

Schultz, T. Paul

**Working Paper**

## School Expenditures and Enrollments, 1960-1980: The Effects of Income, Price and Population Growth

Center Discussion Paper, No. 487

**Provided in Cooperation with:**

Yale University, Economic Growth Center (EGC)

*Suggested Citation:* Schultz, T. Paul (1985) : School Expenditures and Enrollments, 1960-1980: The Effects of Income, Price and Population Growth, Center Discussion Paper, No. 487, Yale University, Economic Growth Center, New Haven, CT

This Version is available at:

<https://hdl.handle.net/10419/160410>

**Standard-Nutzungsbedingungen:**

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

**Terms of use:**

*Documents in EconStor may be saved and copied for your personal and scholarly purposes.*

*You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.*

*If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.*

ECONOMIC GROWTH CENTER

YALE UNIVERSITY

P.O. Box 1987, Yale Station  
27 Hillhouse Avenue  
New Haven, Connecticut 06520

CENTER DISCUSSION PAPER NO. 487

SCHOOL EXPENDITURES AND ENROLLMENTS, 1960-1980:  
THE EFFECT OF INCOME, PRICES AND POPULATION GROWTH

T. Paul Schultz

July 1985

Notes: This research was supported by a grant from the General Service Foundation and research assistance was provided by the National Research Council of the National Academy of Sciences.

Center Discussion Papers are preliminary materials circulated to stimulate discussion and critical comment. References in publications to Discussion Papers should be cleared with the author to protect the tentative character of these papers.

Abstract

**SCHOOL EXPENDITURES AND ENROLLMENTS, 1960-1980:  
THE EFFECTS OF INCOME, PRICES AND POPULATION GROWTH**

T. Paul Schultz

School systems have expanded rapidly during the last twenty-five years. Nonetheless, it is widely believed that rapid population growth has reduced expenditures on schooling per child, contributed to a deterioration in school quality, and decreased the proportion of children attending schools. This paper proposes a production-demand framework for explaining the level and distribution of national expenditures on schools, teacher student ratios, and enrollment rates of boys and girls at the primary and secondary level. Data for 89 countries from 1960 to 1980 are examined to test empirically the role of real incomes per adult, the relative price of teachers, urbanization, relative size of school aged cohorts, and current total fertility rates on these varied measures of school inputs and enrollments. Although the relative price of teachers is treated as endogenous, the relative size of the school-aged cohort or the delayed effect of population growth is assumed to be an exogenous factor to which the educational sector responds.

1. Introduction

School systems have expanded rapidly during the last twenty-five years. Despite the unprecedented growth in the population reaching school age, enrollment rates at these ages have increased in virtually every country. However, school expenditures in some low and middle income countries have recently not increased as rapidly as enrollment; this growing gap in public educational expenditures per pupil between poorer and richer countries is a worrisome trend that suggests a deterioration in the 'quality' of schooling may be occurring in the low income countries. To put these developments in perspective, this paper proposes a production-demand framework for explaining the level and distribution of national expenditures on schooling and enrollment rates. Incomes, prices, production technology, and demographic factors are interrelated as constraints and conditions affecting the costs of, and demands for, educational services. Data for 89 countries from 1960 to 1980 are then used to test empirically a variety of hypotheses within this framework, including whether rapid population growth, which has contributed to an increase in the relative size of a school-aged cohort, affects that cohort's educational opportunities and achievements. Differences in school enrollment between males and females are also examined. Finally, regional and religious deviations in educational expenditures and achievements are calculated, based on the fitted model. Though the uniformity and quality of the intercountry data and the simplicity of the statistical treatment of this mix of cross sectional and time series materials leave much room for future analytical improvements, this initial examination of educational systems confirms the usefulness of treating these institutions as adapting to the constraints imposed by incomes, relative factor prices, and population growth.

---

\* Presented at the Boston meeting of the Population Association of America, March 28, 1985. It represents a draft of a background paper for the National Academy of Sciences Working Group on Population Growth and Economic Development. The research assistance of Lynn Karoly, Andrew Levin, and Paul McGuire is greatly appreciated. The comments of Allen Kelley, Mark Rosenzweig, Raaj Sah, T. W. Schultz and John Strauss and the Working Group were also valuable.

The hypothesis has been advanced that rapid population growth makes it more difficult for a society to educate its youth (Jones, 1971, 1975; Robinson, 1975; World Bank, 1974, 1984). Obviously, a reduction in fertility leads to a reduction in the number of children of school age in six to eight years. This demographic development reduces in this sense the need for schools, and these potential public savings due to fertility declines can be used to achieve other social goals (Coale and Hoover, 1958, p. 25). To quantify the consequences of population growth on the educational system and society, it is often assumed that the allocation of resources to this public sector activity is fixed and does not respond to the changing private demands of the society for these services.

Perhaps, a more plausible institutional hypothesis is that public expenditures on the educational system respond to private demands for schooling and one determinant of these demands is the size of school-aged cohorts. But the public sector responds imperfectly and with lags, due to bottlenecks, as for example, the time required to increase the supply of trained teachers to educate a growing student population. According to this view, educational expenditures and achievements per child may fall short of long-run desired trends (equilibrium) in periods when the school-aged population is a relatively large and growing fraction of the total population, and the opposite tendency may emerge when school staff and structures exceed requirements temporarily due to a decline in fertility. At issue is how important is the relative size of the school aged population for the allocation of resources to the national educational system (e.g. Freeman, 1979; Lee, 1979; Welch, 1979; Easterlin, 1980; Simon and Pilarski, 1979). Empirically measuring the elasticity of educational inputs and outputs with respect to the relative size of school-aged cohorts is, therefore, a central objective of this study.<sup>1</sup>

The statistical problem is to hold constant for other exogenous factors that might explain the level and distribution of public expenditures on schooling and school achievement across countries and over time. It is particularly important to measure and hold constant those factors that might help to account for educational priorities in a society or that represent supplementary private inputs to the educational process. When these other factors are omitted from the empirical analysis and they are also associated with the relative size of the school-aged population, the observed partial association between schooling and cohort size will be a biased measure of the hypothesized demographic effect of cohort size on schooling per child. The challenge is to minimize this potential source of bias.

One reason it is difficult to measure the relationship between relative cohort size and educational inputs and outputs is because the size of the school-aged cohort is primarily a lagged measure of period fertility rates. The fertility of parents is closely related to what parents privately invest in the schooling of each of their children, and this trade-off of quantity and quality has attracted the attention of many social scientists (e.g. Wray, 1971; Belmont and Marolla, 1973; Terhune 1974; Becker and Lewis, 1974). The observation that fertility and schooling are inversely related does not imply 'one' causes the 'other'. Indeed, both are jointly chosen to some degree by parents in response to their economic and biological endowments, constraints and preferences. It is important, therefore, that the inverse correlation between fertility and child schooling must not be mistaken for evidence confirming the effect of relative cohort size on public educational expenditures or enrollments (Schultz, 1971, 1981; Rosenzweig and Wolpin, 1980). The analytical problem is how to distinguish between two possible parallel associations: the first at the level of family choice between

increases in parent investments in the schooling of their children and declines in their fertility, and the second at the aggregate level between the relative size of a school-aged cohort and the resultant squeeze on available school inputs and outputs per child. The strategy adopted here for separating these two relationships is to estimate the partial correlation between relative school-age cohort size and indicators of school expenditures and outputs, holding constant for current total fertility rates. Estimates are also reported in the Appendix, without controlling for current period fertility. Information on a better indicator of the lifetime reproductive performance of the parents of the school-aged cohort is not available from the majority of countries. If the estimated 'effect' of school-aged cohort size remains important after controlling for current total fertility, the aggregate 'squeezing out' causal hypothesis is tentatively sustained.

This empirical strategy should be more successful when fertility and child mortality are in flux. At such times it should be possible to discriminate statistically between (1) the covariance of current fertility and current parent investments in child schooling and (2) the repercussions of lagged fertility (and child mortality) on cohort size and thus on the schooling system. The framework may therefore be more discriminating in the study of the effects of cohort size on schooling at the secondary level rather than at the primary level, because the lag separating fertility and the size of these school-aged cohorts is longer, about 12 compared to 8 years, on average.

To improve on this relatively crude method for evaluating the exogenous effect of changes in the relative size of school-aged cohorts on the allocation of public resources and the performance of school systems more data and more explicit modeling would be required. Changes in fertility, child mortality,

and age structure could be dynamically analyzed within countries over time, or determinants of cumulative fertility and parental investment in child schooling could be derived from an explicit model of household behavior. Both of these alternative approaches to estimating the effect of cohort size on the schooling system would require more data and would therefore be based on a smaller and probably less representative sample of countries over time. Moreover, these alternative estimation strategies would appear to call for a theory of fertility determination, about which there is limited consensus today.

The next section of the paper reviews world trends in school enrollments and central government expenditures on education and identifies a number of issues for further study. Sections 3 and 4 model the determinants of demand for public schooling to specify how to proceed with the empirical analysis. Sections 5 through 9 report the empirical findings of an analysis of data from about ninety countries in the last three decades, and the concluding section uses these results to predict the recent trends overtime. A data appendix describes the sources, character and limitations of these data, and provides supplementary tables.

