Do Students Care about School Quality? Determinants of Dropout Behavior in Developing Countries

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School quality and grade completion by students are shown to be directly linked. Unique panel data on primary school–age children in Egypt permit estimation of behavioral models of school leaving that incorporate output-based measures of school quality. With the student's own ability and achievement held constant, a student is much less likely to remain in school if attending a low-quality school rather than a high-quality school. This individually rational behavior suggests that common arguments about a trade-off between quality and access to schools may misstate the real issue and lead to public investment in too little quality.

I. Introduction

It is a matter of faith that students and parents are concerned about school quality and take school quality into account in various other decisions, but little evidence provides convincing support for these presumptions. What evidence does exist comes from adding measures of school resources or of cognitive test performance into the behavioral models of interest. But both approaches yield biased estimates of school quality effects because both generally ignore family background and

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individual ability differences, which themselves influence individual knowledge and skills. Moreover, direct resource measures suffer from further problems, because common school resource measures—such as per student expenditure or pupil-teacher ratio—are known to be poor proxies for differences in school quality (see Harbison and Hanushek 1992; Hanushek 1995, 2003). This article employs direct measures of school quality to investigate its importance in individual decision making about school attendance.

The focus is on how school quality affects student decisions in developing countries to drop out of school, a topic of increasing importance as efforts to increase schooling levels are expanded. Almost all developing countries are rightfully concerned about the problem of low school completion rates, both because of lost investment opportunities for society and because of general inefficiency in the provision of public schooling. The Education for All initiative attached explicit schooling goals. Specifically, it emphasizes the goal that all nations ensure universal primary education by 2015 and, while identifying school quality as a related issue, has emphasized getting all students through the early phases of schooling.[1]

This article investigates the underlying causes of dropping out of school using a rich longitudinal database on primary school–age children in Egypt. The central finding is that children appear to be strongly influenced in their schooling decisions by the quality of their prospective school. To the extent that dropping out is a rationally based decision, the traditionally perceived trade-off between access and quality may be a very bad way of viewing the policy choices. Moreover, common estimates of rates of return to schooling may give a very distorted picture of the options facing individuals and countries. The correlation of school quality and school attainment, which may also be important in more developed countries, implies that many of those with lower quantities of schooling could not necessarily expect to receive the incomes and investment returns of those with more school attainment simply by staying in school longer.

The investment-benefit perspective on school policy concentrates on potential lost productivity from premature school dropout. Historically, high estimated rates of return to schooling have been contrasted with low school completion. Although standard methods of calculating the returns to schooling investments have been questioned in the past, virtually all available estimates indicate that schooling in developing coun-

[1] The Education for All movement is a global commitment to provide quality basic education for all children, youths, and adults. The movement was launched at the World Conference on Education for All in 1990. Ten years later, with many countries far from having reached this goal, the international meeting in Dakar, Senegal, affirmed a commitment to achieving Education for All by the year 2015. This objective is parallel to the education portion of the UN Millennium Development Goals, which also called for universal primary schooling by 2015. For a discussion of the quality elements, see UNESCO (2005).

tries has a high payoff, especially for lower levels of schooling (e.g., Psacharopoulos 1994; Psacharopoulos and Patrinos 2004). Two problems with this research are, however, important. First, school quality and quantity of schooling completed may be positively correlated, leading to upward biases in rates of return estimated by traditional approaches. This possibility was found to be important when analyzed in terms of both resource differences among schools (Behrman and Birdsall 1983) and student performance differences (Harbison and Hanushek 1992). Second, school attainment might be driven by student ability, leading to normal selection concerns (e.g., Griliches 1977). This article investigates both possibilities and provides strongly suggestive evidence about their importance.

Even though schooling completion has been increasing in much of the world, it remains low in an absolute sense in many economically depressed areas. In 2001, the net enrollment rate in primary education for developing countries was still only 83 percent, and this falls to 63 percent in sub-Saharan Africa (UNESCO 2005). The static schooling investment picture is amplified by analyses of economic growth that suggest that human capital, as measured by school attainment, is an important determinant of the rate of economic growth across countries (e.g., Lucas 1988; Romer 1990; Barro 1991). Thus, both viewpoints suggest that having significant numbers of students fail to complete primary schooling, let alone higher levels, is an important problem.

Further, closely related to the key aspects of the analysis here, economic growth has been shown to be highly related to the quality of schooling. Hanushek and Kimko (2000) find that measures of labor force quality based on international mathematics and science tests dramatically increase the explanatory power of basic cross-sectional growth models while reducing the estimated importance of average school attainment. Extensions and additions to this work by Barro (2001), Wößmann (2002, 2003), Bosworth and Collins (2003), Coulombe, Tremblay, and Marchand (2004), and Jamison, Jamison, and Hanushek (2007) all support the importance of quality differences for growth. Most recently, Hanushek and Wößmann (2006), in extending these analyses to a wider group of countries and a longer time period, identify cognitive skills as much more important than just school attainment in determining economic growth.

The second reason for concern about dropouts comes from a cost of education–efficiency perspective. If the objective is to get a given number of students through some level of schooling—say through the primary cycle—having students drop out earlier raises the cost of achieving the goal.[2] Beyond that, large numbers of dropouts (and of grade re-

[2] Resources spent on dropouts and on grade repeaters are commonly, but misleadingly, called "wastage." Students leaving school presumably learned something and improved their skills by attending for the time they did, even if this does not achieve public outcome goals for the schools.

peaters, the related problem) may distort the normal instruction, raising the costs of schools.

While school completion levels for individuals and aggregate data on the age-grade distributions of students provide some overall sense of the dropout situation, they do not allow investigation of underlying behavioral factors or institutional structures that are driving high dropout rates. The concentration on aggregate data masks all individual-specific factors, and analysis of school completion levels cannot examine time-varying family or school factors that enter individual decisions. The key to understanding dropout determinants is longitudinal data on individual students, but such panel data have rarely been available. This article exploits a unique panel data set containing detailed information about family circumstances, schooling, and achievement for both school attenders and school dropouts from a sample of Egyptian primary schools in 1979 and 1980.

A central feature of this analysis is the development of an output-based measure of school quality, instead of relying on the ubiquitous input approach. The novel finding of this analysis is that students appear to recognize quality differences among schools and act rationally in the face of such differences. This finding reinforces prior evidence on the positive correlation of quality and school attainment (Harbison and Hanushek 1992) and casts serious doubt on the common policy debate about perceived trade-offs between wide access to schooling opportunities and the development of high-quality schools. Complete consideration of optimal investment in school quality requires information about the costs of improving quality, but even in the absence of cost information, it is clear that the usual returns to quantity of schooling are frequently biased upward.

II. Egyptian Schooling

Egypt, like many other developing countries, neared the end of the twentieth century facing significant problems with enrollment outcomes in its primary schooling system (World Bank 1991). This section paints a picture of schooling in Egypt during the last half of the twentieth century. The educational institutions of this period provide a particularly interesting environment for analyzing student enrollment decisions, because dropout decisions were made at a point where there is little doubt about the large market returns to schooling. Thus, it is possible to trace behavior that, on the surface, appears to be irrational in the sense of leaving large returns unexploited.

Under existing law around 1980, attendance through the sixth grade of primary education was compulsory. However, primary school enrollment in the 1991/92 school year was only about 80 percent of the corresponding age cohort. Middle school enrollment represented less than 70 percent of its age cohort. The highest dropout rate, nearly 15 percent, occurred near the end of the primary cycle, with an additional 10–15 percent leaving school by the end of middle secondary school. Geographical disparities in enrollment rates within Egypt were another important dimension of this policy concern. Specifically, the majority of the primary school–age children who do not attend school were concentrated in rural areas, where resource constraints appear most severe. Significantly lower female enrollment rates were an added element of the problem. Gender inequalities persisted as females remained outside the reach of formal education: 62 percent of women were illiterate, as opposed to 38 percent of men, and girls' primary school enrollment remained stuck at 45 percent of total enrollment from 1966 to 1986 (World Bank 1991). In rural areas, enrollment rates of girls often did not exceed 50 percent of the age cohort and could be as low as 10 percent in some regions.

A second set of problems, also identified by the World Bank study, revolved around the inputs of the public schooling system. For example, the construction rate of schools lagged behind the identified demand and was insufficient to meet the government's objectives of decreased class size and reduced reliance on multishift teaching. Similar concerns related to the "quality" of schooling, and of teaching in particular. Examples often cited included outdated curricula and superficial assessment techniques along with dependency on a set of textbooks that were themselves frequently outdated. The overall quality problem was thus summarized as being multifaceted: the combination of inadequate facilities and generally poor quality of teachers, teaching methods, and curricular content. These problems, which appeared to be fostered by a deficiency of core management skills, each actually recur in contemporary discussions.

In this article we examine the potential linkages of these two schooling problems: completion and quality. While in the end we will not measure quality in the ways suggested by conventional policy discussions, we will provide insights into key linkages.

