LSMS
Living Standards
Measurement Study
Working Paper No. 107

School Quality, Achievement Bias, and Dropout Behavior in Egypt

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Public Disclosure Authorized

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The LSMS Working Paper series was started to disseminate intermediate products from the LSMS. Publications in the series include critical surveys covering different aspects of the LSMS data collection program and reports on improved methodologies for using Living Standards Survey (LSS) data. More recent publications recommend specific survey, questionnaire, and data processing designs and demonstrate the breadth of policy analysis that can be carried out using LSS data.

LSMS Working Paper
Number 107

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The World Bank
Washington, D.C.

The complete backlist of publications from the World Bank is shown in the annual *Index of Publications*, which contains an alphabetical title list (with full ordering information) and indexes of subjects, authors, and countries and regions. The latest edition is available free of charge from the Distribution Unit, Office of the Publisher, The World Bank, 1818 H Street, N.W., Washington, D.C. 20433, U.S.A., or from Publications, The World Bank, 66, avenue d'Iéna, 75116 Paris, France.

ISSN: 0253-4517

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Library of Congress Cataloging-in-Publication Data

Hanushek, Eric Alan, 1943–
School quality, achievement bias, and dropout behavior in Egypt /
Eric A. Hanushek, Victor Lavy.
p. cm. — (LSMS working paper, ISSN 0253-4517 ; no. 107)
Includes bibliographical references.
ISBN 0-8213-2998-7
1. School dropouts—Egypt. 2. School attendance—Egypt.
3. Academic achievement—Egypt. 4. Public schools—Egypt—
Evaluation. 5. Education, Elementary—Economic aspects—Egypt.
6. Educational surveys—Egypt. I. Lavy, Victor. II. Title.
III. Series.
LC145.8.E3H35 1994
371.2'912'0962—dc20 94-32798
CIP

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Foreword

Almost all developing countries are concerned about the problem of low school completion rates. The difficulty from a policy perspective is a lack of fundamental information about why students drop out of school. This paper investigates the underlying causes of dropping out of school using an exceptionally rich longitudinal data base on primary school-aged children in Egypt. The central finding is that children are strongly influenced in their schooling decisions by the quality of their prospective school. 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. Higher school quality improves earnings opportunities and is positively correlated with the quantity of schooling 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 only on simple quantity returns might lead to suboptimal policies.

This paper is part of a broader research effort in the Policy Research Department (PRD) that examines the effect of the quality of social services on human capital investment outcomes. This work is located in the Poverty and Human Resources Division.

Lyn Squire
Director
Policy Research Department

Abstract

School quality and grade completion are shown to be directly linked, leading to very different perspectives on educational policy in developing countries. Unique panel data on primary school age children in Egypt permit estimation of behavioral school dropout models. Students perceive differences in school quality, measured as expected achievement improvements in a given school, and act on it. Specifically, holding constant the student's own ability, achievement and earnings prospects, a student is much less likely to remain in school if attending a low quality school rather than a higher quality school. This individually rationale 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. Further, because of this behavioral linkage, there is an achievement bias such that common estimates of rates of return to years of school will be overstated. The paper demonstrates the analytical importance of employing output-based measures of school quality.

Acknowledgements

We are indebted to Xiang Wang for exceptional assistance in the data analysis and estimation. Eric Swanson provided us with the data and with help in understanding the sampling and the schooling situation in Egypt. We benefitted from many useful comments and suggestions by Joshua Angrist, Bruce Chapman, Paul Chen, Elizabeth King, Emmanuel Jimenez, Martin Zelder, participants of the World Bank's Seminar on Household's Human Capital Investments and of seminars at the University of Rochester, the Hebrew University of Jerusalem, the Australian National University, Texas A&M, and Cornell University. Finally, Finis Welch helped clarify some key modeling points.

Introduction

Almost all developing countries are concerned about the problem of low school completion rates. This well-founded concern is actually generated by two different perspectives—the possibility of lost investment opportunities for society and the possibility of general inefficiency in the provision of public schooling. The difficulty from a policy perspective, however, is not uncertainty about the desirability of increasing school completion but instead a lack of fundamental information about why students drop out of school. This paper investigates the underlying causes of dropping out of school using an exceptionally rich longitudinal data base on primary school-age children in Egypt. The central finding is that children are strongly influenced in their schooling decisions by the quality of their prospective school. This rationally-based decision implies that 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 those with lower quantities of schooling could not expect to receive the incomes and investment returns of those with more schooling 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 countries has a high pay-off, especially for lower levels of schooling (e.g., Psacharopoulos 1985).[1] In contrast, even though schooling completion has been increasing in much of the world, it remains low in an absolute sense. As late as 1980, the average completion levels of adults age 25-29 in the lowest income countries was less than three years; for lower middle income countries, it is still less than five years (Lockheed and Verspoor 1991, p. 17). The static schooling investment picture is amplified by recent analyses of economic growth which 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.

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

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1. Two problems are most 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 1987) 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 paper investigates both possibilities and provides strong evidence about their importance.

the goal.[2] Beyond that, large numbers of dropouts (and of grade repeaters, the related problem) may distort the normal instruction, raising the costs of schools.

Given the policy focus on school completion and dropout behavior, remarkably little is known about the underlying determinants of dropouts. While completion levels and aggregate data on the age-grade distributions of students provide some overall sense of the dropout situation, these 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, while analysis of school completion levels cannot examine time-varying family or school ingredients. The key to understanding dropout determinants is longitudinal data on individual students, but such panel data have rarely been available. This paper exploits a unique panel data set to investigate the underlying determinants of school leaving. The data base contains 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 an investigation of the role of school quality in affecting dropouts. If low quality schooling leads to dropouts, altering the character of the schools may be an effective way to keep students in school. In fact, that is a central finding of this analysis: Students 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 developing high quality schools.

The dropout decision is based on both school quality and earnings opportunities of students. The empirical work requires separate investigations of each of these, and they hold their own interest. Little is known about systematic factors affecting work and earnings of primary school-age students. And, the measurement of school quality itself provides insights into schooling variations in developing countries. Specifically, this paper develops an output based measure of quality, instead of relying upon the ubiquitous input approach.

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

Egyptian Schooling

Egypt, like many other developing countries, faces significant problems with enrollment outcomes in its primary schooling system (World Bank 1991). Under existing law, attendance through the sixth grade of primary education is compulsory. However, primary school enrollment in the 1991-92 school year is only about 80 percent of the corresponding age cohort. Middle school enrollment represents less that 70 percent of its age cohort. The highest dropout rate, nearly 15 percent, occurs 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 are another important dimension of this policy concern. Specifically, the majority of the primary school-age children who do not attend school are concentrated in rural areas where resource constraints appear most severe.

Significantly lower female enrollment rates are an added element of the problem. Gender inequalities persist as females remain outside the reach of formal education: 62 percent of females are illiterate, as opposed to 38 percent of men, and girls' primary school enrollment remained stuck at 45 percent of total enrollment from 1966-1986 (World Bank 1991). In rural areas, enrollment rates of girls often do not exceed 50 percent of the age cohort and can be as low as 10 percent in some regions.