## 2. World Trends

Table 1 summarizes the level and increase in enrollment ratios at the primary, secondary and higher education level for countries grouped by income level, market/nonmarket economy, and oil exporter status. For summary comparisons of overall levels of schooling, a synthetic cohort measure is constructed and called hereafter the 'expected years of schooling'. It is defined as the sum of six times the primary, six times the secondary, and five times the higher educational enrollment ratios; where these weights, i.e. 6,



Table 1

Growth in Educational Enrollments by School Level and Countries  
by Income Classes, 1960 - 1981

World Bank Country Class <sup>a</sup> (Number)	Primary (6-11) Education		Secondary (12-17) Education		Higher (20-24) Education		Expected Years of Enrollment <sup>b</sup>		Percent of Increase in Enrollment Ratios (1960 - 1981)			
	1960 (1)	1981 (2)	1960 (3)	1981 (4)	1960 (5)	1981 (6)	1960 (7)	1981 (8)	Primary (9)	Secondary (10)	Higher (11)	Expected (12)
Low Income (34)	.80	.94	.18	.34	.02	.04	5.98	7.68	18	89	100	32
Excluding China <sup>c</sup> and India	.38	.72	.07	.19	.01	.02	2.75	5.56	89	171	100	162
Middle Income (38)												
oil exporters	.64	1.06	.09	.37	.02	.08	4.48	8.98	66	311	300	100
oil importers	.84	.99	.18	.44	.04	.13	6.32	9.23	18	144	225	46
Upper Middle Income (22)	.88	1.04	.20	.51	.04	.14	6.68	10.0	18	155	250	50
High Income - oil exporters (5)	.29	.83	.05	.43	.01	.08	2.09	7.96	186	760	800	281
Industrial Market (18)	1.14	1.01	.64	.90	.16	.37	11.5	13.3	-11	41	131	16
East European Non-market (8)	1.01	1.05	.45	.88	.11	.20	9.31	12.6	4	96	82	35

<sup>a</sup>The low income class has an annual GNP per capita of less than US \$410 in 1982 prices. The middle income class includes countries with GNP per capita between \$410 and \$1650, while the upper middle income class ranges from \$1650 to about \$6000.

<sup>b</sup>Synthetic cohort concept defined as six (years) times the sum of primary and secondary enrollment ratios plus five (years) times higher educational enrollment ratio.

<sup>c</sup>The lack of expenditure data for China and India in Table 2 justifies our consideration of the "low income" class of countries excluding these two large states.

Source: 1984 World Development Report, World Bank Staff, New York: Oxford University Press, 1984. Table 25, pp. 256-257.

6 and 5, correspond to the average number of single year age groups combined in the denominators of these three standardized enrollment ratios.

Expected years of schooling increased 32 percent from 1960 to 1981 in the low income class of countries; 46 percent gains were achieved in the middle income countries who imported oil, and 50 percent gains occurred in the upper middle income class. The East European non-market countries increased their expected years of schooling by 35 percent, while the industrial market high income countries advanced 16 percent. Oil exporters in the middle income class achieved a doubling of expected schooling levels, while nearly a fourfold increase was reported in the high income oil exporters.

In general, the percentage gains in schooling were greater for those countries that started from a lower level in 1960. The gap in expected years of schooling between the low and high income countries is therefore closing, on average, whether expressed in relative terms or even as an absolute difference in years. This closure in the education gap appears to be even more rapid in relative terms than that achieved in health, analogously summarized by life expectation at birth. The gap in expected education and life at birth between the lowest income countries (excluding India and China in the World Bank categories) and the high income industrial market economies decreased markedly in the last two decades. Life expectation stood at about 43 and 71 years in 1960, and had increased to roughly 51 and 75 years by 1982 in these two groups of countries, respectively. Expected years of schooling, on the other hand, increased for these two groups of countries from almost 3 and 11.5 years in 1960, to almost 6 and 13.3 years in 1982, or from one-to-four to almost one-to-two. These achievements were recorded despite the fact that income (GNP) per capita in constant prices grew in the same period three times faster in the high income countries than it did in this lowest income group of countries.<sup>2</sup>

The salient fact is that all classes of countries, and indeed every country for which overall comparisons can be drawn, increased the expected schooling that it provided to the 'average' child over these two decades, despite the extraordinarily rapid growth in the number of school-aged children in many of the poorest countries. The number of children between the ages of 6 and 17 more than doubled in the less developed regions from 1950 to 1980. The proportion of the population in these ages increased from 24.5 percent in 1950 to 29.1 percent in 1980, or by 19 percent.<sup>3</sup> That the poorest countries and those that have suffered actual declines in their real income in this period were nonetheless able to expand their schooling systems rapidly enough to accommodate an increasing fraction of their children is a remarkable achievement.

However, a less sanguine picture of recent educational progress emerges from World Bank data assembled in Table 2. Central governmental expenditures on education (and health), when expressed in terms of constant GNP prices, have declined in many countries in the past decade. Among low and middle income countries who are not oil exporters the share of central government expenditures allocated to education (and health) declined (Col. 1-4). The share of total government expenditures in GNP also declined in the low income countries and increased only slightly in the middle income oil importers (Col. 5 and 6). Resources allocated to education per capita by central governments appear to have declined in real terms by about two-thirds in the low income countries (including or excluding India and China) and increased by only 22 percent in the middle income oil importing countries. In contrast, oil exporting middle income and upper middle income countries were able to more than double their per capita real public expenditures for education, while the

Table 2

## Central Government Expenditures: 1972, 1981

World Bank Country Class <sup>a</sup> (Number)	Percent of Government Expenditures on:				Total Government Expenditures as Percent of GNP		Percent of Growth in Real Per Capita GNP	Percent of Growth in Per Capita Real Expenditures, 1972-81 on:	
	Education		Health		1972	1981	1972-1981 <sup>b</sup>	Education	Health
	1972 (1)	1981 (2)	1972 (3)	1981 (4)	(5)	(6)	(7)	(8)	(9)
Low Income (34) <sup>c</sup>	16.4	5.9	6.2	2.9	21.0	13.4	26	-67	-57
excluding China and India <sup>c</sup>	16.4	11.5	6.2	4.4	21.0	17.6	7	-63	-41
Middle Income (33)									
Oil Exporters	15.4	16.6	5.7	5.6	17.2	27.3	34	+133	+113
Oil Importers	11.0	10.0	6.9	4.6	20.7	21.8	28	+ 22	- 10
Upper Middle Income (22)	10.8	14.3	7.0	5.5	15.0	20.6	32	+140	+ 42
High Income - Oil Exporters (5)	13.5	9.2	5.5	5.5	36.6	26.3	0	- 51	- 28
Industrial Market (18)	4.3	5.1	9.9	11.4	21.7	28.3	21	+ 88	+ 81
East European Balkans (6)	NR	NR	NR	NR	NR	NR	NR	NR	NR

<sup>a</sup>The low income class has an annual GNP per capita of less than US \$410 in 1982 prices. The middle income class includes countries with GNP per capita between \$410 and \$1650, while the upper middle income class ranges from \$1650 to about \$6000.

<sup>b</sup>Annual Growth. Rate on per capita real GNP derived for 1970 to 1982 from Bank Tables, and interpolated for the nine years corresponding to expenditure data, 1972-1981.

<sup>c</sup>The lack of data for China or for India throughout this period makes the overall "Low Income" country class comparisons of limited value.

Source: (1984 World Development Report, World Bank Staff, Oxford University Press, New York, 1984. Appendix. Tables 2, 19 and 26.

high income industrial countries raised their real outlays on education by 88 percent. A comparable decline occurred in the central government expenditures in the low income countries on health, which fell by about one-half, and grew less rapidly than educational expenditures in all other classes of countries (Col. 9, Table 2).

The puzzle is how did the poorer countries sustain the growth in enrollments in an era when central government real outlays for education per capita were tapering off? Several developments could be responsible for these seemingly divergent trends. The unit costs of producing educational services may have declined, such as might occur if the price of educational inputs declined relative to the GNP deflator or economies of scale in school systems were realized. Alternatively, the quality of schooling may have deteriorated.

The dominant cost of primary and secondary school systems is the salary of teachers. Teacher wages may have declined relative to the general wage level with development, as they have in the twentieth century in the United States (Williamson and Lindert, 1980, p. 308). The supply of teachers may have 'outgrown' the demand in many countries, while highly paid expatriates were replaced by less expensive indigenous personnel. Alternatively, the quality (and pay) of teachers may have deteriorated. Both may have occurred. In the first case, the real resources available to the school system may not have fallen as rapidly as (or grown more rapidly than) the figures suggest in Column 8 of Table 2. Human and physical capital may also have been used more intensively over time, with teacher-to-student ratios increasing and capital expenditures as a share of total expenditures falling. These developments would be associated with larger classes, and perhaps less effective or lower quality instruction.