Most Egyptian primary schools were classified under one of three administrative headings: public schools, subsidized private schools, or unsubsidized private schools. The public and subsidized private schools were, for all practical purposes, indistinguishable. The facilities of the former were owned by the government, whereas the latter were in private hands and were leased to the government through a "grant-in-aid." Neither charged any tuition, and both types of schools followed the same, centrally prescribed curriculum. Private (unsubsidized) schools accounted for less than 5 percent of all primary school enrollments in Egypt. Those that existed were almost entirely found in urban areas.[3]

[3] Three types of private schools were recognized: "private schools with fees" (tuition), "language schools," and "service classes." The service classes were not proper schools but consisted, rather, of remedial classes for sixth graders who failed their primary certificate examination. The language schools were the remaining legacy of the many foreign and

In school year 1978/79, the first year of the survey used in this analysis, there were 710 private schools out of the country total of 11,051 schools; of these, 582 were located in urban areas (out of a total of 4,261 schools).

Virtually all recurrent expenditure and most capital expenditure for primary education were initiated and financed by the Ministry of Education. A small proportion of construction of new schools was undertaken by local jurisdictions; these schools were subsequently turned over to the Ministry of Education, which assumes responsibility for their operation. Teachers were allocated to schools on the basis of official enrollment levels and were paid out of the central budgets allocated to each educational zone. Books and most other student supplies were centrally purchased and, likewise, distributed in kind to the schools on the basis of enrollments.

At the level of the individual schools, attempts to strengthen local participation through the creation of parent-teacher associations began to be made. The associations seemed to serve as a forum for the presentation of suggestions and complaints to the teachers and principals. How effective these associations were is an open question. However, they did not serve as a medium for additional funding and resources to the schools. Given the centrally controlled character of the primary education system in Egypt, the budget and resources available at the time to each school are reasonably taken as exogenous.

Until 1968, promotional exams and repetition in primary school were not allowed, and the only criterion for promotion was 75 percent attendance in each school year (Swanson 1988). In 1968, repetition was reinstated; this policy provided for the examination of all students at the end of fourth grade; but only one repetition was permitted, and promotion to the fifth grade was automatic after the second attempt. Repetition was extended to the second grade in 1972 under arrangements similar to those for grade 4. In response to the introduction of exams and repetition largely during the 1980s, the phenomenon of private tutoring arose, but it was not central to the schools during the time analyzed here. The sixth-grade exam was the major hurdle for most children. Those who failed were essentially cut off from the remaining educational ladder, and the possibility of repetition of the sixth grade was limited by space. Children who failed the exam the first time often enrolled in private classes in order to make a second try the next year.

Partial tutoring later emerged as a partial supplement to teachers'

missionary schools. Since 1958, these schools were under Ministry of Education control, although they were also permitted some independence. Unlike the public schools, they offered training in foreign languages—primarily English and French—starting in the early grades. Of the students enrolled in private schools, 95 percent were found in urban areas. Most rural private schools were service classes, whereas the complete private schools served an elite population concentrated in a few large cities. More detailed descriptions of the Egyptian schooling system are found in Swanson (1988) and in World Bank (1991).

salaries and became an integral part of the educational process. The upsurge in private lessons for selected school children at all educational levels has also been identified as potentially exacerbating the overall problems of the schools. This aspect of schooling was, however, much less important during the 1979–80 period of our data and analysis.

III. The Economics of Dropping Out of School

The central focus of this work is the dropout decision of primary school students. Dropout decisions are directly related to school completion, but concentrating on these decision points permits a more accurate characterization of the various time-specific factors underlying the behavior. And, while all students will eventually drop out of school, there is a clear prima facie case that doing so during the primary grades is suboptimal from both public and private viewpoints.

The opportunities facing the student both in and out of school are important to understanding school leaving. The underlying conceptual framework coming from a simple optimization model on the part of the student is well known and needs little elaboration. The student is seen as maximizing lifetime utility through the choice of schooling level, and this is driven by the earnings opportunities of the student, which in turn are a function of the past and future schooling experiences of the student. (For discussions of optimal decisions about school attainment, see Ben-Porath [1970], Heckman [1976], and Rosen [1976].) In broad terms, with perfect capital markets, schooling choices can generally be summarized by a simple optimal stopping rule for an individual: Everything else equal, continue investing in schooling until the rate of return for a year of schooling falls below the market interest rate on alternative investment options. With borrowing constraints or imperfect capital markets, the magnitude of forgone earnings and of family wealth and income could also separately influence decision making, because some families may not be able to take advantage of high rates of return that involve large up-front costs.

For our purposes, however, a key consideration is that the investment in human capital involves not only years of schooling but the quality of that schooling, an individual's ability and prior achievement, and prior skill and human capital accumulation. If school quality differs and if student performance has important subsequent implications for the labor market, one would expect variations in student dropout decisions to be directly related to the quality of the school. Where the costs of schooling come chiefly through forgone earnings from being out of the labor market, higher-quality schooling is cheaper (with prior achievement and ability held constant) and thus would be expected to induce more investment in schooling by the individual. This relationship is exactly the one central to this article. The more learning during any period of time, the more likely it is that a student will continue in school rather than drop out. This notion is at the heart of the empirical analysis below.[4]

IV. Empirical Implementation

Virtually all past analyses of school attainment, dropout behavior, and the like ignore any quality differences across schools, essentially presuming that a year is a year when it comes to schooling. Those studies addressing school quality, particularly the effects of school quality on other behavioral outcomes of interest, most commonly employ simple input measures of quality. For example, it is common for various labor market investigations to include expenditure per pupil or measures of real resources (e.g., average class size or teacher credentials) if they include anything about quality. Both approaches, based on the results of past analyses, are inappropriate. Achievement differences among students are large, and direct analyses of earnings opportunities of workers suggest that differences in cognitive skills may be very important in determining earnings alternatives. The inappropriateness of input measures of school quality is examined and reviewed in Harbison and Hanushek (1992) and Hanushek (2003); see also Card and Krueger (1992) and the critiques by Betts (1996), Hanushek, Rivkin, and Taylor (1996), and Heckman, Layne-Farrar, and Todd (1996).

The approach here is to estimate directly variations in school quality, based on student outcomes in different schools. As discussed below, these estimates of school quality are subsequently used as one element of dropout behavior. School quality here is defined simply as the gain in achievement that a student can expect from attending a given school for an additional year (with other influences on achievement held constant). This outcome-based perspective, which contrasts sharply with most other research, permits analysis of the effect of school quality on individual student decisions about remaining in school. The achievement formulation, equation (1), follows from commonly employed educational production function estimation (Hanushek 1979, 2006):

$$A_{it} = f(X, F_A) + \gamma_A A_{it-1} + \delta_s + \varepsilon_{it}. \quad (1)$$

The estimation of school quality follows a very simple value-added model of achievement. Current achievement (A_t) is viewed as a function of prior achievement (A_{t-1}), which is included to capture unmeasured

[4] Similar problems arise with individual ability. Extensive work on "ability bias" in wage-schooling equations treats measured achievement or ability as fixed and independent of schooling (see, e.g., Griliches 1977). With individual student abilities, the impact on school decisions depends on the relative strength of ability on subsequent school performance and on market opportunities. The original Ben-Porath (1970) formulation of the school investment decision separates ability and achievement and treats additions to individual human capital (which might be interpreted as school-related achievement) as neutral, i.e., equally potent in the market and in school. While convenient for modeling purposes, there is little prior empirical evidence on this neutrality proposition.

prior school inputs and ability differences. Direct inputs during period t come from the family (F_A), from peers and other individual-specific differences (X), and from schools (δ_s). School influences are modeled in an agnostic manner without attempting to find explicit measures for the components of schools that are important, and δ_s is simply an index of how school s influences achievement, thus giving it the natural interpretation of the quality of school s. As might be anticipated, with panel data on students' achievement over time, this formulation can be addressed with a fixed-effect estimator for schools.

An alternative approach is simply to analyze ΔA (the difference in achievement between $t-1$ and t), which effectively constrains γ_A to one. We do not impose that constraint here for several reasons. First, in actual application it is common to employ test measures of achievement, and these test measures are not necessarily based on the same scale of measurement; γ_A provides the appropriate rescaling. Second, the impact of past inputs may decline over time, implying, say, that the impact of the first-grade teacher may be more important in determining first-grade achievement than third-grade achievement. Third, gains in achievement may be more difficult to obtain as achievement grows, implying some decreasing returns to initial achievement levels. (In the latter two situations, eq. [1] will include a more complicated error structure, and the potential estimation difficulties posed by this are addressed below.) The interpretation of alternative estimation forms is discussed in Rivkin (2005).

The ability to estimate equation (1) is fundamentally dependent on the ability to separate δ_s from the stochastic error, ε_{it}, which incorporates unobserved and unmeasured influences on achievement. Formulation of this model as including lagged achievement, A_{t-1}, is motivated by the necessity to consider the past family, peer, and school influences that enter into the knowledge and skills that the individual achieves at time t. But a variety of other systematic factors could clearly also enter into the problem.