A second set of problems, also identified by the World Bank study, revolves around the inputs of the public schooling system. For example, the construction rate of schools has lagged behind the identified demand and is insufficient to meet the government's objectives of decreased class size and reduced reliance on multi-shift teaching. Similar concerns relate to the "quality" of schooling, and of teaching in particular. Examples cited often include outdated curricula and superficial assessment techniques along with dependency on a set of textbooks that are themselves frequently outdated. The overall quality problem is thus summarized as being multifaceted: the combination of inadequate facilities and generally poor quality of teachers, teaching methods, and curricular content. Each of these problems appears to be fostered by a deficiency of core management skills.

Here we examine the potential linkages of these two schooling problems: completion and quality. While we will not in the end measure quality in the ways suggested by conventional policy discussions, we will identify key linkages.

Most primary schools are classified under one of three administrative headings: public schools; subsidized private schools; or unsubsidized private schools. The public and subsidized private schools are, for all practical purposes, indistinguishable.[3] The facilities of the former are owned by the government, while the latter are in private hands and are leased to the government through a "grant in aid". Neither charges any tuition, and both types of schools follow the same, centrally prescribed curriculum. Private (unsubsidized) schools account for less than 5 percent of all primary school enrollments in Egypt. Those that exist are almost entirely found in urban areas.[4] In

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3. Descriptions of the Egyptian schooling system are found in World Bank (1991) and in Swanson (1988).

4. Three types of private schools are recognized: "private schools with fees" (tuition); "language schools"; and "services classes". The service classes are not proper schools but consist, rather, of remedial classes for sixth graders who have failed their primary certificate examination. The language schools are the remaining legacy of

school year 1978/79, the first year of the survey used in this analysis, there were 710 private schools out of the country total 11,051 schools; of these, 582 were located in urban areas (out of total of 4261 schools).

Virtually all recurrent expenditure and most capital expenditure for primary education are initiated and financed by the Ministry of Education. A small proportion of new schools construction is undertaken by local jurisdictions. These schools are subsequently turned over to the Ministry of Education which assumes responsibility for their operation. Teachers are allocated to schools on the basis of official enrollment levels and are paid out of the central budgets allocated to each educational zone. Books and most other student supplies are 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 have been made recently. The associations seem to serve as a forum for the presentation of suggestions and complaints to the teachers and principals. How effective these associations have been is an open question. However, they do not serve as 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 to each school is 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 four. In response to the introduction of exams and repetition largely during the 1980s, the phenomenon of private tutoring has arisen. The sixth grade exam is the major hurdle for most children. Those who fail are, essentially, cut off from the remaining educational ladder, and the possibility of repetition of the sixth grade is limited by space. Children who fail the exam the first time often enroll in private classes in order to make a second try the next year.[5]

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the many foreign and missionary schools. Since 1958, these schools have been under Ministry of Education control, although they have been permitted some independence. Unlike the public schools, they offer 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 of the rural private schools are service classes, while the complete private schools serve an elite population concentrated in a few large cities.

5. Partial tutoring has recently emerged as a partial supplement to teachers' salaries, and has became an integral part of the educational process. The practice varies widely and includes individual and group tutoring, both throughout the school year and just during examination periods. The recent 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. The concerns raised by this include a widening disparity in outcomes by income group, a reduced classroom effort by regular school teachers, and generally lessened support and resources for the schools. This aspect of schooling is, however, much less important during the 1979-1980 period of our data and analysis.

Overview of Model

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 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 nonoptimal from either a public or private viewpoint.

The opportunities facing the student both in and out of school are important to understanding school leaving. The underlying conceptual framework here is a simple optimization model on the part of the student. The student is seen as maximizing lifetime utility through the choice of schooling level. A key element of this choice is the earnings opportunity of the student, which is a function of the past and future schooling experiences of the student. But, market earnings for primary students are difficult to characterize and may be only one part of the overall school decision process. Moreover, the relationship between school experiences and earnings may not be completely clear. This section presents an overview of the basic approach and estimation strategy. The subsequent sections describe the results of the empirical analyses of the various components.

The maximization of lifetime income with respect to years of schooling is a straightforward optimization problem that has been solved in various contexts. While details vary depending on the structure of the problem analyzed, the key idea is trading off foregone current earnings for enhanced future earnings. With perfect capital markets, the central result can generally be summarized by a simple optimal stopping rule for an individual: everything else equal, continue investing in schooling until i_s, the rate of return for s years of schooling, falls below the market interest rate on alternative investment options.[6] With borrowing constraints or imperfect capital markets, the magnitude of foregone earnings (Y_{today}) 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.

As it stands, however, this investment model is not easily implementable for empirical analysis. The formal analysis is conducted for an individual and ignores most personal and family factors that might interact with the rate of return derived from market work. It is frequently simply assumed that it is possible to employ this analytical structure related to individual stopping rules to explain differences in schooling across individuals, but the appropriateness of such a step deserves consideration. First, it is necessary to characterize nonschool factors that might enter into such schooling decisions, and the theoretical works seldom address these. Second, the relevant rate of return, i_s, pertains to each individual, and there is a presumption that this varies across individuals (consistent with variations in school completion in the population). Clearly, if i_s is constant for individuals, variations in the choice of schooling level will be determined completely by considerations other than the foregone and future earnings opportunities that are included in the rate of return calculations. Yet, dealing with this is difficult and seldom undertaken explicitly.[7]

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6. The formal analyses have delved into a variety of aspects of investment including the transition to on-the-job training and work-leisure decisions. With respect to formal schooling, however, these predictions do not significantly vary with modeling structure.

7. There are, of course, important exceptions. Theoretically, Becker (1975) considers individual variations in costs and benefits in describing the distribution of individual schooling decisions. Empirically, Willis and Rosen (1979) consider individually varying returns to different amounts of schooling. A thoughtful discussion and

Typically, information is available on only the average returns to schooling across groups of individuals, and any variations across individuals occur in highly structured ways. Even average earnings opportunities facing individual students may be difficult to characterize, because of thin markets and of significant selection problems, and it may be difficult to separate current from future earnings to the extent that they both vary by individual characteristics and by local labor markets.

Finally, and central to this discussion, it has been common to assume that schooling is homogeneous and directly measured by the length of time spent in school. Such an assumption, which greatly simplifies analysis by restricting attention to just the quantity margin, implies that the schooling investment decision is unrelated to quality differences among programs. On the other hand, it seems likely from the individual decision making view that there will be interactions of school stopping rules with quality. 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. The more learning during any period of time, the more likely it is that a student will continue in school rather than dropout. This must be incorporated into empirical analysis.[8] Clearly, any problem definition that ignores school quality also contrasts sharply with the policy debate, where attention invariably concentrates on potential decisions about resources and quality for schools at different levels and in different areas.