Other developments may also explain the aggregate trends. Private school expenditures may have increased as a share of total educational outlays. But this appears unlikely, because private school enrollments are generally modest, and are a declining share of total enrollments in most low income countries.<sup>4</sup> Tuition and fees may also transfer some of the resource costs of public schools from public expenditures to parents.<sup>5</sup> The reliance on such user fees, though increasingly debated as an auxiliary means of supporting educational expansion, have nonetheless been eroded by recent inflation and policy changes even in Africa (Jimenez, 1984). Sub-national and local public expenditures on education are excluded from the worldwide figures reported in Table 2, and the central government's share of educational expenditures may have declined recently.

In sum, many factors could be behind the decline in central governmental expenditures on education in the lowest income countries: (1) the actual quality of schooling per student may have declined; (2) the price of constant quality educational services relative to the general price level (GNP deflator) may have declined; (3) central government revenues for education may have declined relative to other sources of support for public education; (4) private school expenditures may have increased their share of the market, though enrollment data do not support this conjecture; and (5) the underlying data may be in error. The subsequent cross country empirical analysis of public educational systems is restricted to countries for which there appear to be consistent data on enrollments, teachers, expenditures on current and capital account, estimates of GNP in constant prices, urbanization and the population's age composition. The restricted data are believed to be more reliable than the comprehensive estimates reported in Table 2, but possible

less representative. UNESCO public expenditure data also represent the sum of government outlays at all administrative levels, but they probably in fact frequently omit local resources provided in kind to construct and maintain basic school structures. Estimates are later obtained of changes in relative prices (2) and changes in factor intensity or quality (1) in the use of teachers and physical capital. However, there is no unambiguous way to distinguish between changes in the quality of school inputs and changes in the prices of quality-constant inputs, since the capacity of schools to raise the market productivity and to augment the utility of students remains unobserved.

The question raised in this review of world trends is how were enrollment rates increased, when central government expenditures slackened in real per capita terms or rose more slowly than did the school-aged population. Before considering patterns in these data from various countries, it is useful to have an overall framework within which to account for variation in the provision of educational services. The framework involves three parts: an interpretation of the political economy translating private demands into public expenditure decisions, a production technology linking educational inputs to outputs, and the determinants of household demand for public educational services.

### 3. Adjustment of The Educational System to Demand and Supply

Analyses of the private demand for public goods have generally assumed that citizens know about the costs of production and the benefits of government spending (e.g. Borcharding and Deacon, 1972). The political process is assumed to be more or less democratic, in the sense that entrepreneur-politicians seek 'election' to deliver efficiently the public goods and services and the associated tax burden that command jointly the support of a majority of

voters.<sup>6</sup> The essential idea is that public, as well as private, institutions are constrained in their input allocation and production decisions by consumer incomes, relative input prices, and perceived benefits of outputs.

The private demand for public education, however, involves several special features that warrant additional discussion. First, education is demanded both as a consumer good that yields direct utility and as a producer good that is expected to enhance the future productivity of the educated individual (T.W. Schultz, 1961). Private demand of consumer goods depends on consumer income, relative prices, and tastes. The taste for education is conventionally assumed uncorrelated with observed demand determinants, though this can be relaxed, if an exogenous proxy for taste can be distinguished; the examination in section 7 of male and female enrollment rates conditional on religion might be viewed as assuming religion is such a proxy for exogenous cultural taste.

Education is also a produced means of production, and economists have reasoned that the private and social demand for education should be influenced by its private and social rates of return, relative to alternative investment opportunities (Becker, 1964). The cross-sectional relationship observed between the rate of return to schooling and the public (and private) expenditures on schooling need not represent only the private supply function of investment in this means of production. The rate of return is also affected by the aggregate economy's derived demand for more and less educated workers. Unless factors can be specified a priori that shift one and not the other side of this market for more educated labor, it is not generally possible to identify statistically the individual's investment supply response function from the aggregate derived demand function for educated labor. It would be useful for our purposes to specify exogenous endowments to the economy or



technological dimensions to the development process that affect the derived demands for relatively better educated labor and hence displace the producer returns to education. However, there is as yet no agreement on what these factors might be. In the later empirical analysis, income, relative prices and technological constraints may influence the consumer's demand for education and also shift the derived demand for educated labor and thereby vary the rate of return to education as a producer good.<sup>7</sup>

The approach adopted here is to assume simply that the demand for educated labor is primarily a function of the current level of national income per worker, and other specified technological and demographic constraints. Within these general long run constraints, the political system seeks to allocate the resources to the educational system that are economically justified and privately demanded. Hence, consumer demand for schooling is itself a reduced-form relationship that embodies structural parameters from an individual investment supply relationship and an aggregate derived demand for relatively educated labor. Identifying these underlying structural parameters is not attempted here.

A second unusual feature of the educational system is that it produces its own main input, teachers. It thereby affects by its past production the current wage required to retain the services of teachers and consequently the unit cost of producing further education, other things being equal. This feedback effect of output on unit costs suggests that choosing the best expansion path for education involves issues of intertemporal optimization and intergenerational equity, topics that implicitly arise in the educational planning literature, but which have not been explicitly incorporated into empirical analyses (Bowles, 1969; Freeman, 1971). For example, to expand a

school system rapidly from a very limited national educational base involves inevitably bidding up temporarily the cost of teachers and may even require the costly importation of trained personnel. These high initial costs of expansion tend to decline as the pool of domestically trained secondary school graduates increases and these new graduates compete for available teacher posts. This decline in the relative price of teachers then encourages, along with rising incomes, more private demand for public education as both a consumption and investment activity. Figure 1 illustrates this downtrend in the relative price of teachers in a number of African countries which have recently expanded their national educational systems. The wages of teachers relative to the average worker showed less obvious trends in the middle income countries, such as in Latin America. In the high income market economies this relative wage of public school teachers followed a variety of paths, but there was often a tendency for the relative wages of teachers to increase temporarily in the 1960's as the educational system expanded to accommodate the large cohorts of babies born after the Second World War.

Although there is no established framework for dealing with these dynamic and recursive features of national educational systems, it is clear that the current wage of teachers directly depends on the level of current demands for schooling. Consequently, the price of teachers is endogenous to a model determining the demand for educational services. To estimate without simultaneous equation bias the effect of this price on current demand, instrumental variable methods will be adopted. The instruments will be selected such that they are correlated with the current wage of teachers but are not correlated with the errors in the equation determining current educational demands.



#### 4. A Model of The Educational System

The technological possibilities for producing educational services are assumed to be identical across countries. This production function for educational services is also assumed in the long run to exhibit constant returns, which does not seem to be an unrealistic assumption, if we exclude very small countries, say, of less than a million persons, and concentrate separately on the primary and secondary school systems (see Data Appendix). The production function may then be expressed in standard Cobb-Douglas form:

$$X = Z L^{\alpha} K^{1-\alpha}, \quad (1)$$

where X is the output of educational services, L is the labor input, K is the physical capital input, and  $\alpha$  is the share of wages in output, and  $1-\alpha$  is the capital share, while Z is a set of exogenous technological shifters that affect the unit costs of producing schooling in different environments, but are neutral with respect to labor and capital productivity and use. One such technological factor is the distribution of the population. Dispersed populations may incur greater private and public transportation costs, in terms of both time and money, to provide the same effective schooling services.

Another technological factor that appears to influence the effectiveness of the school's resources is children's home environment, and notably the education of their parents (Leibowitz, 1974); Rosenzweig, 1982). Consequently, I anticipate that if other things were equal, the effective demand for schooling services would be higher in a more urbanized population, and in one where parents are better educated. Finally, reductions in mortality

increase the expected returns from schooling to the parent, the child, and society (Schultz, 1971; Ram and Schultz, 1979). Although this actuarial effect on average returns to education may not be large, since recent mortality declines occur disproportionately among pre-school aged children, returns might nonetheless increase in recent decades by one-tenth in a typical low income country due to this factor alone (Preston, 1980).

However, parent education and life expectation are both factors that also contribute to the market productivity of the parents and hence to the current level of real GNP per person. Moreover, with increased income, more resources in both the public and private sector may be allocated to health expenditures which augment the expectation of life. If the education and expectation of life of parents are included as explanatory variables in an educational expenditure or output equation, both of these variables would be causally related to income in complex ways. It would be unrealistic, therefore, to expect that country level data could separately distinguish the effects of parent income, parent education, and expectation of life on the performance of the schooling system. Merged family level data and aggregate community data might be able to sort out the effects of these interrelated factors (Schultz, 1984). Only the technological effects of urbanization on schooling costs will be estimated here.