For our estimation here, one distinct possibility revolves around selection effects arising from dropout behavior. Our main estimation goal in this analysis is investigating why some students drop out of school and particularly the impact of school quality on this. To see the potential issues, we introduce a simple empirical model of dropout propensity:

$$D^*_{it} = g(W, F_D) + \gamma_D A_{it-1} + \lambda\delta_s + \nu_{it}, \qquad (2)$$

where D^* is the propensity to drop out of school in year t, F_D is a vector of family inputs affecting dropping out of school including potentially credit constraints, W includes exogenous influences on achievement, δ_s is the same measure of the quality of school s found in equation (1), and λ indicates how sensitive the dropout decision is to school quality.

The dropout model in equation (2) provides a formulation of how school quality and other factors affect dropout propensities. Of course,

D^* is not directly observed. Instead, we simply observe whether or not somebody has dropped out of school. We assume that ν_{it} in equation (2) is normally distributed and that a person is observed to drop out when $D^* > 0$ and to remain in school when $D^* < 0$. This specification implies that the dropout equation is a probit problem.

The key parameter in equation (2) is λ, the effect of school quality on dropout probabilities. This provides direct estimates of how varying school quality affects individual stopping decisions on schooling. The underlying notion of this is that individual-specific factors of ability, own achievement, and parental factors (including wealth and income to control for borrowing constraints) are incorporated in $g(W, F)$; so this is the effect of school quality after allowing for individual differences in performance.

But putting equations (1) and (2) together highlights problems with the estimation of δ_s. If students who do not like school or who have difficulty in school are most prone to drop out, it is possible that the unobserved errors in equations (1) and (2) (ε_{it} and ν_{it}) are correlated. Since equation (1) depends on observations of those in school between periods $t-1$ and t, the unobserved factors influencing both achievement and dropping out could imply that the sample is not a random one, but one that is self-selected through dropouts—thus leading to potential biases in the estimation of school quality and in the subsequent influence of school quality on the dropout decision. This mirrors the classic formulation in Heckman (1979), where the problem of female labor supply is directly analogous to the school attendance decision.

The impact of potential selection biases depends on a number of factors. In this context, a central question is how well prior achievement characterizes any inherent systematic differences between students who drop out and those who do not, such as incorporating the underlying innate ability differences of the two groups. (For alternative formulations of the estimation issues in education production functions, see Boardman and Murnane [1979], Hanushek [1979], and Todd and Wolpin [2003].)

Our primary approach to the empirical application is the simultaneous estimation of school quality and dropout behavior using maximum likelihood estimation (MLE). In our formulation, we assume that ε_{it} and ν_{it} are joint normal with no constraint on independence. This leads to estimation of equation (2) as a probit model along with the linear, school fixed-effects achievement model. By this simultaneous estimation, we not only obtain appropriate standard errors that reflect the simultaneous estimation of school quality but also permit correlation of the errors across equations. This latter aspect deals directly with unobserved selection of dropping out that could bias the estimates of school quality. At the same time, we also provide single-equation ordinary least squares (OLS) estimation of the school quality equation, which can then be directly applied to the estimation of dropouts through a natural single-equation probit technique. This alternative single-equation approach corresponds to other readily available estimates and thus provides a useful point of comparison. Moreover, under a variety of circumstances it could even be preferred, because it gets around problems of any cross-equation contamination through specification problems in the dropout equation, at the expense of some stronger assumptions about the nature of the stochastic terms in equation (1).

We have emphasized the importance of sample selection, because the potential problems of this arise naturally from our interest in the determinants of school dropouts. While perhaps less important in other contexts—such as achievement in developed countries in which dropout propensities are much smaller—the selection into schools is central to this analysis. Nonetheless, they are not the only issues that arise. A variety of unmeasured factors (correlated with families and schooling decisions) could influence dropout behavior and compromise the identification of the causal impacts of school quality. For example, if the most scholastically motivated parents systematically moved to a given set of schools, other types of selection or omitted variables could be operating in the estimation of equation (1). As another example, achievement here is measured with assessments that are themselves error-prone, raising the possibility of biases through errors in variables. We evaluate the importance of some of the more likely of these problems below, although admittedly we probably cannot cover all. Therefore, confidence in the causal interpretation will require further analyses that can control for possibly contaminating influences not considered here.

V. Estimation Samples

The empirical analysis employs data collected in a longitudinal survey of primary school students in Egypt during two academic years, 1978/79 and 1979/80. The survey was part of the Egyptian Retention Study financed by the World Bank. The principal objective of the study was to examine skill retention among dropouts with special attention directed at urban/rural and male/female differences. Three key elements of the database make it uniquely well suited to our task: (1) the provision of repeated observations on children of primary school age; (2) the collection of data on children both in and out of school; and (3) the extensive testing of children, both in and out of school, to determine their cognitive achievement and ability.

The 1978/79 sample was drawn from a two-stage stratified sample of primary school students and dropouts. (A complete description of the background for the data collection along with the details of sampling can be found in Swanson [1988].) Beginning with a random sample of 30 urban and 30 rural primary schools, random samples of students currently attending grades 3–6 and dropouts who had attended the same grades between 1975 and 1978 were selected. Sampling rates for schools and students varied with the rural/urban location of the school. Nominal sampling rates for dropouts from the sample schools were set at 100 percent. The realized sample included 8,570 usable observations on test scores. In addition, 1,808 dropouts of an estimated 2,747 were located and included in the sample.

In the second year, a one-third subsample of the 1978/79 sample was drawn within each sampled school. The in-school sample was taken from those who continued in school in fourth, fifth, and sixth grades in the 1979/80 school year, dropping students who had completed the sixth grade during the first survey year. In total, 1,976 students were both located and tested in the 1980 follow-up. The corresponding 1979/80 dropout sample consisted of all members of the previous dropout sample that could be relocated and tested in 1980. Further, all "new" dropouts (from school year 1978/79) and any additional "old" dropouts (who had not been located in the previous year) were included. In total, 1,725 dropouts were included in the 1979/80 sample.

In the estimation of dropout behavior, the biggest concern is possible confusion about the status of a student present in 1979 but not observed in school in 1980. Most important, because grade 6 frequently marks a change of school, the sampling could not always identify which students continued and which did not. For this reason, we restrict the estimation of the dropout equation to grade 5 or earlier in 1979.[5]

Seven skill-specific achievement tests and two ability, or "intelligence," tests were developed for the survey. The two intelligence tests were intended to capture noncurriculum dependent measures of the child's skills. In the first year, all nine tests were assigned to the dropout sample, whereas in-schoolers were assigned to only those tests considered appropriate to their grade level.[6] In 1979/80, all nine achievement and intelligence tests were assigned to every member of the sample. The complicated testing program in general implies that a substantial number of students might be lost because of missing data on one or more

[5] Our estimation below includes both simultaneous and separate estimation of the two equations. In the simultaneous MLE approach, no information on students in grade 6 is used in the estimation of school quality, whereas the OLS estimation of school quality can use grade 6 data. Questions about the impacts of missing information on dropouts who could not be located in 1980 appear not to have a major impact on this estimation, but may be more important in the estimation of earnings of dropouts below. The random sampling of in-schoolers and dropouts does not in general lead to concerns about choice-based sampling and is not central to any of our estimation here.

[6] There are four literacy skill tests: Reading A and Reading B measure reading skills; Writing A and Writing B require the child to write words, sentences, and, finally, an entire paragraph. The three numeracy tests included a simple operations test (28 problems), a problem-solving test (14 "story" problems), and an elementary geometry test (eight problems). The tests were designed to be appropriate for different grade levels: the Reading A, Writing A, simple operations, and problem-solving tests were given children in grade 4 or lower; the Reading B, Writing B, and the three mathematics tests were given in the higher grades. Testing was done in one session. In-schoolers were tested in their classrooms during regular school hours, whereas dropouts were brought to school for special sessions. For details, see Swanson (1988).

parts of the examinations. However, by employing appropriate psychometric techniques, it is possible to equate scores across the tests.[7] Our analysis uses the simple average of Rasch equivalent scores for all achievement tests by year and for the ability tests in 1979, the initial period of observation.

In addition to the achievement tests, four questionnaires were employed in 1978/79 to collect information about students, their families, their schools, and their associated community. In the second year, two additional questionnaires were used to collect information about the child's school record, family background, work experience, and attitudes toward school.

These basic samples are combined to create the student panel data employed in the empirical analyses. The descriptive statistics for the subsequent analytical samples are found in Appendix tables A1 and A2.

VI. Basic Empirical Results

The school quality and dropout models have been estimated simultaneously with maximum likelihood techniques along with separate estimation by OLS and probit techniques. Here we describe the results from each separately.