Here we maintain the conceptual starting point that the primary determinant of school completion and school dropout behavior at any point is the individual's rate of return from further schooling. The empirical implementation, however, presumes that all we will actually be able to measure is average earnings and returns. We will then examine directly the impact of the various individual-specific factors—school quality, individual specific earnings opportunities, ability, and other family influences—on the probability of dropping out of school. The starting point for the empirical analysis is:

$$\text{Prob(dropout)} = g(\overset{(?)}{\text{ability}}, \overset{(?)}{\text{achievement}}, \overset{(-)}{\text{school quality}}, \overset{(+)}{\bar{Y}_{today}}, \overset{(-)}{\bar{i}_r}, Z) \qquad (1)$$

where **Z** represents other family and community factors influencing school completion and bars indicate averages over the relevant population. Ability and achievement have ambiguous effects on dropouts because they increase both current earnings possibilities and future earnings possibilities (through their impact on continued production of human capital). While the "conventional" assumption of neutrality (Ben-Porath 1972) would imply no effect of achievement on dropout behavior, this remains an empirical question. School quality here is defined as the expected improvement in student achievement during any year of schooling. School quality, because it is

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interpretation of existing work is found in Willis (1986).

8. 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 formulation (Ben-Porath 1972) 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.

expected to increase future benefits but not increase costs (or, at least, time costs of school), should unambiguously lower dropout probabilities for an individual. School quality and earnings opportunities, however, are not directly observed and must be inferred from available data. The next section discusses the measurement of school quality, while the following one considers earnings opportunities of students of primary school age.

School Quality

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. This outcome-based perspective contrasts sharply with most other research. Many studies ignore school quality altogether. Virtually all analyses of school attainment, drop-out behavior, and the like ignore any 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 matters 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 are inappropriate. Achievement differences among students are large, and direct analyses of earnings opportunities of workers suggest that differences in school achievement may be very important in determining earnings alternatives.[9] The inappropriateness of input measures of school quality is examined and reviewed in Harbison and Hanushek (1992).

The approach here is to estimate directly variations in school quality, based on student outcomes in different schools. This unique approach then permits analysis of the effect of school quality on individual student decisions about remaining in school. The estimation of school quality follows a very simple value-added model of achievement. Current achievement (A_t) is viewed as a function of current and past inputs both from the family (F_τ) and from schools (R_τ). (The individual subscript, j, is suppressed for presentational purposes). Additionally, individuals differ in ability (μ), which is assumed to be fixed over time and to enter primarily in determining the level of achievement. Achievement in each time period is also subject to stochastic fluctuations (ϵ_τ) reflecting unmeasured influences on achievement. This implies that current achievement can be written (in linear form) as:

$$A_t = \alpha_t F_t + \alpha_{t-1} F_{t-1} + \ldots + \alpha_o F_o + \beta_t R_t + \beta_{t-1} R_{t-1} + \ldots + \beta_o R_o + \mu + \epsilon_t + \epsilon_{t-1} + \ldots + \epsilon_o \quad (2)$$

At the same time, A_{t-1}, achievement in the prior time period, is a function of many of the identical resources by virtue of the cumulative nature of education:

$$A_{t-1} = \alpha_{t-1} F_{t-1} + \ldots + \alpha_o F_o + \beta_{t-1} R_{t-1} + \ldots + \beta_o R_o + \mu + \epsilon_{t-1} + \ldots + \epsilon_o \quad (3)$$

9. Discussion of performance differences can be found in Lockheed and Verspoor (1991). For labor market analyses in developing countries, see, for example, Behrman and Birdsall (1983); Knight and Sabot (1987); Boissiere, Knight, and Sabot (1985). For developed countries, see Bishop (1989); Hanushek, Rivkin, and Jamison (1993).

This suggests that we could rewrite the model to relate the change in achievement (ΔA) to the contemporaneous school and family inputs over the period t-1 to t. We actually look at a slightly modified version:

$$A_t = \alpha_t F_t + \beta_t R_t + \gamma A_{t-1} + \epsilon_t \quad (4)$$

The parameter representing the effect of A_{t-1} on A_t (γ) is not constrained to one 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 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.[10] (In the latter two situations, Equation 4 does not follow precisely from the specification in Equation 2 but will include a more complicated error structure, and the potential estimation difficulties posed by this are addressed below).

Equation (4), the basic value-added form, offers considerable simplification for both data collection and estimation. With this formulation, one need observe just past achievement and the intervening school and family inputs. Further, ability (μ), which is generally viewed as unobservable, drops out of the value-added representation employed here.

Past work has demonstrated that differences in schools are very important but does not provide any clear indication of how school quality can be reliably measured (see the summary in Harbison and Hanushek 1992). Therefore, the approach here is to estimate unconstrained differences across schools by including a dummy variable for each school as in:

$$A_t = \gamma A_{t-1} + \alpha_t F_t + \sum \delta_i S_i + \epsilon_t \quad (5)$$

where $S_i=1$ if the student attends school i and $=0$ otherwise.

The δ_i's from this covariance structure are then the mean achievement growth in each school after allowing for other student-specific differences. These are interpreted as a measure of school quality across the sampled schools, and they are used directly in the estimation of the student dropout models.

This value-added characterization of the achievement relationship does not, however, avoid all complications. Specifically, when it comes to estimation, there are concerns about both the accuracy of measurement of prior achievement (A_{t-1}) and the possibility that prior achievement is correlated with the error in the equation (ϵ_t).[11] The faulty measurement of prior achievement can be thought of

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10. The estimation below employs log-linear formulations that allow a form of decreasing returns to inputs.

11. Both of these problems could be avoided if it were plausible to constrain the parameter on A_{t-1} to equal one so that the achievement model could simply be estimated in terms of ΔA. But, as described above, this is inappropriate in the context of the achievement models considered here.

as arising from observations ($\tilde{A}_{t-1}$) that differ from the true achievement by a random error, ν, as described in Equation (6):

$$\tilde{A}_{t-1} = A_{t-1} + \nu_{t-1} \qquad (6)$$

The presence of such measurement error will generally lead to biased estimates of all of the parameters in Equation (5), even when ν_{t-1} has mean zero. This situation is frequently hypothesized because of the widespread impression that individual achievement measurement is difficult and subject to considerable uncertainty. Alternative treatments for dealing with this problem are generally available, including direct correction of the measurement error variance and the use of instrumental variables.[12] The second concern is that ϵ_t will be correlated with A_{t-1} when the ϵ_r's are correlated over time. Such correlations, which could result from unmeasured individual or family factors that are not captured by μ, also lead to inconsistent estimates of the model's parameters. Again, however, if suitable instruments for A_{t-1} can be found, it is possible to correct the estimation for these problems of endogeneity.

Opportunities Outside School

To understand dropout behavior, it is necessary to characterize the options facing the student. One important element is the earnings possibilities outside of school. Even though we are talking about primary school children, it is clear that they have real earnings possibilities, particularly in the agrarian parts of the economy. The basic structure involves estimation of an earnings model that varies systematically with the student's schooling, experience, ability, and labor market location. In this, we concentrate on the immediate work opportunities as characterized by children of primary school age who have been working in the market.