If the educational sector minimizes its unit costs, that is, produces efficiently, the marginal cost or price of schooling services,  $P_x$ , can be expressed as a multiplicative function of the wages rate paid labor in the

educational sector,  $W$ , and the return,  $r$ , required on public capital (e.g. Borcherding and Deacon, 1972):

$$P_x = \left(\frac{1}{Z}\right) \left(\frac{W}{a}\right)^a \left(\frac{r}{1-a}\right)^{1-a} \quad (2)$$

To some degree, world capital markets work to equalize the rental rate on educational physical capital, and then the only remaining constraints that would influence the marginal cost of education across countries and over time are the real wage paid to teachers,  $W$ , and the exogenous technological conditions denoted by  $Z$ . Teacher salaries are the bulk of recurrent expenses for most school systems. In recent years about 95 percent of current expenses in the primary school systems of low income countries were teacher salaries, whereas in high income countries the proportion is about 75 percent (World Bank, 1983, p. 99). Current expenditures in a school system divided by the number of teachers is, therefore, a useful approximation of the wage paid for labor by the educational system and is the principal factor determining the relative price of educational services in a country. Taking logarithms of the price equation,

$$P_x = e^{\beta_0} Z^{\beta_1} W^{\alpha} e^{u_1}, \quad (3)$$

where  $\beta_0$  is a constant,  $\beta_1 = -1$ , and  $u_1$  is a multiplicative error in the production technology affecting unit costs. Because labor's share of educational expenditures,  $\alpha$ , can be observed, the effect of price variation can be estimated from data on teacher wages (Gramlich and Rubinfeld, 1982).

Educational services are assumed to flow equally to all citizens. The quantity demanded is defined as  $q$ .

$$q = X / P^\gamma, \quad (4)$$

where  $P$  is the population of children of school age, and  $\gamma$  is the 'public good' parameter, equal to unity if it is a private good, and zero if it is a pure public good. Public externalities of basic education are often cited as a reason for public subsidization of education, suggesting that  $\gamma < 1$ .

The median voter is assumed to pay a share to finance the output of educational services for each of his or her children:

$$t = (P_x X) / (FAq) = P_x P^{(\gamma - 1)}, \quad (5)$$

where  $t$  is the tax share per tax paying adult  $A$ , who has on average  $F$  children of school age, and hence  $FA = P$ .

Finally, the demand function for schooling of the median voter is conventionally assumed to be log-linear in the tax,  $t$ , paid (or price), in the taxpayers's income,  $Y$ , and possibly in technological factors,  $Z$ ,<sup>8</sup>

$$q = Dt^\eta Y^\delta Z^\epsilon e^{u_2}, \quad (6)$$

where  $u_2$  is a multiplicative error in the demand relationship.

Combining (4) and (5) with (6), to eliminate the tax rate, an expenditure (E) function is obtained per school-aged child in terms of income, prices,

children, and technological constraints:

$$E/P = tq = DY^\delta P_x^{(\eta+1)} P^{(\eta+1)(\gamma-1)} Z^\varepsilon e^{u_2}, \quad (7)$$

To simplify the interpretation of the effect of the relative size of the cohort of school aged children,  $X$  is assumed to be a purely private good, that is,  $\gamma = 1$ . In this case, after substituting (3) in for the price of educational services, logarithms are taken of (7) and the partial effects of income per adult, relative prices (teacher wage), and technological shifters on public educational expenditures per child can be expressed as a combination of household demand and production technology parameters:

$$\ln(E/P) = b_0 + b_1 \ln Y + b_2 \ln W + b_3 \ln Z + v, \quad (8)$$

$$\text{where } b_0 = (\eta + 1)(\beta_0) + \ln D,$$

$$b_1 = \delta,$$

$$b_2 = \alpha(\eta + 1),$$

$$b_3 = \beta_1(\eta + 1) + \varepsilon,$$

$$v = u_1(\eta+1) + u_2.$$

In sum, equation (8) is a reduced-form relationship derived from both the education production technology (1) and the form of household demands (6). The production and demand errors  $u_1$  and  $u_2$ , are assumed to be independently distributed and serially uncorrelated and uncorrelated with  $Y$ ,  $Z$  and lagged  $Y$ ,  $Z$  and  $S/P$ . The income elasticity,  $\delta$ , that is directly estimated from a regression in the form of (8) would capture the effect of income on public



expenditures for education that is due to both consumption demands and producer demands induced by increasing rates of return to educated labor. Since  $\alpha$  is known from the input share of labor in total educational expenditures, the Cobb-Douglas form of the technology permits one to identify the price elasticity,  $\eta$ . But the wage of teachers is likely to be endogenous and hence correlated with  $v$ , and it is later transformed into a relative price of schooling that is defined in terms of income and the component of current school expenditures per teacher. Ordinary least squares estimates of  $\eta$  and  $\delta$  may thus be biased due to simultaneity and by errors-in-variables that are likely to generate spurious correlations among measured relative price, income, and school expenditure variables. An asymptotically unbiased instrumental variable estimator is therefore later proposed.

The net effects of  $Z$  factors on educational inputs and outputs can also be inferred from estimates of (8). The estimated impact of the relative size of the school-aged population on schooling expenditure per child is an estimate of the cohort size effect squeezing out educational expenditures as hypothesized in the demographic-development literature. Alternative interpretations could also be attached to a negative estimate of the relative cohort size effect.<sup>9</sup> The proportion of the population living in urban areas is a second variable.

##### 5. An Empirical Decomposition of Educational Expenditures

It is of practical interest to evaluate how the composition of educational expenditures varies with price, income and demographic factors, in addition to the behavior of overall educational expenditures. For this purpose, it is convenient to divide school expenditures per school-age child ( $E/P$ ) into a

multiplicative function of four observable components:

$$\frac{E}{P} = \left(\frac{S}{P}\right) \left(\frac{T}{S}\right) \left(\frac{E}{C}\right) \left(\frac{C}{T}\right) \quad (9)$$

The first term on the right hand side is the ratio of students enrolled to the number of children of school age, the enrollment ratio, which can be computed in many countries for boys and girls separately. The second term is the teacher to student ratio, that will be treated as an indicator of the human capital 'quality' of schooling (Pryor, 1968; Bowles, 1969), which may be contrasted with the 'quantity' response in terms of enrollments. The third term is the ratio of total expenditures to current expenditures, or an index of the physical capital intensity of the educational system. The fourth and final term is the current expenditures per teacher. Logarithms of the four component ratios in question (9) are then regressed on the same income, price, technology, and population composition variables used to explain expenditures per child. The sum of the log-linear regression coefficients for each conditioning variable in these four component regressions is equal to that variable's coefficient in the overall expenditure per child function. In this way, the effect of income, price, and other factors on overall educational expenditures estimated from equation (8) may be decomposed into the additive effects of that conditioning variable operating on quantity, quality, capital intensity, and teacher salaries.<sup>10</sup>

Educational expenditures are deflated to constant local prices using the GNP deflator and converted to 1970 U.S. dollars according to the prevailing

average foreign exchange rate in 1969-71 (See Data Appendix for details).<sup>11</sup> The wage of primary and secondary school teachers is defined as the public current expenditures on that level of schooling divided by the number of teachers at that level. This 'average' teacher salary should then be deflated by the local price level to obtain a relative price. I have used the national productivity of the average adult as a numeraire for the teacher's salary. Thus, this relative price of teachers is defined as the ratio of teacher salaries to GNP per person of working age (age 15 to 65).

This measure of the relative price or cost of educational services is likely to be determined jointly and simultaneously with production costs and consumer demands for schooling. The endogeneity of the relative price of teachers is reflected in the likelihood that unexplained variation in either production costs ( $u_1$ ) or consumer demands ( $u_2$ ) will be correlated with observed relative prices of teachers. Ordinary least squares (OLS) could overestimate  $b_2$  in equation (8), because of the resulting simultaneous equation bias. Consequently, the model is estimated first by OLS, under the assumption that the relative price of teachers is exogenous, and then by instrumental variable (IV) techniques, under the assumption that the price variable is endogenous but instrumental variables such as secondary school enrollment rates, incomes, and urbanization, all lagged ten years, are uncorrelated with production and demand errors in the current schooling system equations.<sup>12</sup> The IV estimates incorporate our anticipations that the relative price of teachers today will be reduced by increases in the supply of potential teachers trained in the country in previous years. The IV estimates also eliminate the errors-in-variable problem that arises because the logarithmic transformation of relative prices, incomes, and teacher wages are linearly dependent on each other.<sup>13</sup>

Although the auxiliary instrumental variable equations for wages undoubtedly simplify the structural process underlying time series of educational systems, these simultaneous equation techniques should provide consistent estimates of the reduced-form equation (8) based on demand/technology determinants of educational expenditures and enrollments.<sup>14</sup>

Income is measured as GNP in local constant prices, expressed in 1970 dollars by conversion at the average foreign exchange rate prevailing from 1969 to 1971.<sup>15</sup> To avoid definitional dependence on fertility this measure of real GNP is divided by the population of working age, 15 to 65. Population density is measured as the proportion of the population living in an urban area, as defined by the World Bank and estimated from national censuses. The relative size of the school-aged cohort is the proportion of the population age 6-11 for primary school, the proportion age 12-17 for secondary school, following UNESCO conventions. For the consolidated expenditure and enrollment equations, the child cohort is defined as the proportion of the population age 6 to 17. Period fertility is measured by the total fertility rate, which is equivalent to the sum of age specific birth rates for women age 15 to 49.