A. *School Quality*

The focus of the school quality modeling is estimation of expected achievement gains in individual schools (with variations in individual achievement, family background, and the like held constant). The basic value-added relationship of equation (1) is first estimated by OLS (with school fixed effects), mirroring the increasingly common approach to estimating achievement relationships (see Hanushek 2006; Hanushek and Rivkin 2006). This can be compared with MLE results, with estimation of the achievement and dropout equations done simultaneously.[8] This latter analysis deals with the potential impact of student selection on the estimation of school quality, but it employs a smaller sample and

[7] Item response theory allows questions to be equated by difficulty and provides an empirical way to equate student performance on the tests. The analysis here uses the Rasch equivalent scores developed in the Egyptian testing program. See Swanson (1988) on the application to the Egyptian assessment data.

[8] A third approach was also pursued but is not reported. Instrumental variables (IV) were employed to deal with the potential endogeneity of initial achievement in eq. (1) that could arise because of the measurement errors in the tests. Two sets of instruments were employed to deal with the accuracy of measurement of prior achievement (A_{t-1}): the initial ability score and characteristics of the school in 1979 (which corresponds to period $t-1$). Neither is a strong instrument. Prior ability may enter into achievement growth, making it correlated with ε_{it}, and the measured school characteristics are not highly correlated with prior achievement (as is consistent with substantial other modeling of educational production functions [Hanushek 2003]). Nonetheless, when employed, the IV estimation had virtually no effect on the estimated school quality, the δ_s.

TABLE 1
ACHIEVEMENT VALUE-ADDED MODELS: 1980
Dependent Variable: ln ACHIEVE$_t$

	Estimation Method		
Input	OLS (1)	OLS (2)	MLE[a] (3)
ln ACHIEVE$_{t-1}$	.544	.54	.53
	(41.66)	(35.70)	(34.32)
Grade 4	−.017	−.017	−.012
	(−.82)	(−.49)	(−.4)
Grade 5	.042	.042	.040
	(1.83)	(1.86)	(1.06)
Grade 6	−.331	−.329	
	(−8.75)	(−8.68)	
Mother's education	−.005	−.005	−.0025
	(−1.06)	(−1.07)	(−.20)
Father's education	.007	.007	.006
	(2.69)	(2.71)	(1.5)
Male	.029	.029	
	(1.67)	(1.66)	
ln ABILITY$_{t-1}$		−.007	
		(−.49)	
Constant	2.547	2.549	2.528
	(37.23)	(37.16)	(38.72)
F-test school equality	5.13 *F*	5.12 *F*	
	(57,1871)	(57,1870)	
R^2	.64	.64	
Observations	1,938	1,938	1,714
School fixed effects (δ)	Yes	Yes	Yes

Note.—*t*-statistics are in parentheses.
[a] Maximum likelihood estimates jointly estimated with dropout model.

relies on having the correct structure for both equations. Therefore, it is useful to compare these alternative approaches, each of which has both strengths and weaknesses.

The OLS approach relies on the "school quality" sample made up of 1,938 students, which represents all 1979/80 in-schoolers with usable test scores in both years and with complete background data. (Variable definitions and descriptive statistics are found in App. tables A1 and A2.) Thirty-one percent of the students are at grade 3, 33 percent at grade 4, 30 percent at grade 5, and the rest at grade 6 in 1980. The MLE estimates employ a sample that eliminates the sixth graders (because of imperfect measurement of dropout status) and is subject to more observations that had to be dropped for missing data problems. This restricted sample with 1,714 cases is also described in Appendix table A1.

Table 1 displays estimates of the basic value-added achievement model estimated in log-log form. Two variants of the OLS model and one of the MLE model are presented. The two OLS variants differ by the direct inclusion of the ability measure, which has virtually no impact on achievement after lagged achievement is included.[9] A remarkable feature is that the estimated parameters across the models and estimation approaches are so similar in magnitude and statistical significance.

There is limited evidence suggesting that parental background systematically has much effect on achievement growth, or value-added. Father's education level shows a positive effect on student performance, but the estimated effect is uniformly small. Mother's education is always small and statistically insignificant. In this sample, however, the level and variation of parental education, particularly mother's education, are extremely limited. There is some indication that, other things equal, boys have higher achievement growth than girls, but again the effects are small. Preliminary estimation included a wider range of characteristics of the family (income, wealth, and family size), but none proved to be significant, and only the more parsimonious results are presented here. This of course does not imply that differences in family inputs are totally unimportant. Their impact on achievement growth rates cannot be detected, but family factors clearly enter into the starting level of achievement, A_{t-1}.

The key finding of this estimation is that sampled schools are clearly very different in terms of quality as measured by their impacts on student achievement growth. The precise quantitative estimates of school quality vary somewhat with the estimation method, although they are very highly correlated. The estimated school quality measures from the simple OLS estimates (col. 1) and the MLE estimates (col. 3) have a correlation of .85. The *F*-statistics in table 1, against the null hypothesis of homogeneous schools, confirm that there are significant differences among the sampled schools.

The estimates indicate that student growth in achievement can be dramatically different depending on the specific school. Table 2 displays descriptive statistics for the OLS and the MLE estimates of school quality variations. These are presented for all schools and for schools divided by urban and rural location. While the estimation approaches produce slightly different patterns, the overall picture is quite consistent. The range is instructive: By the OLS estimates, one school has 33 percent higher achievement growth than the base school, whereas at the other end of the range, we find a school that has about 72 percent lower growth; by the MLE estimates, the range is 40 percent higher to 43 percent lower. The estimation in the table presents estimates as deviations from the Taha Hussein urban school. Since all that can be esti-

[9] As discussed in the prior footnote, one reason for inclusion of ability in these models is to consider its possible use as an instrument for measurement error in lagged achievement. When ability is used as an instrument (not shown), it has little effect on the estimated coefficient for A_{t-1}. This is unexpected because both potential problems would be expected in this situation to bias this parameter toward zero. In both the OLS and IV models, the estimated coefficient on prior achievement is significantly different from one, implying that simple differencing of achievement would be inappropriate in this context.

TABLE 2
DISTRIBUTION OF ESTIMATED SCHOOL QUALITY

	All Schools	Rural	Urban
	OLS Estimates[a]		
Mean	−.120	−.178	−.063
Minimum	−.72	−.72	−.30
Maximum	.33	.33	.18
	MLE Estimates[b]		
Mean	−.063	−.101	−.025
Minimum	−.43	−.43	−.26
Maximum	.40	.40	.17

Note.—School quality is measured as proportional deviations from Taha Hussein School.
[a] School quality estimates from col. 1, table 1.
[b] School quality estimates from col. 3, table 1.

mated is variations across schools, it does not matter which school is chosen as the basis for comparison. Note that, when achievement is measured in logarithms, the school-specific coefficient (times 100) is approximately the percentage deviation from the base school.

These estimates imply that 1 year in the best school can be equivalent (in expected achievement gain) to more than 2 years in the worst school. This magnitude of difference obviously can have a huge effect on the achievement of a student when compounded over just primary schooling, and it implies that the rate of return to a year of individual schooling investment could vary systematically.

Table 2 also indicates that the average quality of urban schools is some 7–11 percent above that of the sampled rural schools. Nevertheless, the distributions show considerable overlap, with both the best school and the worst school identified as being in the rural areas. The estimation of school quality across the entire sample allows for distinct urban and rural differences through the fixed effects. If one allows the other parameter estimates (in table 1) to vary by urban or rural location of the schools, the noticeable difference is that the coefficient on lagged achievement ($\hat{\gamma}_A$) is larger in the urban than in the rural sample (0.58 vs. 0.52). While statistically significant, the substantive effect is small. In terms of the influence of parents, there is no significant difference.

It is important to remember that these estimates will contain sampling error. The average number of students used to estimate the fixed effects in each school is 41, but this ranges from 13 to 110. The sampling error for each estimated school quality term is strongly related to sample size and will be affected by the underlying estimation samples in each school. Nonetheless, the quality range observed in table 2 is not the result of just the schools with few students. Nine schools have samples of fewer than 25 students, but none of these are the extremes of the overall distribution shown in table 2. The average standard error across the estimated MLE fixed effects drops from 0.11 with all schools to 0.098 when these smallest nine schools are excluded.[10] (Because of the sampling of students, the small schools are evenly split between urban and rural schools.) The range in estimated quality substantially exceeds any confidence bounds for sampling error that might be derived from these estimates.

These differences are interpreted as reflecting quality variations in the schools, even though the underlying characteristics of teachers and schools that are important are not identified. To the extent that it is some combination of school, teacher, and peer factors, it does not make much difference for our interpretation and subsequent modeling. However, it would be more problematic if the estimated effects involve more than just school effects—such as some unmeasured individual student effects or some community effects. Several additional pieces of evidence point to the school quality interpretation, although the evidence is not entirely conclusive.

First, school expenditure is reasonably considered as exogenous, given the nature of funding by the central government. Attendance at public schools is geographically determined by residence location. For rural areas, this implies virtually no Tiebout-like choice, especially given the absence of a private sector. For urban areas, some choice of location is possible, but the central funding, curriculum, and decision making lessen its importance.