The estimation employs a sample of prior dropouts who are working in the market for pay to understand the earnings opportunities of current students. While little is known about the earnings possibilities facing primary school children, the basic structure of the model employed simply adapts a standard earnings function:

$$Y = f(\text{achievement, ability, experience, school attainment}, \mathbf{X}) \qquad (7)$$

where **X** is a vector of other income generating characteristics.

Many children, however, do not enter the formal labor market after leaving school. Instead they tend to work in the home, on the family farm, and the like. This presents two complications for the analysis. First, those working in the market probably are not a random sample of all dropouts, implying that the earnings of just those working might not fully describe the potential earnings of all prospective dropouts. Second, the value of alternative activities—i.e., nonschool, nonlabor market

12. Note that measurement error in current achievement, A_t, can be subsumed in the equation error and generally causes no special statistical problems. If the variance of the measurement error is known, the estimation can directly incorporate this, yielding consistent estimates of all parameters. While information about measurement error is rarely available, the special characteristics of test measures of achievement at times provide this possibility through use of test reliability estimates. When done in the past, however, it has not led to significant changes (Hanushek 1992).

activities—undoubtedly figures into dropout decisions. But, lacking direct market information or other ways of valuing nonmarket activities, it is difficult to develop consistent measures of how this might vary across individual students.

For this analysis, we deal with both problems through incorporating information on the probability of labor market activities. The statistical models, which characterize how these probabilities vary across sampled children, provide a means of correcting for the potential sample selection biases. They also provide direct information about other opportunities facing students, suggesting that the probability on nonmarket activities itself contains potentially useful insights into alternatives.

The basic dropout model thus builds on the prior estimation of Equations (5) and (7), and the empirical specification of Equation (1) becomes:

$$\text{Prob(dropout)} = g(A_t, AB_t, \hat{Y}, \hat{\delta}, \hat{\phi}, W) \qquad (8)$$

where individual achievement level (A_t), individual ability (AB_t), and other important factors (W) combine with estimated earnings opportunities ($\hat{Y}$), estimated school quality ($\hat{\delta}$), and estimated probability of market work ($\hat{\phi}$) to determine dropout probabilities.

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 data base 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. This section discusses the general sampling design. The separate empirical investigations below provide a description of how the various basic samples are combined into the analytical samples used for the specific modeling purposes.

The sample was drawn from the population of primary school students and dropouts during school year 1978/79.[13] The two-stage stratified design began with a random sample of 30 urban and 30 rural primary schools. Within each school, random samples of students currently attending grades three through six 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 observation 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 subsample (one third) of the 1978/79 sample was drawn within each sample school. The in-school sample was taken from those who continued in school in fourth, fifth, and sixth graders 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.

Seven skill-specific achievement tests and two ability, or "intelligence," tests were developed for the survey. The two intelligence tests were intended to capture non-curriculum dependent measures of the child's skills. In the first year, all nine tests were assigned to the dropout sample,

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13. A complete description of the background for the data collection along with the details of sampling can be found in Swanson (1988).

while inschoolers were assigned only those tests considered appropriate to their grade level.[14] In 1979/80, all nine achievement and intelligence tests were assigned to every member of the sample.

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 towards school.

These basic samples are combined in different ways to support the separate empirical analyses. The descriptive statistics for each analytical sample are found in Appendix Table A1.

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14. 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 (fourteen "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 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. Inschoolers were tested in their classrooms during regular school hours, while dropouts were brought to school for special sessions. For details, see Swanson (1988).

Basic Empirical Results

In describing the results, we first present the basic estimates of the school quality and market earnings models and then turn to the overall dropout models.

School Quality

The focus of the school quality modeling is estimation of expected achievement gains in individual schools (holding constant variations in individual achievement, family background, and the like). This estimation relies on the "school quality" sample made up of 2,431 students, which represents all 1979/80 inschoolers with usable test scores in both years and with complete background data.[15] Variable definitions and descriptive statistics are found in Appendix Table A1. Six percent of the students are at third grade, 42 percent at fourth grade, 33 percent at fifth grade and the rest at sixth grade in 1980. The sum of the scores on the Reading A and simple operations tests are our measure of the student's scholastic achievement. The mean achievement score is 20.8 in 1979 and 26.2 in the following year.

Table 1 includes estimates of the basic value-added achievement model of Eq. 5, estimated in log-log form. The basic model is estimated in four different ways. The first column employs ordinary least squares, while the remaining three employ instrumental variables (IV) estimates. In the simple measurement error model of Equation (6), the independent information on measured student ability is used as an instrument. This multiple measure model, shown in col. 2, presumes that any errors in measuring ability are generated by a different process than those in measuring achievement but that true ability and true achievement are correlated. An alternative IV formulation—column 3—concentrates on the identification problems arising from correlated equation errors (the ϵ_r's). This estimation uses data on characteristics of prior teachers (1978/79) as instruments for A_{t-1}. Specifically, the years of experience, qualification level, and seniority in school of the 1979 teacher are employed as instruments. Finally, the instruments for both the measurement error and serial correlation models are combined in the last column of Table 1.

The estimation methodology has its largest effect on the estimated coefficient for A_{t-1}. This is expected because both potential problems would be expected in this situation to bias this parameter toward zero. Nevertheless, in each of the IV models, the estimated coefficient on prior achievement is significantly different from one, implying that simple differencing of achievement would be inappropriate. Further, the very imprecise estimate of the coefficient on prior achievement (and the other coefficients in the model) in column 3 suggests that the prior teacher characteristics are not particularly good instruments. This of course should be expected because of the extensive accumulated evidence about the limited relationship between specific teacher resources and student performance (Harbison and Hanushek 1992).

There is limited evidence suggesting that parental background systematically affects 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, is extremely limited. Preliminary estimation included a wider range

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15. These sample sizes are subsequently reduced in the instrumental variables estimation because of missing data for the instruments. See Table 1 on page 14.

Table 1. Achievement Value-Added Models: 1980
(t-statistics in parentheses)
Dependent Variable: $LnACHIEVE_t$

Input	*(1)*	*(2)*	*(3)*	*(4)*
$LnACHIEVE_{t-1}$	0.548 (33.64)	0.735 (23.54)	1.237 (5.12)	0.767 (23.30)
Grade 4	0.353 (7.52)	0.230 (4.56)	−0.159 (−0.88)	0.181 (3.38)
Grade 5	0.416 (8.42)	0.226 (4.01)	−0.347 (−1.31)	0.163 (2.71)
Grade 6	0.280 (5.43)	0.085 (1.44)	−0.524 (−1.86)	0.026 (0.42)
Mother's Education	0.002 (0.17)	−0.006 (−0.77)	−0.003 (−0.30)	−0.006 (−0.74)
Father's Education	0.008 (2.25)	0.010 (2.04)	−0.010 (−0.91)	0.009 (1.60)
Constant	1.371 (16.17)	0.939 (8.90)	−0.152 (−0.28)	0.883 (7.76)
F-test School equality	7.25	7.85	13.59	6.41
R^2	0.55	0.52	0.22	0.52
Observations	2431	2431	2207	2167
Estimation	OLS	IV[a]	IV[b]	IV[c]

Notes:
a. Test measurement error model: ln $Ability_{t-1}$ as instrument.
b. Endogeneity of $Achieve_{t-1}$: prior teacher characteristics as instruments.
c. Combined measurement error and endogeneity: ln $Ability_{t-1}$ and teacher characteristics as instruments.