Data were first collected for 155 countries with populations greater than one million in 1983, for each five years from 1950-1980. Data on all required series were obtained for at least one year in 89 countries, of which 30 were in Africa, 19 Latin America, 21 Asia, 2 Oceania, 1 North America and 16 Europe (See Table A-1). The maximum number of country-year observations was 321 for primary schools and 252 for secondary schools. In pooling of time series observations from a cross section, it is clear that all observations are not independent; neglect of covariation across observations on a particular

country undoubtedly biases reported tests of statistical significance and may bias point estimates as well.

The variables are defined and sample characteristics summarized by region for primary and secondary school systems in Tables 3A and 3B, respectively. Beneath the mean of the variable is its standard deviation in parentheses, and if the variable is expressed in logarithmic form, the antilog of the mean is reported as the third value in brackets to provide an absolute measure of level. For example, primary enrollment ratios are 59 percent in Africa and 95 percent in Latin America, while the teacher student ratios and capital intensity are similar, .024 and .030, and 1.22 and 1.15, respectively. Primary school teachers are paid about the same in the two regions, but because GNP per adult is one third as large in Africa, the relative price of teachers is twice as high in Africa as it is in Latin America. Expenditure per primary school aged child is \$20 in Africa compared with \$51 in Latin America. The potential explanatory role of income and relative prices in determining school expenditures and achievements is suggested from such gross regional comparisons. The large differences between enrollment ratios for boys and girls in Africa compared with Latin America may also stem from economic differences between regions. The next section proceeds to fit the multivariate production/demand relationships across country observations to estimate the magnitude of price and income effects as well as the effects of urbanization and population growth.

Table 3A

Characteristics of Sample of Primary Schooling Systems  
from 1960 to 1980, by Region

Region	Africa	Latin America	East Asia	South and West Asia	Europe, Canada and Oceania	Total Sample
(Sample size)	(62)	(43)	(21)	(24)	(36)	(186)
<u>Dependent Variables:</u>						
Enrollment Ratio - Total (S/P)	-.523 (.538) [.593]	-.0506 (.198) [.951]	.0150 (.111) [1.02]	-.398 (.470) [.672]	.0315 (.0708) [1.03]	-.229 (.440) [.743]
Enrollment Ratio - Male (S/P)	-.339 (.479) [.713]	-.0235 (.181) [.977]	.0370 (.103) [1.04]	-.145 (.353) [.865]	.0332 (.0763) [1.03]	-.126 (.355) [.882]
Enrollment Ratio - Female (S/P)	-.737 (.619) [.479]	-.0717 (.231) [.930]	-.00466 (.121) [.995]	-.835 (.823) [.434]	.0277 (.0744) [1.03]	-.365 (.604) [.694]
Teacher-Student Ratio (T/S)	-3.73 (.266) [.0238]	-3.51 (.260) [.0299]	-3.48 (.238) [.0308]	-3.49 (.318) [.0305]	-3.06 (.345) [.0469]	-3.49 (.366) [.0305]
Capital Intensity Index (E/C)	.199 (.238) [1.22]	.141 (.162) [1.15]	.188 (.108) [1.21]	.270 (.184) [1.31]	.192 (.114) [1.21]	.192 (.184) [1.21]
Current Expenditures per Teacher (C/T)	7.03 (.667) [1130.]	7.35 (.613) [1156.]	7.44 (1.02) [1703.]	6.17 (.961) [478.]	8.86 (.723) [7044.]	7.39 (1.10) [1620.]
Real Expenditures per Child (E/P)	2.97 (.885) [19.5]	3.94 (.675) [51.4]	4.16 (1.16) [64.1]	2.55 (1.38) [12.8]	6.02 (.847) [412.]	3.87 (1.51) [47.9]
Expenditure Share of GNP	.0219 (.0087) -	.0190 (.0067) -	.0192 (.0063) -	.0145 (.0095) -	.0227 (.0098) -	.0201 (.0087) -

Table 3A continued:

Region (Sample size)	Africa (62)	Latin America (43)	East Asia (21)	South and West Asia (24)	Europe, Canada and Oceania (36)	Total Sample (186)
<u>Explanatory Variables:</u>						
GNP per Adult Real 1970 \$	5.74 (.619) [311.]	6.83 (.502) [925.]	6.79 (.877) [889.]	5.86 (.785) [351.]	8.09 (.510) [3262.]	6.58 (1.08) [721.]
Relative Price of Teacher	1.29 (.565) [3.63]	.518 (.421) [1.68]	.644 (.387) [1.90]	.306 (.468) [1.36]	.771 (.482) [2.16]	.813 (.606) [2.25]
Proportion Urban Population	.227 (.137) -	.479 (.155) -	.533 (.320) -	.284 (.183) -	.626 (.169) -	.404 (.240) -
Proportion of Pop- ulation Age 6-11	.165 (.0119) -	.170 (.0179) -	.148 (.0271) -	.167 (.0106) -	.104 (.0127) -	.153 (.0292) -
Total Fertility Rate	6.62 (.986) -	5.37 (1.18) -	3.88 (1.47) -	6.29 (.996) -	2.35 (.541) -	5.15 (1.91) -
Proportion Adults Literate	.329 (.193) -	.726 (.166) -	.798 (.124) -	.364 (.202) -	.948 (.0733) -	.598 (.299) -
Life Expectation at birth (yrs)	47.9 (6.40) -	60.6 (6.81) -	65.0 (6.92) -	51.3 (8.88) -	72.0 (1.97) -	57.9 (11.2) -

Table 3B

Characteristics of Sample of Secondary Schooling Systems  
from 1960 to 1980, by Region

Region	Africa	Latin America	East Asia	South and West Asia	Europe, Canada and Oceania	Total Sample
(Sample size)	(49)	(35)	(18)	(16)	(21)	(139)
<u>Dependent Variables:</u>						
Enrollment Ratio - Total (S/P)	-2.45 (.836) [.0863]	-1.21 (.455) [.298]	-.779 (.455) [.459]	-1.59 (.612) [.204]	-.278 (.177) [.757]	-1.49 (1.00) [.225]
Enrollment Ratio - Male (S/P)	-2.13 (.807) [.119]	-1.20 (.424) [.301]	-.714 (.392) [.490]	-1.20 (.525) [.301]	-.271 (.141) [.763]	-1.33 (.882) [.264]
Enrollment Ratio - Female (S/P)	-2.95 (.956) [.0523]	-1.24 (.507) [.289]	-.852 (.523) [.427]	-2.35 (.960) [.0954]	-.295 (.233) [.745]	-1.78 (1.25) [.168]
Teacher-Student Ratio (T/S)	-3.05 (.284) [.0474]	-2.90 (.363) [.0550]	-3.22 (.276) [.0400]	-3.14 (.255) [.0433]	-2.67 (.275) [.0693]	-2.98 (.341) [.0508]
Capital Intensity Index (E/C)	.205 (.261) [1.23]	.127 (.113) [1.14]	.181 (.110) [1.20]	.304 (.171) [1.36]	.197 (.144) [1.22]	.192 (.193) [1.21]
Current Expenditures per Teacher (C/T)	8.76 (.589) [6374.]	8.09 (.725) [3262.]	8.19 (1.01) [3605.]	7.38 (.940) [1604.]	9.18 (.628) [9701.]	8.42 (.903) [4537.]
Real Expenditures per Child (E/P)	3.47 (.867) [32.1]	4.11 (.914) [60.9]	4.37 (1.45) [79.0]	2.96 (1.27) [19.3]	6.42 (.931) [614.]	4.14 (1.47) [62.8]
Expenditure Share of GNP	.0286 (.0113) -	.0195 (.0098) -	.0225 (.0017) -	.0174 (.0105) -	.0358 (.0108) -	.0253 (.0123) -



Table 3B continued:

Region	Africa	Latin America	East Asia	South and West Asia	Europe, Canada and Oceania	Total Sample
(Sample size)	(49)	(35)	(18)	(16)	(21)	(139)
<u>Explanatory Variables:</u>						
GNP per Adult Real 1970 \$	5.75 (.611) [314.]	6.87 (.439) [963.]	6.84 (.938) [934.]	5.85 (.796) [347.]	7.96 (.565) [2864.]	6.52 (1.01) [679.]
Relative Price of Teacher	3.01 (.615) [20.3]	1.22 (.501) [3.39]	1.35 (.570) [3.86]	1.53 (.538) [4.62]	1.21 (.315) [3.35]	1.90 (.979) [6.69]
Proportion Urban Population	.220 (.137) -	.489 (.153) -	.567 (.326) -	.290 (.196) -	.560 (.166) -	.392 (.237) -
Proportion of Pop- ulation Age 12-17	.135 (.0102) -	.143 (.0114) -	.137 (.0199) -	.139 (.0074) -	.0996 (.0108) -	.132 (.0185) -
Total Fertility Rate	6.68 (.973) -	5.34 (1.17) -	3.88 (1.57) -	6.70 (.600) -	2.41 (.602) -	5.34 (1.87) -
Proportion Adults Literate	.328 (.183) -	.744 (.146) -	.798 (.119) -	.285 (.123) -	.936 (.0854) -	.581 (.293) -
Life Expectation at birth (yrs)	47.9 (6.39) -	61.3 (6.73) -	65.3 (7.44) -	49.0 (7.59) -	71.4 (2.28) -	57.2 (11.0) -

## 6. Estimates of School Expenditure Equations

The empirical findings are reported in two basic specifications, one which assumes that the relative price of teachers is exogenous and measured without error, and a second which treats this price variable as endogenous and potentially measured with error. Under the first set of assumptions, ordinary least squares (OLS) estimates of the parameters to equation (8) may be satisfactory, and they are reported in Col.(7) of Tables 4, 5, 6 for the primary, secondary and overall public educational expenditures per school aged child. Columns (3) through (6) provide the component regressions designated in equation (9), although in the case of the total school system the transformation of enrollment rates to expected years of schooling, and the general gaps in data on teachers in the public higher educational systems imply that the analogous total components do not 'add up'. Because the relative price of school teachers is defined as the wage of teachers divided by GNP per adult, the logarithm of the teacher wage component in column (6) is precisely equal to the sum of the logs of the income and price variables in the OLS estimates for the primary and secondary school systems.

