. Long (10369, 11325) examine the effect of college remediation courses. These courses, which are many students’ first postsecondary experience, are controversial. On the one hand, they may provide useful transitional experiences for students whose poor preparation would cause them to fail regular college courses. On the other hand, remediation increases the total number of courses a student must take before attaining his degree, thereby perhaps discouraging students who see a long plod ahead of them. Using rich administrative data from Ohio, where colleges differ in how they assign students to remediation, the authors find that both phenomena (encouragement and discouragement) exist. Being *placed* in remedial courses increases a student’s probability of dropping out or transferring to a less selective college. However, actually completing a remedial course (the treatment on the treated effect) increases a student’s persistence in college. The authors conclude that “remediation may serve...to re-sort students across schools”—in other words, to help them find the institution most likely to serve their needs. Josh Angrist, Kevin Lang, and Philip Oreopoulos (Summer Institute 2006) examine an explicit experiment in which a college randomized students to receive financial incentives for good grades, receive support services, or receive both. They find that, at the end of a year, the financial incentives have modestly improved the grades of female students, especially those who studied more in high school. John Bound and Sarah Turner (12424) investigate whether college students are more likely to persist when they attend a college with more resources. This is not an easy question because of self-selection: students who are more able and more motivated are admitted to colleges with more resources. However, the authors exploit the fact that states rarely increase the resources of their public institution in line with the size of the cohort ready to attend college. Therefore, students in “crowded cohorts” get fewer resources, all else equal, and the authors link this deprivation to decreased persistence.

Several papers examine how financial aid affects students. This is a classic topic, but the new twists are that authors examine persistence and the college selected. Authors have also greatly improved the methods used. Whereas numerous previous papers depended upon variation in financial aid that was fairly obviously endogenous (meritorious students got more, students admitted to selective colleges got more, states gave more when fiscal times were good, poorer students got more), recent papers often exploit a discontinuity in aid formulae or an experiment. For instance, Kane (9703) compares students on one and the other side of a (ex ante unknowable) discontinuity in California’s aid formula. He also (10658) examines a policy change that made the District of Columbia’s residents eligible for in-state tuition at Maryland and Virginia public colleges. The studies find that a \$1000 reduction in cost causes a modest increase in the probability that a student will attend college at all (by 0.3 percentage points in the former study, by about 0.9 percentage points in the latter) but causes substantial shifts in *which* college students chose. In several years, when long-term outcomes can be investigated, researchers will be able to see whether the aid allowed students to attend colleges that were merely more expensive (though not to them) or to attend colleges that were truly better investments, thereby suggesting that students were previously liquidity constrained not to attend the optimal college. Christopher Avery, Kaitlin Burek, Clement Jackson, Glen Pope, Mridula Raman, and I (12029) examine a Harvard policy that eliminated or greatly reduced expenses for students from families with less than \$60,000 in income. While the actual change in aid was modest and the number of students who matriculated as a result was modest as well, the policy greatly increased applications from students with low-income backgrounds. This suggests that disadvantaged students may fail to understand their opportunities to get aid and may need information as much as they need a generous aid formula. This theme is taken up by Susan M. Dynarski and Judith E. Scott-Clayton (12227) who show that much of the complexity in aid formulas, presumably the source of bafflement, serves

very little purpose in terms of identifying aid recipients and determining the dollars for which they qualify.

Finally, several studies examine the effect of a college's curriculum on student outcomes. Daniel S. Hamermesh and Steven G. Donald (10809) use a combination of survey and administrative data to produce estimates of the earnings effect of various college majors. The study is a convincing improvement over previous research because of its authors' unusual ability to control for pre-existing factors, such as incoming achievement and background, with very rich data and precise measures of course taking. Ofer Malamud (Fall 2005 program meeting) investigates the trade-off between forcing a student to choose his major early (thereby increasing his coursework in the area of his eventual degree) and allowing him to choose it later (thereby increasing his likelihood of being well matched to a major because he has had more opportunity to learn about fields before being forced to choose). The optimal timing of such choices has long been a puzzle. The study, which exploits institutional differences between Scottish and English universities, demonstrates that students who choose their major later are less likely to switch out of the field after college but that, conditional on staying in a field, students who choose their major early attain higher starting wages. Finally, Ronald G. Ehrenberg, George Jakubson, Jeffrey Groen, Eric So, and Joseph Price (12065) analyze an unusual policy experiment in which some graduate programs were given funding to alter their structure in ways intended to increase students' probability of and speed in getting their doctoral degrees. This study is especially noteworthy for demonstrating how mutually beneficial the relationship between institutions (in this case, the Mellon Foundation) and researchers can be. An institution wants to learn how to use funds well to produce particular outcomes; researchers need to find policy experiments that allow them to identify the effects of policy.