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. The precise quantitative estimates of school quality vary somewhat with the estimation method, although they are very highly correlated. The estimated quality measures from the simple OLS estimates (col. 1) and the most complete instrumental estimates (col. 4) have a simple correlation of .92, and, perhaps more importantly, the identification of the top and bottom quartiles of schools is very consistent across estimation method. In the subsequent analysis, we rely on the conceptually superior estimates from the full instrumental procedure, although the dropout models (below) are qualitatively invariant to the precise estimation of the school quality differences. The addition of the school dummy variables raises the explained variance in achievement from .47 to .55 in the OLS model and from .46 to .54 in the full instrumental variable model. 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 growth in achievement can be dramatically different depending on the specific school. Table 2 displays descriptive statistics for all schools and for schools divided by urban and rural location. The range is instructive: One school has 30 percent higher achievement growth than the base school while, at the other end of the range, we find a school that has about 62 percent lower growth.[16] This implies that one year in the best school can be equivalent (in expected achievement gain) to more than two 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. Distribution of Estimated School Quality
(Proportional deviations from Taha Hussein School)

	All schools	*Rural*	*Urban*
Mean	−.084	−.111	−.057
Minimum	−.62	−.62	−.52
Maximum	.30	.30	.21

16. The estimation in the table presents estimates as deviations from the Taha Hussein urban school. Since all that can be estimated 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. With the OLS estimation, the range of the school quality estimates is virtually identical, going from −.38 to +.39.

Table 2 also indicates that the average quality of urban schools is some 5 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.

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. This implicit measurement raises the possibility that the estimated effects involve more than just school effects—importantly, that they might include some individual student effects or some community effects. Several additional pieces of evidence support this school quality interpretation.

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 lessens 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, we correlated average mother's education and average father's education for all students in the school with school quality. 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. Average mother's and father's education were correlated $-.027$ and $+.045$, respectively, with our measure of school quality ($\hat{\delta}$).

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.[17] The simple correlation is only .099, insignificantly different from zero.

Fourth, we have compared our indirect estimates with those from direct estimation employing explicit measures of school quality. Specifically, we first estimate individual level, value-added achievement models where we substitute explicit measures of teacher and school characteristics for the covariance structure.[18] We then create teacher quality and school quality indexes by aggregating average teacher and school characteristics according to the coefficients from these models. Finally, we regress our measure of total school quality on these two indexes. Each index is positively

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17. 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.

18. These models include the individual characteristics in Table 1 plus four teacher variables (sex, age, schooling, and experience) and four school variables (wealth measured by facilities, availability of desks, availability of boards, and class size). Results are available from the authors.

correlated with our measure, although the teacher index is insignificantly different from zero.[19] The R^2 is only .16, but this is what was expected given our general inability to measure specific components of school quality. Thus, our measure includes the small amount of information available in standard input measures but goes considerably farther in capturing important other dimensions of quality.

We take these further tests as justification for interpreting the variation in school fixed effects as variation in school quality. 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, all of the evidence points toward a school quality interpretation.

Finally, these estimates are obtained from the sample of students who remain in school over both years. While the samples are large, over 2,100 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 achievers, 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 models are estimated in value-added form that takes into account initial achievement. Thus, there would only be a significant bias if dropouts would have the lowest expected achievement growth. An important point to remember, moreover, is that such an effect would imply that the estimated effect of school quality on dropout probabilities will be underestimated. We return to this later.

The presumption in subsequent sections is that these estimates ($\hat{\delta}$) accurately reflect quality differences among schools *and* that students and their parents can gauge the differences that exist.

Earnings Opportunities

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 work for pay in the formal market and provide information on labor market work and wages. The full dropout sample is used to estimate earnings functions and the probability of market work. Of those engaged in market work, forty-six percent are urban children, their mean age is 13 years, on average they have been out school for about four 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 one 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 piaster a day, and it is larger in rural areas (36.1) than in urban areas (32.8).

19. The estimated equation is:

$$\hat{\delta} = -.22 + \underset{(1.2)}{1.31TI} + \underset{(3.0)}{0.79SI}$$ where TI=teacher index; SI=school index. (t-statistics in parentheses)

n=59 $R^2 = .16$

In all of the analysis, the sample of young workers is stratified into urban and rural samples in order to capture fundamental differences 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 3 presents the basic earnings estimates using OLS techniques for the sample of all working dropouts in 1980. Subsequent analysis considers joint estimation of the probability of market work and the earnings functions.

While the models explain a relatively low portion of the overall variance in wages, the estimated parameters are quite consistent with expectations. Moreover, the wage data are likely to contain considerable measurement error in addition to simply unexplained variations in wage rates. Even though this is a 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 nonCairo urban sample suggests even larger male-female

Table 3. Income Models — All Working Dropouts: OLS Estimates

		Urban		
Variable	*Rural*	*Total*	*Cairo*	*NonCairo*
Male	0.422 (4.5)	0.333 (2.2)	−0.018 (−0.1)	0.641 (2.8)
LnACHIEVE	0.024 (0.7)	0.107 (2.6)	0.069 (1.4)	0.144 (2.0)
Highest Grade	0.050 (1.4)	0.122 (2.5)	0.187 (2.8)	0.086 (1.2)
Experience (time out of school)	0.033 (1.2)	0.022 (0.7)	0.082 (1.9)	0.010 (0.18)
Constant	2.804 (12.9)	2.451 (7.6)	2.444 (5.7)	2.218 (4.7)
R^2	0.08	0.07	0.08	0.09
Observations	348	297	151	146

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 (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.[20]

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 where urban jobs were more skilled and where 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.

Models like those in Table 3 except substituting the ability measures for achievement are also estimated. These models are virtually indistinguishable in all respects. The achievement and ability measures are correlated in the range .65 to .75, depending on the year and the precise sample.[21]

Finally, 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 maximum likelihood 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

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20. Note, however, that we do not have actual labor market experience. Instead we simply have time since dropped out of school. In the Cairo area, where work in the labor market is more likely for these drop outs, 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.