Second, because of the geographic basis of schools, it is possible that other community factors—from intensity of schooling preferences to health and nutrition characteristics—are the key feature but are confounded with schools through the estimation strategy. As a test of this and other dimensions, we correlated average mother's education and average father's education, school achievement levels, and measured school factors with our measure of school quality. The results, shown in table 3, provide some insights. We hypothesized that parental education would be an important determinant of any broader community factors as well as the ability of parents to identify and act on such differences. In the exploratory look at differences in the estimated school quality, neither measure is statistically significant. Even in terms of just the simple correlations with δ_s (as opposed to the multivariate estimates in table 3), neither is statistically significant.

[10] A second source of error in the school quality estimates comes from relying on standardized tests that have measurement error. Thus, the variance in the school quality estimates is inflated by the error variance related to test reliability. It is difficult to say exactly how large the errors are, because test reliability statistics are not available for these Egyptian assessments. In a somewhat comparable set of estimates of teacher quality from the state of Texas (using individual teacher fixed effects), the variance of the measurement error was estimated to be about half of the total variance estimated (Hanushek, Kain, et al. 2005). But, in these estimates, there were fewer students per teacher than observed in the Egyptian schools. Even if half of the variation in table 2 came from measurement error, the remaining quality differences would be very large and significant.

TABLE 3
Explanatory Models for School Quality Estimates

	MLE School Quality Estimate[a]		OLS School Quality Estimates[b]	
	(1)	(2)	(3)	(4)
School average $ACHIEVE_{t-1}$	.001		.001	
	(1.04)		(1.58)	
Average teacher experience	.011		.01	
	(1.53)		(1.13)	
Proportion new teachers	.285	.151	.337	.204
	(1.81)	(1.15)	(1.85)	(1.32)
Proportion BA degrees	.203	.23	.187	.221
	(1.12)	(1.23)	(.89)	(1.01)
Proportion with pedagogical training	.08	.087	.031	.047
	(.71)	(.74)	(.24)	(.34)
Proportion male teachers	.229	.127	.202	.081
	(2.25)*	(1.69)	(1.71)	(.92)
Urban school	.079	.071	.101	.103
	(1.88)	(1.66)	(2.08)*	(2.06)*
Mean mother's education		−.036		−.039
		(.59)		(.56)
Mean father's education		.037		.039
		(1.31)		(1.17)
Constant	−.588	−.333	−.669	−.361
	(2.93)**	(2.78)**	(2.88)**	(2.57)*
Observations	59	59	59	59
R^2	.19	.18	.22	.19

Note.—School quality is measured as proportional deviations from Taha Hussein School. Coefficients are marginal probabilities at means of exogenous variables. Absolute values of t-statistics are in parentheses.
[a] School quality estimates from col. 3, table 1.
[b] School quality estimates from col. 1, table 1
* Significant at 5 percent.
** Significant at 1 percent.

Third, the individual ability factors are assumed to enter into the level of achievement but not growth, so the school effects might just be a measure of having a collection of smart students. As a crude test of this, we calculate the correlation between our estimated school quality and the mean level of 1979 achievement in the school.[11] The simple correlation is only .099, insignificantly different from zero. The insignificance also holds in the multivariate models of table 3.

Table 3 also shows that the generally accepted measures of quality—teacher experience, training, or education—are not closely related to our quality measures. Admittedly, the data are thin with only 60 total schools. Yet even in very parsimonious models, these school resource measures are not closely related to our estimates of overall quality.

[11] Ordinary least squares techniques will imply that individual parental education and achievement in 1979 will be uncorrelated with the error terms in the equations for the total sample. Here, however, we are concerned with the correlation of the school-level aggregate of 1979 achievement and parents' education with the school-level average growth in achievement, and these correlations are not constrained by the estimation.

It is difficult in these analyses to rule out all other interpretations, and exogenous instruments that do not enter directly into the achievement models are virtually impossible to find. Nonetheless, the available evidence points toward a school quality interpretation.

The OLS estimates are obtained from the sample of students who remain in school over both years. While the samples are large, over 1,900 students in the 60 schools, it is possible that missing test scores for the dropouts could bias these estimates. Specifically, if a school had a large dropout rate and if dropouts were the lowest-growth achievers (in the value-added models), its aggregate gain in average student performance could be pushed up relative to a school with a low dropout population. On the other hand, the MLE models are estimated to take such a possibility into account. Thus, it does not appear to be highly driven by selection. This selection correction may be a partial explanation for the imperfect correlation between the OLS and MLE estimates of school quality, although the different samples undoubtedly also contribute. The presumption in the subsequent section is that these estimates (δ_s) provide direct measures of quality differences among schools and that students and their parents can gauge the differences that exist.

B. *School Dropout Behavior*

The final and most important component of the estimation looks specifically at the dropout decision. Beginning with the sample of all in-school children in 1979, we attempt to understand why some drop out by 1980 whereas others remain in school. All sixth graders are eliminated from the sample because it is not possible to distinguish between those who drop out of school and those who go on to another school (a common occurrence at this grade). The estimation sample for the MLE joint estimation relies on 1,714 students, including both students who remained in school in 1979/80 and those who dropped out (4.2 percent) in that year.

Figure 1 presents raw dropout rates plotted against the estimated school quality using the MLE estimates. (The plot with comparisons of the MLE and OLS estimates is found in App. fig. B1. Schools with no dropouts in 1980 are excluded from the figures.) There is a clear fall in dropout rates as school quality increases.[12] The plot also distinguishes

[12] As mentioned previously, one concern with the OLS estimates (but not the MLE estimates) is that higher dropout rates would tend to bias upward the estimates of school quality if dropouts were the lower–achievement growth students. But if this is the case, the bias would work against the hypothesis that lower-quality schools induce more dropouts. In other words, the observed relationship should be even more pronounced than it is. Appendix fig. B1 also suggests little difference in the simple quality-dropout relationship when comparing OLS and MLE estimates, although the OLS estimates are more scattered. This figure displays the simple regression lines that relate school quality to dropout rates, and the best line relating school quality (estimated by either MLE or OLS estimation) to dropout rates shows that the overall pattern is extremely similar.

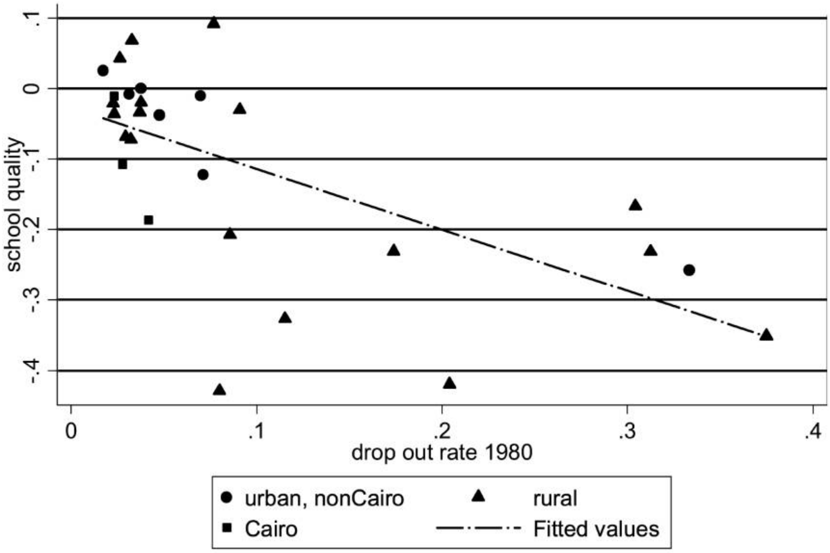

Figure 1.—School quality and dropout rates, 1980

among urban, rural, and Cairo schools. The majority of schools with very high dropout rates are rural schools, where dropping out tends to occur earlier and more frequently. Nonetheless, a linear fit through the nonrural observations yields virtually the same slope as that through just the rural observations.

We present MLE probit models of dropout determinants, equation (2), in table 4. The difference between the two columns is the estimation form for the achievement models. Column 1 excludes log of measured 1979 ability from the achievement function and column 2 includes it. The estimates are extremely similar and do not require separate discussion.

Perhaps the most novel feature of this estimation is the direct investigation of school quality (δ_s) on dropout behavior. These results suggest strongly that high-quality schools in and of themselves serve to retain students and to prevent dropouts. Independent of the student's own achievement and ability level, better schools directly increase the probability that a student will stay in school. School quality is separately estimated and not based on simple survey questions about perceptions, but the evidence does indicate that parents and children can observe quality differences and find them important. Moreover, it must be emphasized that school quality is estimated from value-added models so that this effect is not the result of confusion with better students.