The second set of regressions in Tables 7, 8 and 9 report instrumental variable (IV) estimates, which are preferred because they are consistent under the more realistic assumptions specified above regarding the endogeneity of relative prices. However, since these estimates depend on the availability of information on income and secondary school enrollments a decade earlier, the working sample for which these estimates can be obtained is reduced from 321 to 186 at the primary level, from 252 to 139 at the secondary level, and from 240 to 132 at the level of the total school system. Nonetheless, the countries in the samples do not change appreciably, only the time period shifts with the

Table 4

Estimates of Primary School Expenditures and  
Components, with the Price of Teachers Exogenous<sup>a</sup>

Dependent Variables in Logarithms	Enrollment Ratio			Teacher- Student Ratio	Capital Intensity Index	Teacher Salary	Total Expenditure per Child Age 6-11
	Male	Female	Total				
	(S/P)	(S/P)	(S/P)	(T/S)	(E/C)	(C/T)	(E/P)
Explanatory Variables:	(1)	(2)	(3)	(4)	(5)	(6)	(7)
GNP per Adult in 1970 (log)	.158 (3.79)	.332 (5.07)	.224 (4.66)	.145 (3.75)	-.0002 (.01)	1.0	1.37 (26.5)
Relative Price of Teachers (log) <sup>a</sup>	-.188 (5.13)	-.153 (2.67)	-.194 (4.61)	-.158 (4.65)	-.0428 (1.72)	1.0	.606 (13.4)
Proportion of Population Urban	.0898 (.54)	-.0173 (.07)	.0390 (.20)	-.308 (2.00)	-.0925 (.82)	0.0	-.362 (1.76)
Proportion of Pop- ulation Age 6-11	2.44 (1.88)	7.87 (3.88)	4.25 (2.86)	-4.03 (3.36)	-1.22 (1.39)	0.0	-1.00 (.63)
Total Fertility Rate	-.0130 (.55)	-.110 (2.97)	-.0508 (1.87)	-.0270 (1.23)	.0155 (.97)	0.0	-.0623 (2.13)
Intercept	-1.36 (4.15)	-3.05 (5.97)	-1.95 (5.19)	-3.44 (11.3)	.372 (1.68)	0.0	-5.01 (12.4)
R <sup>2</sup>	.430	.517	.511	.539	.029	1.0	.952
Sample Size is 186							
Dependent Variable							
Mean (Standard Deviation)	-.126 (.355)	-.365 (.604)	-.229 (.440)	-3.49 (.366)	.192 (.184)	7.39 (1.10)	3.87 (1.51)

<sup>a</sup>The price is treated as exogenous and estimated with ordinary least squares. Absolute value of t ratio reported in parentheses beneath regression coefficients.

Table 5

Estimates of Secondary School Expenditures and  
Components, with the Price of Teachers Exogenous<sup>a</sup>

Dependent Variables in Logarithms	Enrollment Ratio			Teacher- Student Ratio	Capital Intensity Index	Teacher Salary	Total Expenditure per Child Age 12-17
	Male	Female	Total				
	(S/P)	(S/P)	(S/P)	(T/S)	(E/C)	(C/T)	(E/P)
<b>Explanatory Variables:</b>	(1)	(2)	(3)	(4)	(5)	(6)	(7)
GNP per Adult in 1970 (log)	.399 (4.97)	.766 (9.13)	.526 (7.03)	.0377 (.69)	-.0132 (.37)	1.0	1.55 (27.8)
Relative Price of Teachers (log) <sup>a</sup>	-.354 (6.84)	-.403 (7.45)	-.389 (8.05)	-.0927 (2.63)	-.0225 (.99)	1.0	.496 (13.8)
Proportion of Population Urban	-.219 (.71)	-.575 (1.78)	-.380 (1.32)	-.0181 (.09)	-.0766 (.56)	0.0	-.474 (2.21)
Proportion of Pop- ulation Age 12-17	1.69 (.63)	10.5 (3.74)	4.53 (1.81)	-9.69 (5.29)	-2.14 (1.81)	0.0	-7.29 (3.91)
Total Fertility Rate	-.104 (2.91)	-.192 (5.13)	-.134 (4.03)	.0454 (1.87)	.0113 (.72)	0.0	-.0775 (3.12)
Intercept	-2.84 (4.05)	-6.15 (8.40)	-3.92 (6.00)	-2.01 (4.20)	.574 (1.86)	0.0	-5.35 (11.0)
R <sup>2</sup>	.763	.872	.839	.261	.039	1.0	.959
Sample Size is 139							
<b>Dependent Variable</b>							
Mean (Standard Deviation)	-1.33 (.882)	-1.78 (1.25)	-1.49 (.999)	-2.99 (.341)	.192 (.193)	8.42 (.903)	4.14 (1.47)

<sup>a</sup>The price is treated as exogenous and estimated with ordinary least squares. Absolute value of t ratio reported in parentheses beneath regression coefficients.

Table 6

Estimates of Total School Expenditures and  
Components, with the Price of Teachers Exogenous

Dependent Variables in Logarithms	Enrollment Ratio			Teacher- Student Ratio	Capital Intensity Index	Teacher Salary	Total Expenditure per Child Age 6-17
	Male	Female	Total				
	(S/P)	(S/P)	(S/P)	(T/S)	(E/C)	(C/T)	(E/P)
Explanatory Variables:	(1)	(2)	(3)	(4)	(5)	(6)	(7)
GNP per Adult in 1970 (log)	.237 (4.66)	.457 (5.98)	.314 (5.66)	.114 (3.22)	-.0085 (.23)	.919 (24.0)	1.41 (24.4)
Relative Price of Teachers (log) <sup>a</sup>	-.250 (5.21)	-.239 (3.31)	-.267 (5.09)	-.103 (3.08)	-.0154 (1.50)	1.17 (32.4)	.485 (8.87)
Proportion of Population Urban	-.0471 (.25)	-.314 (1.08)	-.161 (.76)	-.161 (1.20)	-.108 (.78)	-.0642 (.44)	-.334 (1.51)
Proportion of Pop- ulation Age 6-17	.432 (.52)	3.31 (2.64)	1.47 (1.61)	-2.92 (5.05)	-1.03 (1.73)	-.551 (.88)	-2.81 (2.96)
Total Fertility Rate	-.0381 (1.46)	-.127 (3.26)	-.0746 (2.62)	.0130 (.72)	.0166 (.89)	.0478 (2.43)	-.0365 (1.23)
Intercept	.885 (2.05)	-1.11 (1.71)	.221 (.469)	-3.09 (10.3)	.565 (1.83)	.527 (1.62)	-4.82 (9.82)
R <sup>2</sup>	.660	.693	.717	.527	.043	.948	.956
Sample Size is 132							
Dependent Variable							
Mean (Standard Deviation)	2.03 (.461)	1.72 (.728)	1.90 (.551)	-3.31 (.271)	.195 (.196)	8.80 (.886)	3.89 (1.45)

<sup>a</sup>The price is treated as exogenous and estimated by ordinary least squares. Absolute value of t ratio reported in parentheses beneath regression coefficients.