21. The term "ability" is often taken to imply a fixed individual-specific factor. However, the evidence here suggests that it is best thought of as another, perhaps broader, measure of achievement. Specifically, school quality models similar to those in Table 1 except that they employed ability instead of achievement were estimated with OLS. The estimates of school quality from the ability and the achievement models were correlated .71. In other words, schools that were good at increasing achievement were also good at increasing ability—and the interpretation of a fixed ability term appears inappropriate.

samples and correlations among the variables.[22] These estimation problems are consistent with some previous experience[23] and lead us to concentrate on the OLS estimates, which are very consistent with expectations. The maximum likelihood estimates of the earnings model, the probability of market work, and the subsequent school dropout models are, however, presented in Appendix Tables A2-A4. Importantly, the other primary determinants of dropout behavior (excluding earnings opportunities) are very consistently estimated and reasonably independent of the choice of earnings estimation technique.

Probability of Market Work

The remaining component of the first stage analysis is consideration of the work activities of primary school age children. Of those out of school, a large portion do not work for wages in the market. Only 14 percent of the rural dropouts and 17 percent of the urban dropouts report a wage for market work, but the chance of working varies sharply across the population. Table 4 presents estimated probit models of the determinants of market work.

Market work is considerably more likely for males than females. Moreover, this effect is stronger in urban areas. As would also be expected, market work increases with age and with prior experience (length of time out of school). The average sampled dropout is 11 years old (with a standard deviation of about 2.5 years). At the sample means, each year of age increases the probability of working for pay by some .02 in urban areas, and with each additional year out of school the probability goes up by .10. The effect of experience is quite similar across urban and rural labor markets, but any effect of age is less pronounced in rural areas—presumably because of the importance of working on the family farm.

The potential impact of opportunities on the farm is reinforced by the estimated effect of wealth. Wealthier families (identified by land ownership and possessions in the home) tend to keep dropouts out of the market in rural areas, but any such effect is statistically insignificant and quantitatively much smaller in urban areas.

Finally, the effect of parental health status is mixed. The only statistically significant effect on market work is found in rural areas, where children with a deceased father are noticeably more likely to enter the formal labor market. This presumably reflects the necessity of providing monetary support for the family when the head of the household cannot. In urban areas, a child whose father has health limitations tends to work in the market more frequently. The remainder of the health status factors are insignificantly different from zero.

The market work models were also estimated jointly with the income models through maximum likelihood methods. These results, presented in Appendix Table A3, are quantitatively

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22. The earnings models exclude the individual's age, presence and health of father and health of mother, and family wealth, factors which are expected to determine the locus of the person's activities but not the wage received in the market. Note, however, that these identifying restrictions are confounded by the close relationship between age and school completion and experience.

23. See the debate in Hay and Olsen (1983), Hay, Leu, and Rohrer (1987), Duan *et al* (1983), Duan *et al* (1984), Manning, Duan, and Rogers (1987), and Leung and Yu (1992).

Table 4. Probability of Working in Market: Probit Estimates

		Urban		
Variable	*Rural*	*Total*	*Cairo*	*nonCairo*
Male	0.990 (9.00)	1.783 (13.18)	1.832 (8.15)	1.796 (10.34)
Age	0.020 (0.94)	0.083 (3.54)	0.078 (2.49)	0.053 (1.37)
Experience (time out of school)	0.345 (12.24)	0.404 (13.18)	0.469 (8.23)	0.433 (10.58)
Father deceased	0.450 (2.41)	−0.330 (−1.23)	−0.275 (−0.61)	−0.327 (−0.95)
Health limitation				
Father	−0.154 (−0.89)	0.404 (1.72)	0.894 (1.76)	0.514 (1.80)
Mother	0.082 (0.36)	−0.188 (−0.56)	−0.554 (−0.44)	−0.043 (−0.12)
Wealth	−1.253 (−4.17)	−0.332 (−1.32)	−0.078 (−0.20)	−0.487 (−1.44)
Constant	−2.565 (−9.30)	−3.828 (−11.40)	−3.879 (−7.96)	−3.693 (−7.46)
Observations	1606	1445	667	787

very similar in terms of coefficients and precision of estimation to those from the probit estimation.

The interpretation of these models is that the probabilities provide some indication of where children's time is more valuable. When younger and less experienced, children tend to work in the home, but they move into the formal labor market as they age and as necessity dictates. The lower the probability of market work, the more relatively valuable other activities are.

School Dropout Behavior

The final and most important component looks specifically at the dropout decision. Beginning with the sample of all in-school children in 1979, we attempt to understand why some dropout by 1980 while others remain in school. The "observed dropout" sample includes all inschoolers of 1978/79 who have also been tested in the second year, forming a panel data set. This sample of 1,803 students includes both students who remained in school in 1979/80 and those who dropped out (9.3 percent) in that year. The share of urban and female students in this sample is higher than in the earnings sample which relied on sampled dropouts since 1975.

We estimate probit models of the form of Equation 8 where we substitute in the predicted school quality and earnings opportunities from the previous models. Table 5 presents alternative estimates of dropout models. These differ in two ways: by the precise measure of predicted earnings opportunities facing the student and by whether or not the probability of market work is included directly in the model. The first and third columns predict earnings ($\hat{Y}$) on the basis of the urban and rural models in Table 3; the second and fourth columns employ the division into the three labor markets of rural, Cairo, and other urban in calculating predicted income.[24] The first two columns do not include estimated probabilities of market work; the final two columns then include the estimated individual-specific probability of market work ($\hat{\phi}$) predicted from Table 4 and relying on the labor market definition corresponding to the source of estimated income. The models also include the direct estimates of school quality ($\hat{\delta}$) corresponding to school specific achievement growth from the full IV estimates in Table 1.

We emphasize the results that are found in the first and third column of Table 5; these correspond to estimated earnings based on the simple urban-rural split instead of the finer split of labor markets. The imprecision of the earnings estimates in the latter case, which was apparent before, also reappears when employed in the dropout models.

The overall results related to the key aspects of individual achievement and of school quality are very consistent across the estimated models. Inclusion of the probability of market work does alter some of the quantitative results, but the pattern and general interpretation is unaffected.

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 has traditionally had lower schooling for females along with less labor market attachment and lower wages if working. Moreover, the school dropout probabilities are significantly less in urban areas, perhaps because of clearer demands for more advanced labor market skills.

The grade dummy variables are included simply because the models indicate the probability of dropping out, conditional upon reaching any given grade. One would expect these overall probabilities to vary with grade. The left out category is grade 3. Other things equal, a student that progresses past grade three is less likely to dropout during any year than those in grade 3, and this effect remains unabated through primary school.

Somewhat surprisingly, individual drop out 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 (1992) which found strong intergenerational transmission of schooling differences in their analysis of Malaysian schooling. It is clear that average schooling levels of parents in our Egyptian sample is very low and displays little variation.

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24. In each case, predicted earnings are derived from the relevant earnings equation based on the student's 1979 residence. An alternative formulation was investigated to permit rural students to also consider opportunities if they moved to an urban area. It is very difficult, however, to distinguish between the effects of rural and urban opportunities for these students, and this effort was not pursued further.