Emerging Themes

As more accountability programs are implemented, studies will increasingly

trace their effect on students. Signs of this appear in Edward P. Lazear's work (10932), which provides insights into the incentives generated by accountability programs; Hanushek and Margaret E. Raymond's study (10591), which uses the staggered implementation of states' accountability programs to assess early effects on achievement; and Christiana Stoddard and Peter Kuhn's paper (11970), which investigates whether teachers work more hours when under pressure from accountability programs. Construing accountability more broadly, one can learn about the impacts of high school exit exams from Dee and Jacob (12199) or Francisco Martorell (Summer Institute 2005), or the effects of financial incentives for students to perform from Michael Kremer, Edward Miguel, and Rebecca Thornton (10971).

Working out empirical methods to deal with general equilibrium problems in education continues to be a challenge. General equilibrium is especially relevant to issues like school choice, school finance, the relationship between housing markets and schools, and desegregation. Progress is being made, however. Patrick Bayer and Robert McMillan (11802), Bayer, McMillan, and Kim Reuben (11095), and Bayer, Fernando Ferreira, and McMillan (10871) all display innovative methods of identification that exploit, but do not attempt to set aside, equilibrium properties of the market for education. On school finance, Katherine Baicker and Nora Gordon (10701), Ilyana Kuziemko and I (10722), Christian A. L. Hilber and Christopher J. Mayer (10804), and Kane, Staiger, and Stephanie K. Riegg (11347) explore links between house prices, inter-governmental aid for schools, and local school budgets. The linkages make it challenging to design effective redistributive aid among schools but do allow one generation to help finance another's education. Finally, Nora Gordon, Elizabeth Cascio, Sarah Reber, and Ethan Lewis (Fall 2005 program meeting) offer a striking new interpretation of school desegregation in the South, which they demonstrate was, to a large extent, a response to federal financial incentives (especially Title I) rather than explicit court orders and the like.

Connections between health and edu-

cation have often been neglected, but a number of interesting papers suggest that a new wind is blowing. David M. Cutler and Adriana Lleras-Muney (12352) provide an overall introduction; Justin McCrary and Heather Royer (12329) investigate whether more education makes women better mothers in terms of infant health; and Ding, Lehrer, J. Niels Rosenquist, and Janet Audrain-McGovern (12304) use data on genetic markers to evaluate the causal impact of health on education. Much of the relationship between health and education is associated with infancy and early childhood, where health, nutrition, and the environment may have disproportionate effects on cognitive development. This, in turn, may affect a person's later education, which may, in turn, affect the environment she provides for her infant. Janet Currie and Enrico Moretti (11567), Sandra E. Black, Paul J. Devereux, and Kjell Salvanes (11796), and Eric I. Knudsen, James J. Heckman, Judy L. Cameron, and Jack P. Shonkoff (12298) explore these linkages.

Summing Up

It is striking that many of the themes that I identified as emerging in my last program review have now been explored in a good number of studies. It is also striking how quickly new topics in the economics of education are emerging. While some of the appearance of novelty in this program review is deliberate (I have de-emphasized studies in areas that are well-trodden), much of the novelty simply reflects the evolution of the program, which continues to develop rigorous methods for investigating problems of fundamental importance and policy relevance.

¹ J.E. Rockoff, "The Impact of Individual Teachers on Student Achievement: Evidence from Panel Data," *American Economic Review, Papers and Proceedings, May 2004*.

² C.M. Hoxby, *College Choices: The Economics of Where to Go, When to Go and How to Pay for It, Chicago: University of Chicago Press, 2004*.