Table 7

Estimates of Primary School Expenditures and Components  
with Price of Teachers Endogenous<sup>a</sup>

Dependent Variables in Logarithms	Enrollment Ratio			Teacher- Student Ratio	Capital Intensity Index	Teacher Salary	Total Expenditure per Child Age 6-11
	Male	Female	Total				
	(S/P)	(S/P)	(S/P)	(T/S)	(E/C)	(C/T)	(E/P)
Explanatory Variables:	(1)	(2)	(3)	(4)	(5)	(6)	(7)
GNP per Adult in 1970 (log)	.239 (3.96)	.430 (4.84)	.314 (4.53)	.168 (4.12)	.0008 (.03)	.870 (33.7)	1.35 (20.2)
Relative Price of Teachers (log) <sup>a</sup>	-.627 (4.81)	-.760 (3.96)	-.698 (4.67)	-.181 (2.06)	-.0106 (.16)	1.05 (18.8)	.161 (1.11)
Proportion of Population Urban	-.286 (1.14)	-.520 (1.41)	-.389 (1.35)	-.351 (2.08)	-.0736 (.60)	.193 (1.80)	-.620 (2.23)
Proportion of Pop- ulation Age 6-11	1.93 (1.08)	6.39 (2.43)	3.50 (1.71)	-2.98 (2.48)	-.773 (.88)	-7.07 (9.26)	-7.33 (3.71)
Total Fertility Rate	.0450 (1.23)	-.0277 (2.43)	.0163 (.39)	-.0268 (1.08)	.0102 (.57)	-.0120 (.76)	.0116 (.29)
Intercept	-1.60 (3.62)	-3.20 (4.92)	-2.18 (4.31)	-3.71 (12.5)	.291 (1.34)	1.75 (9.27)	-3.86 (7.87)
F	16.05	25.03	21.78	38.06	.46	1383.	441.
Sample Size is 186							
Dependent Variable							
Mean (Standard Deviation)	-.126 (.355)	-.365 (.604)	-.229 (.440)	-3.49 (.366)	.192 (.184)	7.39 (1.10)	3.87 (1.51)

<sup>a</sup>The price is treated as endogenous and estimated with instruments of secondary enrollment ratio, urbanization, and GNP per adult, all lagged ten years. Absolute value of asymptotic t ratio reported in parentheses beneath regression coefficients.

Table 8

Estimates of Secondary School Expenditures and Components,  
with Price of Teachers Endogenous<sup>a</sup>

Dependent Variables in Logarithms	Enrollment Ratio			Teacher- Student Ratio	Capital Intensity Index	Teacher Salary	Total Expenditure per Child Age 12-17
	Male	Female	Total				
	(S/P)	(S/P)	(S/P)	(T/S)	(E/C)	(C/T)	(E/P)
Explanatory Variables:	(1)	(2)	(3)	(4)	(5)	(6)	(7)
GNP per Adult in 1970 (log)	.304 (2.70)	.649 (5.13)	.428 (3.85)	.105 (1.53)	-.0087 (.24)	.942 (51.4)	1.47 (21.9)
Relative Price of Teachers (log) <sup>a</sup>	-.905 (6.58)	-1.07 (6.92)	-.964 (7.11)	.194 (2.33)	-.0082 (.19)	1.02 (45.5)	.242 (2.97)
Proportion of Population Urban	-.776 (1.76)	-1.25 (2.52)	-.963 (2.22)	.238 (.89)	-.0661 (.47)	.143 (1.99)	-.649 (2.49)
Proportion of Pop- ulation Age 12-17	-2.19 (.58)	5.67 (1.33)	.593 (.16)	-6.16 (2.67)	-1.87 (1.53)	-5.22 (8.42)	-12.7 (5.61)
Total Fertility Rate	-.0049 (.09)	-.0597 (.98)	-.0203 (.38)	-.0093 (.28)	.0087 (.50)	-.0114 (1.28)	-.0322 (1.00)
Intercept	-1.02 (.97)	-3.92 (3.31)	-2.04 (1.97)	-3.27 (5.12)	.492 (1.46)	1.03 (6.04)	-3.78 (6.08)
F	48.99	86.87	69.58	6.42	.88	1264.	419.
Sample Size is 139							
Dependent Variable							
Mean (Standard Deviation)	-1.33 (.882)	-1.78 (1.25)	-1.49 (1.00)	-2.98 (.341)	.192 (.193)	8.42 (.903)	4.14 (1.47)

<sup>a</sup>The price is treated as endogenous and estimated with instruments of secondary enrollment ratio, urbanization, and GNP per adult, all lagged ten years. Absolute value of asymptotic t ratio reported in parentheses beneath regression coefficients.

Table 9

Estimates of Total School Expenditures and Components,  
with Price of Teachers Endogenous<sup>a</sup>

Dependent Variables in Logarithms	Enrollment Ratio			Teacher- Student Ratio	Capital Intensity Index	Teacher Salary	Total Expenditure per Child Age 6-17
	Male	Female	Total				
	(S/P)	(S/P)	(S/P)	(T/S)	(E/C)	(C/T)	(E/P)
Explanatory Variables:	(1)	(2)	(3)	(4)	(5)	(6)	(7)
GNP per Adult in 1970 (log)	.277 (3.80)	.496 (5.03)	.357 (4.54)	.126 (3.40)	-.0018 (.05)	.756 (12.9)	1.35 (20.8)
Relative Price of Teachers (log) <sup>a</sup>	-.767 (5.08)	-.863 (4.37)	-.816 (5.14)	.0267 (.36)	-.0223 (.30)	1.43 (12.0)	.168 (1.28)
Proportion of Population Urban	-.473 (1.59)	-.821 (2.03)	-.614 (1.91)	-.0763 (.50)	-.0927 (.62)	.280 (1.17)	-.513 (1.93)
Proportion of Pop- ulation Age 6-17	-.479 (.39)	2.02 (1.23)	.501 (.38)	-2.22 (3.57)	-.792 (1.31)	-3.13 (3.20)	-5.21 (4.80)
Total Fertility Rate	.0450 (.1.06)	-.0292 (.51)	.0137 (.30)	-.0022 (.10)	.0142 (.67)	-.0286 (.84)	-.0073 (.19)
Intercept	1.27 (2.04)	-.529 (.63)	.623 (.93)	-3.49 (11.0)	.423 (1.37)	2.28 (4.57)	-3.40 (6.15)
F	27.85	36.23	34.25	23.38	.69	134.	414.
Sample Size is 132							
Dependent Variable							
Mean (Standard Deviation)	2.03 (.461)	1.72 (.728)	1.90 (.551)	-3.31 (.271)	.195 (.196)	8.08 (.886)	3.89 (1.45)

<sup>a</sup>The price is treated as endogenous and estimated with instruments of secondary enrollment ratio, urbanization, and GNP per adult, all lagged ten years. Absolute value of asymptotic t ratio reported in parentheses beneath regression coefficients.



frequent omission of the 1960s and emphasis given to the 1970s (see appendix table A-1). OLS estimates from the larger samples are similar to those reported here.

Alternatives to these preferred specifications of equation (8) are reported in appendix tables A-2, A-3 and A-4 for OLS estimates excluding total fertility rates, although in this form the proportion of the population of school age may also proxy for parental quality/quantity choices. Tables A-5, A-6, and A-7 report the analogous IV estimates without total fertility rates, with the same caveat. Finally, Tables A-8, A-9 and A-10 report the IV estimates of the preferred specification for the subsample of less developed countries, which constitute about four-fifths of the overall sample.

According to the OLS estimates the income elasticity of expenditures (8) on primary, secondary, and total school systems exceed unity; they are specifically 1.37, 1.55, and 1.41, respectively. The IV estimates are similar, 1.35, 1.47 and 1.35. The share of income expended on each level of schooling tends to increase with real GNP per adult. The elasticity of educational expenditures with respect to the relative price of teachers is .60, .50 and .49 at the three school levels, if we accept the assumptions underlying the OLS estimates. The preferred IV estimates of price elasticities are, as expected, substantially lower at .16, .24 and .17. According to these IV estimates the elasticity of the quantity of schooling services demanded with respect to the price of labor, in the model  $\eta$ , is equal to  $-.80$ ,  $-.70$  and  $-.80$ .<sup>16</sup>

The composition of these income and price effects on public expenditures differs slightly by school level. In the primary schools, the income elasticity is about twice as large for enrollments as for teacher-student ratios; the IV estimates are .31 for quantity and .17 for quality (Col. 3 and 4). The physical capital intensity index is not well explained by any of the economic

or demographic variables, and may contain largely transitory variations in capital appropriations or unsystematic measurement error (Col. 5). There is no evidence of complementarity or substitutability of capital for labor. Teacher salaries increase five percent faster than do incomes per adult (Col. 6), contributing to the elasticity of the income-expenditure relationship (Col. 7).

At the secondary school level (Table 8), the income elasticity is four times larger for quantity (.43) than for quality (.11). The price elasticity of secondary enrollment is substantially larger in absolute value,  $-.97$ , than that at the primary level,  $-.70$ . The price elasticity of total expected years of schooling is also large,  $-.82$  (Table 9, Col. 3), falling between the primary and secondary school estimates. A decline in the price of school teachers relative to national productivity is associated with a substantial increase in enrollment and modest increase in the ratio of primary school teachers to students.

Urbanization exhibits a relatively weak, but consistent, relationship with public expenditures on schooling. According to the IV estimates, a country which has ten percent more of its population in urban areas, tends to expend six percent less on schooling per child, at both the primary and secondary levels. This is accomplished at the primary level by a reduction in enrollments and in teacher-to-student ratios, whereas at the secondary school level most of the reduction occurs through lower enrollments. These estimates, however, are based on the specification that permits urbanization a decade earlier to help determine the relative price of teachers today, and lagged urbanization is significantly associated with lower current relative prices for teachers. Thus, this indirect role of urbanization is to reduce the price of teachers and thereby induce an offsetting, but lagged, effect increasing enrollment rates.