Table 5. Estimated Dropout Models: OLS Income Estimates
(t-statistics in parentheses)

	Labor Market Definition			
Variable	*Rural-Urban*	*Rural-Cairo-nonCairo*	*Rural-Urban*	*Rural-Cairo-nonCairo*
Male	−2.448	−0.476	−4.812	−0.982
	(−6.37)	(−3.11)	(−8.62)	(−4.96)
Urban	−0.637	−0.043	−1.541	−0.296
	(−3.95)	(−0.37)	(−7.17)	(−2.17)
Grade 4	−0.946	−1.630	−0.525	−1.609
	(−2.90)	(−5.96)	(−1.24)	(−5.25)
Grade 5	−1.528	−1.762	−1.437	−1.765
	(−4.94)	(−6.40)	(−3.66)	(−5.78)
Grade 6	−2.575	−2.697	−2.637	−2.793
	(−9.55)	(−11.53)	(−7.61)	(−10.67)
Father's Education	−0.029	−0.026	−0.026	−0.037
	(−1.48)	(−1.31)	(−1.20)	(−1.71)
Mother's Education	0.024	0.015	0.024	0.026
	(0.70)	(0.42)	(0.65)	(0.74)
Predicted Earnings	5.611	0.461	7.989	0.250
($\hat{Y}$)	(5.87)	(1.65)	(6.54)	(0.80)
LnACHIEVE	−0.719	−0.482	−0.865	−0.474
	(−8.47)	(−7.24)	(−7.89)	(−6.42)
LnABILITY	−0.265	−0.234	−0.228	−0.187
	(−3.50)	(−3.18)	(−2.55)	(−2.29)
Wealth	0.151	0.096	1.180	0.417
	(0.56)	(0.37)	(3.53)	(1.41)
School Quality − ($\hat{\delta}$)	−1.229	−1.405	−1.717	−1.600
	(−4.29)	(−4.89)	(−4.93)	(−4.90)
Prob(Mkt Work) − ($\hat{\phi}$)	n.a.	n.a.	21.195	8.084
			(10.16)	(6.50)
Constant	−15.419	0.608	−23.360	0.992
	(−5.17)	(0.65)	(−6.13)	(0.95)
Observations	1803	1803	1744	1744

Note: n.a. = not available.

Predicted earnings, as discussed, are hard to interpret since it is difficult to separate current from future income effects, implying that these are really reduced form results of how income affects dropout behavior. The models indicate quite clearly that higher current earnings opportunities on net entice students out of school and into the labor market. Moreover, a higher estimated probability of entering market work upon dropping out ($\hat{\phi}$) also increases very significantly the probability of dropping out. Thus, the immediate pull of the market, even for these very young students, is quite important in the school completion decision.[25]

It is interesting to see how individual skills enter into the decision. Both higher achievement and higher ability lessen the probability of dropping out.[26] The effect of achievement is somewhat complicated, however, since higher achievement raises the current earnings possibilities of the individual (at least in urban areas), but it also paves the way to even higher future achievement. An extension of a Ben-Porath-like neutrality assumption might suggest that these two effects balance each other so that individual achievement would not have any direct effect on dropouts. Indeed, in urban areas this holds reasonably closely: From column 2 of Table 3 and column 1 of Table 5, we calculate the net effect in urban areas of a change in (log) achievement as $-.719 + 5.611 \times .107 = -.118$, or close to complete neutrality. For rural areas, however, the net effect is $-.719 + 5.611 \times .024 = -.584$; higher achievement unambiguously acts to hold rural children in school. The results about school retention of the higher achievers are strengthened for both urban and rural schools when ability differences are considered. If ability is thought of as simply a broader achievement measure, the effects will be additive, and the estimated dropout models clearly indicate that dropout rates fall with more cognitive skill.

Perhaps the most novel feature of this estimation is the direct investigation of school quality ($\hat{\delta}$) 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 magnitude of the school quality effect is significant. If all of the schools could be moved up to the quality of the top school, the average dropout rate is predicted to fall from .093 to .032. Such changes in primary school drop out rates would have enormous impacts on school completion, since the annual drop out rate is cut by two-thirds. The estimated cut in drop out probabilities is even larger in the model that includes the probability of market work (column 3). There, the effect of upgrading all schools is to reduce the dropout probabilities to about 2 percent. Note also that these

25. These findings are consistent with the anecdotal statements that the opening up of other Gulf states to Egyptian laborers at the time led to a tightening in the Egyptian markets and to a pull of students out of schools.

26. 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.

are lower bounds on the estimated effects of quality to the extent that school quality is overestimated by having a large dropout population (see section V.A., above).

Finally, without consideration of market work, family wealth differences have an insignificant effect on dropout decisions. When the probability of market work is included in the models, the direct effect of wealth is to increase dropout probabilities. This direct effect is, however, offset by the fact that increased wealth decreases the chances of market work—significantly so in rural areas. This apparently anomalous result is probably also complicated by imprecision of measurement.[27]

The dropout models were also estimated with the predicted earnings that came from the jointly estimated earnings and market work models. The results of this (Appendix Table A4) are virtually identical except that higher predicted earnings point to lower dropout rates, the opposite of that in Table 5. The imprecisely estimated earnings models from the joint modeling, however, indicate that the results in the dropout models are probably largely reflecting simple aggregate urban-rural differences.

27. 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. In all cases, however, wealth had a statistically insignificant effect on dropout probabilities when the probability of market work was excluded from the dropout model.

Conclusions

A simple set of conclusions stands out in this analysis. Higher skilled individuals—children with greater ability and achievement—tend to be the ones who stay in school. Lower skilled individuals tend to leave school early.

But, holding constant the individual's own ability and achievement, 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 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.[28] Neither has it estimated the cost that might be incurred in adjusting schools. Nevertheless, the importance of school quality is very clear.

The finding about the effects of school quality on 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 which 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 feedback of quality to school completion has strong implications for policy in developing countries. Every effort should be made to improve school quality. If that is done, attendance and completion will follow.

While this analysis has not considered repetition, the effects of quality on repetition are likely to reinforce these results. Lower quality schools tend to retain students in grade—because they have not accomplished as much as they progress through school (see Harbison and Hanushek (1992) and Gomes-Neto and Hanushek, forthcoming). 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, the best way to deal with it appears to be through school improvement.

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28. The full policy implications of these findings are far beyond the scope of this paper. One central implication of the general inability to identify and measure important inputs is that attention should move to outcome, or performance, incentives in schools. See, for example, Hanushek, Rivkin, and Jamison (1992) or Harbison and Hanushek (1992).

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

Finally, from an analytical perspective, this paper 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.

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Appendix Tables

Table A1. Descriptive Statistics for Analytical Samples

A. School Quality Sample (n=2,431)

Variable	*Mean*	*Standard Deviation*	*Description*
Achievement - 1980	26.2[a]	1.99	Raw test score on Reading A + Simple Operations Tests - 1980
Achievement - 1979	20.8[a]	2.05	Raw test score on Reading A + Simple Operations Tests - 1979
Grade 4	.42	.49	=1 if student in grade 4; =0 otherwise
Grade 5	.33	.47	=1 if student in grade 5; =0 otherwise
Grade 6	.20	.40	=1 if student in grade 6; =0 otherwise
Father's education	1.15	3.3	years of schooling
Mother's education	.32	1.7	years of schooling

Note: a. geometric mean of achievement.