The models indicate that males are less likely to drop out of school, a finding that is totally unsurprising in Egypt. Egypt's Muslim society traditionally had lower schooling for females along with less labor mar-

TABLE 4
MLE ESTIMATES OF THE DETERMINANTS OF DROPOUT BEHAVIOR

Input	(1)	(2)
δ_s (school quality)	−3.8	−3.82
	(−5.10)	(−5.08)
ln ABILITY$_{t-1}$		.048
		(.50)
ln ACHIEVE$_{t-1}$	−.646	−.647
	(−5.96)	(5.95)
Grade 4	.86	.86
	(3.73)	(3.73)
Grade 5	1.38	1.38
	(5.22)	(5.20)
Mother's education	.038	.039
	(.46)	(.47)
Father's education	−.044	−.044
	(−1.36)	(−1.36)
Male	−.322	−.322
	(−1.85)	(−1.85)
Wealth	.151	.152
	(.37)	(.37)
Constant	−.265	−.267
	(−.58)	(−.58)
Correlation (u, v)	−.0096	−.0098
	(−.097)	(−.098)
Observations	1,714	1,714

Note.—Dropout models come from a probit model estimated jointly with school quality (as displayed in col. 3 of table 1). Estimates are coefficients from the probit models.

ket attachment and lower wages if working—even if this has improved in more recent times. Other things equal, males are 6 percent less likely to drop out during elementary grades than females.

The grade dummy variables are included to indicate the overall probability of dropping out, conditional on reaching any given grade. (The left-out category is grade 3.) Other things equal, as a student progresses past grade 3, dropout probabilities steadily increase.

Somewhat surprisingly, individual dropout rates do not appear to be very sensitive to parental education levels. Mother's and father's years of schooling were insignificant by conventional standards. Higher levels of father's education are consistently related to lower dropout rates, but the point estimates are very small; mother's education uniformly shows a small and very insignificant impact on dropouts. This result is quite different from that of Lillard and Willis (1994), who find strong intergenerational transmission of schooling differences in their analysis of Malaysian schooling. Some recent evidence, however, questions whether parental education has a causal impact on child outcomes (Behrman and Rosenzweig 2002; Black, Devereux, and Salvanes 2005; Carneiro, Meghir, and Parey 2007). It is clear that average schooling level of parents in our Egyptian sample is very low and displays little variation.

Note, however, that the models condition on earlier achievement, A_{t-1}, and that this will incorporate differences in learning in the family.

It is interesting to see how individual skills enter into the decision. Higher achievement lessens the probability of dropping out, and measured ability has essentially no effect on dropout behavior. The Ben-Porath-like neutrality assumption, often employed in modeling human capital investment decisions, indicates that human capital has equal return in producing more human capital or in market returns. The estimates here (combined with those of table 6, below) suggest larger schooling returns than market returns of achievement, at least at early grades. Measured ability, on the other hand, appears "neutral."

Achievement and ability are measured in 1979, prior to the decision to drop out or remain in school in 1980. It is still possible, however, that causality is confused in some instances. If a student stopped studying in school or simply did not try hard to complete the tests in anticipation of dropping out in 1980, dropout behavior could lead to lower achievement. It seems doubtful, however, that this is a major problem.

Finally, family wealth differences have an insignificant effect on dropout decisions. While very imprecisely measured,[13] this appears to indicate that borrowing constraints are not overly important in determining school continuation.

The estimation has relied heavily on outcome-based measures of school quality, which, while not directly observed, do seem to be closely related to school dropout decisions. This does not mean, however, that observable factors do not affect dropouts. In order to test the joint impacts of our quality measures and characteristics of schools on dropout behavior, we take the MLE estimates of quality and use them in direct estimation of probit models for determining individual dropouts. Specifically, we merge the estimated school quality with the individual student data and estimate a series of specifications with varying explicit measures of school factors that match the general model in equation (2).

Table 5 displays a series of alternative probit models of influences on dropouts. (The coefficients in table 5 are transformed to give the marginal probability of dropping out that is associated with each variable.) The top part of the table corresponds closely to the estimates in table 4. Individuals with higher achievement tend to drop out less than those with lower achievement. But, with own achievement held constant (and own ability in col. 3), higher-quality schools are strongly associated with lower dropout rates. Thus, the single-equation estimates of dropouts here are quite similar to those from the joint MLE estimation.

Columns 3 and 4 provide information on the influence of teacher

[13] Family wealth is measured by the proportion of the following items: running water, electricity, radio, reading material, and home ownership. Because these crude measures of wealth might have different meanings in urban and rural settings, the effect of wealth was estimated separately for urban and rural areas.

TABLE 5
Probit Models of Dropout Determinants
Dependent Variable: Dropout Probability

	(1)	(2)	(3)	(4)
δ_s (school quality)	−.153	−.146	−.119	
	(8.65)**	(8.16)**	(7.32)**	
ln ACHIEVE$_{t-1}$	−.024	−.022	−.019	−.023
	(7.88)**	(6.17)**	(7.26)**	(7.52)**
Mother's education	.001	.001	.000	.000
	(.300)	(.380)	(.040)	(.020)
Father's education	−.002	−.002	−.002	−.002
	(1.670)	(1.510)	(1.680)	(1.370)
Grade 4	.028	.028	.022	.024
	(3.22)**	(3.24)**	(3.15)**	(3.01)**
Grade 5	.073	.071	.057	.061
	(5.91)**	(5.84)**	(5.55)**	(5.53)**
Male	−.011	−.011	−.008	−.009
	(1.900)	(2.01)*	(1.620)	(1.700)
ln ABILITY$_{t-1}$		−.001		
		(.500)		
Mean father's education		−.002		−.005
		(.81)		(1.54)
Proportion male teacher			−.008	(.043)
			(.540)	(2.83)**
Mean teacher age			.004	.001
			(1.470)	(.180)
Average total teaching experience			−.004	−.002
			(1.360)	(.860)
Proportion new teachers			−.004	−.037
			(.200)	(1.780)
Proportion BA degrees			.357	.401
			(2.85)**	(2.48)*
Proportion pedagogical training			.009	−.013
			(.620)	(.830)
Mean school experience			−.001	.000
			(.240)	(.150)
Teachers with second job			−.010	(.064)
			(.420)	(2.08)*
Secondary school education			.351	.439
			(2.91)**	(2.84)**
Observations	1,907	1,907	1,834	1,834

Note.—School quality is measured as proportional deviations from Taha Hussein School. Coefficients are marginal probabilities at means of exogenous variables. Estimates of school quality from MLE of joint achievement and dropout models; see col. 3, table 1. Absolute values of z-statistics are in parentheses.
* Significant at 5 percent.
** Significant at 1 percent.

and school factors. Column 3 gives the marginal impact of these teacher and school characteristics past δ, and column 4 drops our school quality measure and looks at the total influence of these measurable attributes when δ is excluded. In column 3, none of the factors gives a plausible estimate of quality. The indicators for a bachelor's degree or a secondary school diploma stand out as being statistically significant, but the sign is opposite of conventional wisdom: teachers with a bachelor of arts degree tend to increase dropout rates. Looking at total impacts in column 4 (without our estimate of school quality), the overall picture does not change much.

It is not possible to estimate simultaneously the combination of teacher differences for a school and the fixed-effect estimates of school quality because the characteristics will be constant for a school. (The original survey did attempt to match students and teachers, but imperfect surveying of teachers greatly reduces the sample if estimation is done according to individual teachers for each student.) Repeating the probit estimation in table 5 but using the OLS estimates of school quality does not change the overall story. The results are very similar, although the models with OLS quality measures are less precisely measured.

These estimates reinforce those in table 4. Students and parents appear to be able to figure out the quality of the school and respond to it. They do not get confused by more observable measures of the teachers or other students in the school (that are not linked to quality differences).

The differences in urban and rural areas, both in schools and in the pull of labor markets and other factors, suggest that there might be commensurate differences in the dropout behavior of students in urban and rural areas. Table 6 shows the basic probit models of dropout behavior, where behavior is permitted to vary across urban and rural schools. Specifically, the bottom half of the table provides the marginal influence of each factor on dropout behavior for students in urban schools. Column 1 shows that after we account for individual achievement and for the quality of schools, simply being in an urban school has no impact on dropout probabilities. Column 2, however, separates the behavioral impact of each of the factors for urban and rural schools. The only significant difference is that urban students are much more sensitive to school quality than rural students. Specifically, the impact of school quality (δ) on dropout probabilities estimated across all students in column 1 ($\hat{\lambda} = -0.153$) is seen in column 2 to be a mixture of rural student reactions ($\hat{\lambda}_{rural} = -0.101$) and the much higher urban student reaction ($\hat{\lambda}_{urban} = -[0.101 + 0.134]$). This stronger reaction to quality differences, more than twice as large as the rural reaction, is coincident with both the higher opportunity cost of being in school and the much larger returns to educational quality in the urban labor market, as seen in the next section.[14]

VII. The Market Value of Schooling and Achievement

The underlying theory of school choice considers trading off forgone earnings for enhanced skills. As modified here, it concentrates on the

[14] A further sensitivity test involves estimating dropout behavior employing school quality (δ) estimates from the models that allow all coefficients to be unconstrained. In these dropout models, the impact of school quality remains statistically significant and has the same qualitative effect, although the estimate is less precise.