B. Earnings Sample — Market Work

	Rural (n=1,606)		*Urban (n=1,445)*		
Variable	*Mean*	*Standard Deviation*	*Mean*	*Standard Deviation*	*Description*
Male	.622	.49	.515	.50	=1 if male;=0 if female
Age	11.24	2.62	11.2	2.38	Age in years - 1979
Experience	2.09	2.37	1.39	2.04	Years since left school
Father deceased	.072	.26	.057	.23	=1 if father deceased;=0 otherwise
Health limit					
Father	.098	.30	.068	.25	=1 if father has health limitation; =0 otherwise
Mother	.034	.18	.022	.15	=1 if mother has health limitation; =0 otherwise
Wealth	.468	.18	.643	.21	Proportion of running water, radio, electricity, reading material, home ownership
Market Work	.145	.35	.166	.37	=1 if work in market for pay; =0 otherwise

C. 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
Achievement - 1979	8.95[a]	3.23	15.59[a]	3.21	Score on Reading A + Simple Operations Tests - 1979
Market wage	36.42[a]	1.94	41.85[a]	2.29	Income in piasters per day

Note: a. Geometric mean.

D. Observed Dropout Sample (n=1,803)

Variable	*Mean*	*Standard Deviation*	*Description*
Male	.593	.49	=1 if male; =0 if female
Urban	.497	.50	=1 if urban; =0 if rural
Grade 4	.352	.478	=1 if grade 4 in 1979; =0 otherwise
Grade 5	.302	.46	=1 if grade 5 in 1979; =0 otherwise
Grade 6	.306	.46	=1 if grade 6 in 1979; =0 otherwise
Father's Education	1.79	4.1	Years of schooling
Mother's Education	.52	2.1	Years of schooling
Predicted Earnings	30.91[a]	1.23	Predicted earnings; Table 4, col. 1, 2
Achievement - 1979	20.42[a]	2.05	Raw test score on Reading A + Simple Operations Tests - 1979
Ability - 1979	20.73[a]	1.96	Raw verbal + nonverbal ability test score - 1979
Wealth	.586	.22	Proportion of running water, radio, electricity, reading material, home ownership by family
School Quality	-.075	.17	Estimated school quality; Table 1, col. 4
Prob(Mkt Work)	.034	.04	Estimated probability of market work; Table 3, col. 1, 2
Dropout	.093	.29	=1 if school drop in 1979/80; =0 otherwise

Note: a. Geometric mean.

Table A2. Income Models — All Working Dropouts: Maximum Likelihood Estimates

Variable	*Rural*	*Urban*		
		Total	*Cairo*	*NonCairo*
Male	0.322 (1.51)	−0.157 (−0.62)	4.267 (3.84)	3.031 (1.32)
LnACHIEVE	−0.001 (−0.01)	0.040 (0.65)	−0.499 (−1.04)	0.469 (0.61)
Highest Grade	0.052 (1.09)	0.066 (1.24)	−0.026 (−0.28)	0.114 (1.32)
Experience (time out of school)	−0.036 (−0.48)	−0.102 (−1.70)	0.133 (1.68)	0.036 (0.41)
Constant	3.421 (4.3)	4.256 (6.48)	−0.065 (−0.57)	−0.017 (−0.08)
Observations	232	240	113	127

Table A3. Probability of Working in Market: MLE

		Urban		
Variable	*Rural*	*Total*	*Cairo*	*nonCairo*
Male	0.986	1.762	1.772	1.796
	(9.06)	(14.66)	(8.91)	(11.35)
AGE	0.025	0.083	0.094	0.053
	(1.53)	(5.80)	(4.78)	(1.87)
Experience (time out of school)	0.343	0.401	0.443	0.433
	(10.66)	(12.02)	(7.46)	(9.39)
Father deceased	0.506	−0.372	−0.412	−0.327
	(2.83)	(−1.50)	(−0.83)	(−1.00)
Health limitation				
Father	−0.185	0.479	0.876	0.514
	(−1.07)	(2.46)	(1.63)	(1.96)
Mother	0.036	−0.402	−0.682	−0.043
	(0.12)	(−0.84)	(−0.13)	(−0.09)
Wealth	−1.212	−0.365	−0.269	−0.487
	(−3.81)	(−1.45)	(−0.67)	(−1.37)
Constant	−2.632	−3.790	−3.854	−3.693
	(−11.45)	(−14.56)	(−9.40)	(−9.39)
Observations	1606	1445	667	787

Table A4. Estimated Dropout Models: MLE Income Estimates
(t-statistics in parentheses)

	Labor Market Definition			
Variable	*Rural-Urban*	*Rural-Cairo-nonCairo*	*Rural-Urban*	*Rural-Cairo-nonCairo*
Male	−0.017	0.100	−1.373	−0.374
	(−0.15)	(0.71)	(−5.91)	(−2.00)
Urban	1.745	−0.068	−0.222	−0.477
	(6.37)	(−0.58)	(−0.47)	(−3.17)
Grade 4	−1.993	−1.829	−1.786	−1.829
	(−7.20)	(−6.81)	(−5.48)	(−6.01)
Grade 5	−1.990	−1.845	−1.922	−1.847
	(−7.14)	(−6.78)	(−5.94)	(−6.07)
Grade 6	−2.795	−2.700	−2.915	−2.804
	(−11.82)	(−11.78)	(−10.52)	(−10.84)
Father's Education	−0.020	−0.020	−0.024	−0.031
	(−1.00)	(−0.97)	(−1.07)	(−1.37)
Mother's Education	0.007	0.016	0.019	0.032
	(0.18)	(0.43)	(0.49)	(0.83)
Predicted Earnings	−2.379	−1.113	−0.432	−1.706
($\hat{Y}$)	(−7.19)	(−4.52)	(−0.77)	(4.64)
LnACHIEVE	−0.428	−0.423	−0.455	−0.419
	(−6.52)	(−6.54)	(−6.04)	(−5.76)
LnABILITY	−0.216	−0.223	−0.169	−0.178
	(−2.81)	(−2.98)	(−1.98)	(−2.12)
Wealth	0.176	0.263	0.900	0.639
	(0.66)	(1.00)	(2.78)	(2.12)
School Quality - ($\hat{\delta}$)	−1.451	−1.091	−1.774	−1.299
	(−4.78)	(−3.81)	(−5.18)	(−4.02)
Prob(Mkt Work) - ($\hat{\phi}$)	n.a.	n.a.	16.977	10.514
			(7.55)	(7.67)
Constant	10.987	5.992	3.215	7.909
	(8.46)	(6.40)	(1.46)	(5.73)
Observations	1803	1803	1744	1744

Note: n.a. = not available

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