TABLE 6
DIFFERENCES IN DROPOUT BEHAVIOR BETWEEN URBAN AND RURAL SCHOOLS: PROBIT MODELS
Dependent Variable: Dropout Probability

	(1)	(2)
δ_s (school quality)	−.153	−.101
	(8.38)**	(6.30)**
ln $ACHIEVE_{t-1}$	−.024	−.019
	(7.68)**	(6.54)**
Mother's education	.001	.001
	(.29)	(.45)
Father's education	−.002	−.001
	(1.67)	(.82)
Grade 4	.028	.022
	(3.21)**	(2.55)*
Grade 5	.073	.051
	(5.91)**	(4.34)**
Male	−.011	−.006
	(1.84)	(.94)
Urban	.000	−.005
	(.05)	(.19)
	Urban Dropouts	
Urban × δ_s		−.134
		(3.12)**
Urban × ln $ACHIEVE_{t-1}$		−.004
		(.68)
Urban × father's education		−.001
		(.55)
Urban × grade 4		.005
		(.33)
Urban × grade 5		.018
		(.98)
Urban × male		.002
		(.16)
Observations	1,907	1,907

Note.—School quality is measured as proportional deviations from Taha Hussein School. Coefficients are marginal probabilities at means of exogenous variables. Absolute values of *z*-statistics are in parentheses.
* Significant at 5 percent.
** Significant at 1 percent.

marginal impact of varying quality, measured by student achievement (and the expectation of enhanced achievement from quality). A key issue is whether or not measured achievement is related to labor market outcomes. There is a growing body of literature indicating that the cognitive skills measured with common tests have a strong influence on market resources.[15] A secondary issue is whether or not any of this makes

[15] Analyses of earnings differences and cognitive skills are most readily found in developed countries and particularly the United States, although a number also exist for developing countries. For developing countries, see Boissiere, Knight, and Sabot (1985), Knight and Sabot (1990), Glewwe (1996), Angrist and Lavy (1997), Jolliffe (1998), Moll (1998), Vijverberg (1999), and Behrman, Ross, and Sabot (2008). For developed countries, the clearest analyses are found in the following references (which are analyzed in Hanushek [2002]): Bishop (1989, 1991), O'Neill (1990), Blackburn and Neumark (1993,

a difference for the young dropouts and students of the Egyptian sample. In order to address these issues, we estimate a series of simple earnings-generating functions for those working in the formal labor market.

The earnings estimation relies on actual pay and characteristics for a sample of working children drawn from all old dropouts (1979 or earlier) and all new dropouts (1979/80) who have usable achievement and other basic data. The total sample of 3,051 dropouts yields 648 individuals working for pay in the formal market and provides information on labor market work and wages. Interestingly, the probability of being observed in the formal market is very similar across urban and rural sectors in our data.

This estimation is obviously prone to concerns about sampling, because market work is limited (particularly in rural areas) and because observations for the youthful sample of dropouts may not be indicative of long-run impacts of schooling. Preliminary models of the probability of working in the market were not too informative. They indicated that work probabilities rose significantly with age and with time out of school. Additionally, in rural families, the probability of market work decreased with family wealth (which includes landownership), whereas in urban families, the largest other factor is health limitations of the father, or an apparent need to make up for lost family income. This apparent impetus to help the family through working, albeit not necessarily in the market, is supported by surveys of the Egyptian dropouts (Swanson 1988). None of these factors, however, have obvious implications for sample selection that would bias the earnings models used here. With caveats about potential selection into market work, we simply present common Mincer earnings models similar to others found for developing countries (e.g., Psacharopoulos and Patrinos 2004) except augmented by direct information about achievement and ability.

Of those engaged in market work, 46 percent are urban children, their mean age is 13 years, on average they have been out school for about 4 years when observed in 1980, and most of them (85 percent) are males. The urban and rural components in this sample have the same age and sex means, but the urban children have more years of schooling attained, staying in school 1 more year than their rural counterparts, and their mean score on the ability tests is 22, twice that of rural children (11). The mean wage rate is 38.4 piasters a day, and it is lower in rural areas (36.4) than in urban areas (41.9).

In all of the analysis, the sample of young workers is stratified into urban and rural samples in order to capture fundamental differences

1995), Grogger and Eide (1993), Murnane, Willett, and Levy (1995), Neal and Johnson (1996), Mulligan (1999), Murnane et al. (2000, 2001), Altonji and Pierret (2001), and Lazear (2003). Hanushek and Zhang (2006) provide international comparisons of the returns to cognitive skills for 13 countries, although they are heavily weighted toward developed countries. Hanushek and Wößmann (2006) provide an evaluation of the commonalities of different estimates.

TABLE 7
INCOME MODELS: ALL WORKING DROPOUTS
Dependent Variable: ln(Market Wage)

		Urban		
Variable	Rural	Total	Cairo	Non-Cairo
Male	.422	.333	−.018	.641
	(4.5)	(2.2)	−.1)	(2.8)
ln $ACHIEVE_{t-1}$	.024	.107	.069	.144
	(.7)	(2.6)	(1.4)	(2.0)
Highest grade	.050	.122	.187	.086
	(1.4)	(2.5)	(2.8)	(1.2)
Experience (time out of school)	.033	.022	.082	.00
	(1.2)	(.7)	(1.9)	(.18)
Constant	2.804	2.451	2.444	2.218
	(12.9)	(7.6)	(5.7)	(4.7)
R^2	.08	.07	.08	.09
Observations	348	297	151	146

in the structure of the labor markets. In part of the analysis, the urban sample is further subdivided into the Cairo area and the remaining urban areas of the country, although, because the samples get very small, we concentrate on the basic rural/urban split of the samples. For each stratification, a common log-linear earnings function is estimated. Table 7 presents the basic earnings estimates using OLS techniques for the sample of all working dropouts in 1980.[16]

The models explain a relatively low portion of the overall variance in wages, perhaps because of significant measurement error in the wage rates themselves. Nevertheless, while imprecisely estimated, the wage parameters are quite consistent with expectations. Even for this young and inexperienced group of workers, it is possible to identify several key relationships and, particularly, the effects of schooling.

The estimates indicate that males consistently earn some 33–42 percent more than females in market work for pay. This differential is quite similar across urban and rural areas, although the premium appears largest in rural areas. The gender differential is very imprecisely estimated in the small Cairo sample, although the non-Cairo urban sample suggests even larger male-female differences. Interestingly, from an *F*-test for homogeneity of coefficients, once the level differences are accounted for with the gender dummy variable, the models are insignificantly different for the earnings of boys and of girls.

In neither urban or rural settings is it possible to detect an experience

[16] These earnings models have been estimated jointly with models of the probability that any dropout works for wages in the market. These models, estimated by MLE techniques assuming normally distributed errors, are very imprecisely estimated. While the probability of market work can be characterized in a reasonable manner, the earnings relationships are not well estimated in this joint manner. Further, these estimation problems appear to be more than simple identification problems for the probability and earnings models but instead reflect the small samples and correlations among the variables.

(time since dropout) effect. The estimated relationship with experience is generally small and statistically insignificant, although the effects in Cairo may be larger. The point estimates for the Cairo labor market indicate an 8 percent premium for each year of experience outside of school, but this is considerably above any of the other estimates. Note, however, that we do not have actual labor market experience. Instead we simply have time since dropping out of school. In the Cairo area, where work in the labor market is more likely for these dropouts, the estimated effect could be closer to an actual experience premium. In other words, measurement error for actual experience in the other labor markets may bias their coefficients toward zero. It is conventional for Mincer earnings models to include a quadratic term for experience. We do not do this here because of the short working life that is observed, where even the conventional Mincer models will look quite linear.

The key to the models for our purposes is the interaction of earnings and schooling. This interaction is found along both the quality (achievement) and the quantity (highest grade) margins. In quality terms, achievement differences are directly translated into earnings differences in urban areas. Perhaps the most notable difference between the urban and rural settings is that there apparently is not a premium paid for more cognitive skills in rural areas. This finding would be consistent with a labor market situation in which urban jobs were more skilled and rural jobs were weighted toward manual labor.

More years of schooling yield higher immediate earnings to dropouts—quite clearly so in urban areas. An additional year of schooling is associated with 12 percent higher earnings in urban areas and 5 percent higher earnings in rural areas. The rural earnings effect is, however, imprecisely estimated and is not statistically significant.

The fact that age and time out of school have strong influences on the probability of working in the formal market does imply that substantial elements of the value of skills and schooling across the population might yet be observed in our sampled youth. It is difficult to know precisely how later entry into the formal sector might affect the estimated returns to schooling. However, it is possible that over time the returns to measured achievement and cognitive skills would rise as employers have more time to observe the individual's skills. (Altonji and Pierret [2001] and Hanushek and Zhang [2006] present mixed evidence on this.)

These earnings models provide general support for the basic perspective of this analysis. Both quality and quantity of schooling are important, and the dropout decisions of primary school children could be strongly affected by estimates of school quality. Nonetheless, because of the low probabilities of working in the formal sector by our sampled dropouts, the results of the earnings estimates should be viewed with caution.

VIII. Conclusions

The Egyptian government has worked successfully to alleviate many of the primary concerns about school attainment as it existed in the 1980s and 1990s. By 2004, Egyptian primary school net enrollment rates were estimated to have reached 95 percent, and the female enrollment rate had largely caught up with that of males (UNESCO 2007). Moreover, a large-scale intervention aimed at building primary schools in outlying areas made primary school accessible to 99 percent of rural Egyptians by 2001 (World Bank 2002). Yet, while access to primary school is largely universal, many Egyptians fail to take advantage of schooling past the compulsory years. According to this World Bank study, the transition rate from the compulsory preparatory school to secondary school was 81 percent in 2001.

At the same time Egypt has lingering quality issues to face. While not wholly different from those in other developing countries, Egyptian students scored three-quarters to one standard deviation off of the world average in mathematics and science for 2003.[17] Interestingly, the performance of boys and girls on these assessments is virtually the same, an unusual fact around the world and especially in Arab and African countries. Again, the remaining attainment problems and school quality appear by our analysis to be closely linked.

A simple set of conclusions are suggested by this analysis. Higher-skilled individuals—children with greater achievement—tend to be the ones who stay in school. Lower-skilled individuals tend to leave school early.

But, with the individual's own ability and achievement held constant, a student attending a higher-quality school will tend to stay in school. A student attending a lower-quality school is more likely to drop out and complete fewer grades. Students appear to recognize quality differences and act on them. Bringing all schools up to the best-quality school would reduce the dropout rate estimated in the sampled Egyptian schools by two-thirds or more. Of course, making such quality adjustments may be difficult because this analysis has not identified the specific school factors that add up to variations in school quality. This ambiguity about policy pervades both developing and developed countries and is not resolved here. While outside the scope of this study, the obvious direction of policy involves heavier reliance on performance incentives. The case for these, and the outlines of potential policies, can be found in Hanushek et al. (1994) for the United States and in Harbison and Hanushek (1992) and Hanushek and Wößmann (2006) for developing countries. Nor have we estimated the cost that might be incurred in

[17] Egypt has participated in only one set of international tests (for 2003) (Martin et al. 2004; Mullis et al. 2004). This performance has substantial implications for growth rates according to the analysis in Hanushek and Wößmann (2006).

adjusting schools. Nevertheless, the importance of school quality is very clear.

The finding about the relationship of school quality and completion rates provides more evidence that the frequently discussed equity-quality trade-off is misstated. The trade-off typically identified arises from simple consideration of the budget constraint facing schools; money spent on quality reduces that available for expanding the number of school positions available. This simple budget analysis, however, ignores the complementarity of quality and efficiency in production.

Quality interactions with individual student decisions about leaving school have important implications for conventional analyses of school investment. Standard rate of return calculations based solely on quantity of schooling are likely to be misleading because they ignore school quality, which improves earnings opportunities and is positively correlated with quantity completed by individuals. The rate of return to pure quantity of schooling is almost certainly overestimated when quality is ignored, implying that standard policy prescriptions based on just simple quantity returns might lead to suboptimal policies. For example, a policy of significant expansion of schooling made budgetarily viable by expanding poor-quality schools might never yield the gains forecast by standard rate of return estimates. The optimal policy given feedback of quality to school completion depends on the costs of improving quality, something that is unknown given uncertainties about how to improve quality.

While this analysis has not been able to consider repetition because of the sample design, the effects of quality on repetition are likely to reinforce these results. Lower-quality schools tend to retain students in a grade because they have not accomplished as much as they progress through school (see Harbison and Hanushek 1992; Gomes-Neto and Hanushek 1994). Grade repetition then limits overall access to schools, because repeaters are taking up positions in schools that could otherwise be used by an expanded group of students. In simplest terms, if noncompletion of primary schooling is a concern in developing countries, as it should be, school improvement may be an attractive policy.

The Education for All initiative has been primarily aimed at achieving universal primary schooling, although it has recognized that the quality of schooling is also an issue (UNESCO 2005). It has not, however, seen that there is a direct linkage of quality and achievement of its attainment goals. In fact, the strategy for school expansion in developing countries might be quite different if these linkages were recognized and incorporated in planning and policies.

These perspectives on school quality and school completion may also have implications for developed countries. For example, no systematic analysis relates dropout behavior to school quality in the United States. Moreover, most policy discussions completely ignore such linkages, implying instead that dropout behavior is largely an irrational individual decision.[18]

Finally, from an analytical perspective, this article demonstrates the importance of incorporating outcome-based measures of school quality. This analysis separates individual achievement from the expected achievement gains attributable to an individual school. By doing this, it circumvents the serious problems that come with measuring school quality by a selected group of inputs, and it avoids confusing school quality with individual differences in performance that might arise from other sources.

[18] One investigation of parental choice and school quality is found in the case of exit behavior from charter schools in the United States. Hanushek, Kain, et al. (2007) show that parents are much more likely to leave low-quality (i.e., low-value-added) charter schools than high-quality ones.

Appendix A

TABLE A1
DESCRIPTIVE STATISTICS FOR ANALYTICAL SAMPLES

Variable	Mean	Standard Deviation	Description
	A. MLE School Quality-Dropout Sample (n = 1,714)		
Grade 3	.31	.46	=1 if student in grade 3 =0 otherwise
Grade 4	.33	.46	=1 if student in grade 4 =0 otherwise
Grade 5	.30	.45	=1 if student in grade 5 =0 otherwise
Grade 6	.06	.24	=1 if student in grade 6 =0 otherwise
Male	.59	.49	=1 if student is male =0 otherwise
Urban	.51	.50	=1 if student in urban school =0 otherwise
Wealth	.59	.22	Proportion of the following items: running water, electricity, radio, reading material, and home ownership
Father's education	1.79	4.1	Years of schooling
Mother's education	.52	2.2	Years of schooling
	B. OLS School Quality Sample (n = 1,938)		
ACHIEVE_t	26.2[a]	1.99	Rasch combined achievement—1980
ACHIEVE_{t-1}	20.8[a]	2.05	Rasch combined achievement—1979
Grade 3	.31	.46	=1 if student in grade 3 =0 otherwise
Grade 4	.33	.46	=1 if student in grade 4 =0 otherwise
Grade 5	.30	.45	=1 if student in grade 5 =0 otherwise
Grade 6	.06	.24	=1 if student in grade 6 =0 otherwise
Male	.59	.49	=1 if student is male =0 otherwise
Urban	.51	.50	=1 if student in urban school =0 otherwise
Father's education	1.79	4.1	Years of schooling
Mother's education	.52	2.2	Years of schooling

[a] Geometric mean.

TABLE A2
DESCRIPTIVE STATISTICS FOR THE EARNINGS SAMPLE: INCOME ESTIMATION

	Rural (n = 348)		Urban (n = 297)		
Variable	Mean	Standard Deviation	Mean	Standard Deviation	Description
Male	.833	.37	.889	.31	=1 if male =0 if female
Highest grade	4.81	1.08	5.03	1.07	Highest school grade completed
Experience	4.43	1.31	3.58	1.63	Years since left school
ACHIEVE_{t-1}	8.95[a]	3.23	15.59[a]	3.21	Score on Reading A + simple operations tests—1979
Market wage	36.4[a]	1.94	41.85[a]	2.29	Income in piasters per day

[a] Geometric mean.

Appendix B

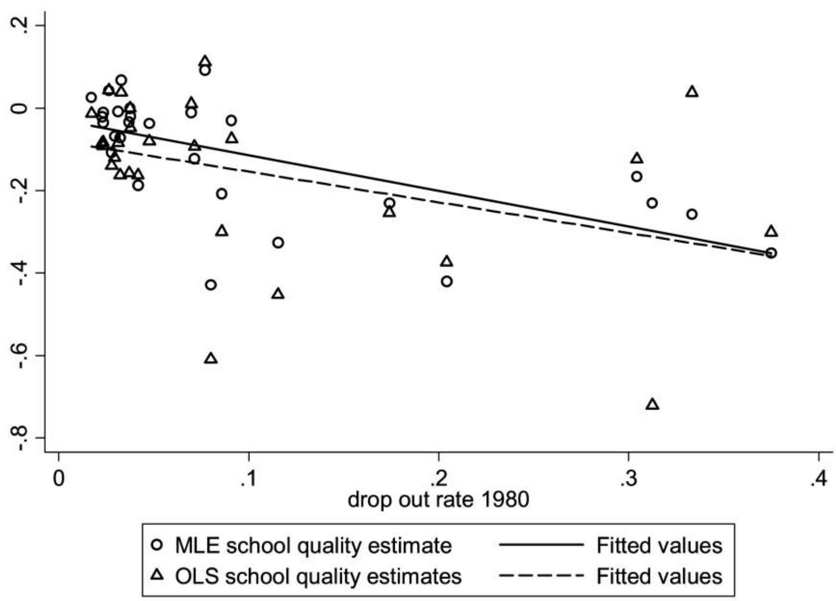

Figure B1.—MLE and OLS school quality and dropout rates, 1980

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