If urbanization is excluded from the list of instruments to estimate price effects, the net contemporary effect of urbanization on school expenditures is to reduce current outlays per teacher, with little net effect on enrollments or teacher-student ratios.<sup>17</sup> Expenditures per child, in either case, are systematically lower in more urbanized countries when income levels and relative prices are held constant.

The data examined here are not very helpful in getting behind these economies of urban schools to determine their precise origin. Consolidation of schools into more efficient sized units to exploit specialized teaching functions in more densely populated areas is often cited as an important source of economies of scale in public schools.<sup>18</sup> Higher population densities could also reduce the private opportunity cost of travel time for students. But the lack of large effects of urbanization reducing teacher-student ratios in secondary schools, or increasing enrollments, suggests that economies of scale or reductions in private student time costs are unimportant.

The relative size of the school aged cohort, which is highly correlated with recent levels of population growth, is associated with lower expenditures on primary, secondary, and total school systems, and according to the preferred IV estimates, reported in Tables 7, 8 and 9, the effect is statistically significant and of a substantial magnitude. An increase in the proportion of the population of primary school age by ten percent, from .153 to .168, is associated with an eleven percent decline in primary school expenditures per child. In other words, the IV estimates suggest primary school expenditures do not increase in response to an increase in the size of the school aged cohort. There are offsetting tendencies for primary school enrollment rates to increase for the larger cohorts, whereas teacher-student ratios fall. Teacher salaries,

in addition, are substantially lower (ten percent) for the larger school aged cohort, and this appears to be the main factor explaining the lower expenditures per child.

The IV estimates imply a ten percent larger cohort is associated with an even larger decline in expenditures per secondary school aged child, of about 17 percent. Secondary enrollments are unaffected, but teacher salaries and teacher-student ratios are notably lower. In the OLS estimates the cohort size effects are substantially smaller and less statistically significant, but similar offsetting movements in enrollment rates and teacher-student ratios are still evident (see Tables 4, 5 and 6). Larger birth cohorts do not seem to receive fewer years of schooling, as attested to by the pattern of enrollment ratios, but they do appear to receive schooling of lower human and perhaps physical capital intensity; this adjustment in the factor intensity in schooling is, moreover, a plausible economic response to the relative scarcity of both forms of capital in many poor countries recently experiencing rapid population growth. Much thought has been given to how health care delivery systems might be encouraged to use less human- and physical-capital intensive technologies in low income countries, rather than directly transfer the highly capital intensive procedures used in the industrially advanced high income countries. The current adoption of western medical technologies in low income countries is cited as contributing both to great inefficiencies and also inequities, since the services of this modern medical system are so costly that they can only be provided to the elite living in a few metropolitan areas of the low income world. The tendency noted in this paper of low income countries to substitute away from human- and physical-capital intensive educational production technologies appears, therefore, to be a reasonable innovation on

economic grounds to different factor scarcities (e.g., Binswanger and Ruttan, 1978) until evidence is presented that the productive benefits for persons being schooled by these less capital intensive methods are greatly reduced.<sup>19</sup>

To determine which country observations are giving rise to this pattern, the model is reestimated within the small strata of high income industrially advanced countries and within the rest of the sample (about 80 percent). The relative cohort size variable exhibits the same statistically significant effect on primary, secondary, and total school expenditures in the sample of lower income countries, and increases in magnitude by five to ten percent. (See Appendix Tables A-8, A-9 and A-10.) In the small sample of industrially advanced countries cohort size is also generally significant (not reported). Among only the low income countries, for whom variation in cohort size relates clearly to the pressures of rapid population growth, the relative number of school aged children is associated with lower teacher-student ratios, and lower wages per teacher. Income and price elasticities based only on the less developed countries are similar to those reported above.

Fertility, as anticipated, is inversely associated in the OLS estimates with school expenditures per child, and this correlation appears to stem from an inverse association between enrollment and fertility, particularly at the secondary level. Such a pattern could be expected if the private substitution by parents of more schooling resources per child in place of having additional children led to an increase in the private demand for schooling, and hence to greater enrollment rates. But the preferred IV estimates indicate no relationship between fertility and school enrollments or expenditures, except perhaps for primary enrollments of girls. The deletion of fertility from equation (8) leads to larger (more negative) estimates of the effect of cohort

size on schooling inputs, as anticipated (see tables A-2 through A-7), but the differences are not substantial (less than 10 percent).

#### 7. Sex Differences in School Enrollment Rates

Differences in the school enrollment rates of boys and girls may have much to do with the level of child mortality and fertility, the rate at which women migrate from rural to urban areas, leave domestic activities for employments in the market labor force, and in particular, for jobs in the nonagricultural sector. The future economic status of women relative to men depends heavily on their enrollment in school and their ability thereby obtained to benefit directly from the increased productive opportunities created by modern economic growth.

First, all of the estimates imply that the income elasticity is larger for female enrollment rates than for male enrollment rates. The preferred (IV) point estimates for female and male enrollment rates are .43 and .24 at the primary level, .65 and .30 at the secondary level, and .50 and .28 for total expected years of schooling. Second, the price enrollment elasticities are greater in absolute value for female than for male enrollments:  $-.76$  and  $-.63$  for primary,  $-1.07$  and  $-.91$  for secondary, and  $-.86$  and  $-.77$  for total expected years of schooling. A fifty percent increase in incomes per adult from the sample mean of 721 (1970 U.S. dollars) would raise primary enrollment rates for girls from 69 to 83 percent, while the rate for boys would increase from 88 to 97 percent. The girls would improve their relative achievement from .78 of boys to .85. The 'gender gap' in secondary schools would also close by a fourth, with girls increasing their enrollment rates from 17 to 22 percent, while the

rate for boys would increase from 26 to 30 percent. Reducing the relative price of schooling has an effect of improving female enrollments relative to males that is similar to that of raising incomes. According to these cross sectional estimates of income and price elasticities, economic development with its effects on adult income and relative wages of teachers is likely to be associated with an equalizing of schooling opportunities between boys and girls; these tendencies are also evident in the restricted sample of less developed countries.<sup>20</sup> Here may be a potent dimension of the development process that unleashes demands for the schooling of girls and young women that in turn play a pivotal role in governing the timing and pace of the demographic transition.

Religion is often cited as a traditional cultural force that influences the status of women and their educational opportunities relative to men. Muslim culture, in particular, is often singled out for its distinctive attitudes toward women's status, education, employment and, consequently, fertility (Kirk, 1966). Adding to our framework percentage of the population that is Muslim and the percent that is Catholic leads to the auxiliary regressions reported in Table 10.

At the primary school level and for total expected years of schooling the difference in the Moslem coefficient for men and women is statistically significant at the 10 percent level. Moving from a country with the sample average percentage of Moslems at 37 percent to a country that is entirely Moslem is associated with a decline in primary enrollments for males of from 88 to 76 percent and for females from 69 to 50 percent. In relative terms, the

Table 10

Enrollment Ratios for Males and Females Including Proportion of  
Population Moslem and Catholic, with Price Endogenous

	<u>Primary</u>		<u>Secondary</u>		<u>Expected Years</u>	
	Male	Female	Male	Female	Male	Female
<b>Explanatory Variables:</b>						
GNP per Adult in 1970 (log)	.234 (3.63)	.404 (4.18)	.337 (3.11)	.607 (4.42)	.274 (3.50)	.450 (4.09)
Relative Price of Teachers (log) <sup>a</sup>	-.664 (4.79)	-.857 (4.14)	-.874 (6.68)	-1.07 (6.49)	-.796 (5.11)	-.966 (4.42)
Proportion of Population Urban	.228 (.85)	.422 (1.06)	.895 (2.13)	1.24 (2.33)	-.417 (1.32)	-.632 (1.43)
Proportion of Population in School Age	1.25 (.69)	4.07 (1.40)	-1.13 (.31)	4.52 (.98)	-.700 (.53)	.840 (.46)
Total Fertility Rate	.0763 (1.86)	.0477 (.78)	-.0283 (.52)	-.0573 (.83)	.0679 (1.43)	.0479 (.72)
Moslem Percent	-.0024 (2.22)	-.0053 (3.27)	.0031 (1.73)	-.0002 (.08)	-.0018 (1.35)	-.0059 (3.16)
Catholic Percent	-.0002 (.22)	.0010 (.70)	-.0001 (.10)	.0025 (1.30)	-.0004 (.35)	.0007 (.45)
Intercept	-1.56 (3.26)	-2.94 (4.11)	-1.27 (1.27)	-3.59 (2.82)	1.29 (1.94)	-.144 (.15)
F	11.08	18.01	39.90	55.54	17.49	24.15

<sup>a</sup> Price treated as endogenous variable and estimated with instruments of secondary enrollment ratio, urbanization, and GNP per adult, all lagged ten years. Absolute value of asymptotic t ratio reported in parentheses beneath regression coefficients.



ratio of female enrollment rates to male would decline in this case from .78 to .66. The regression coefficient on the Catholic variable is not statistically significant, but works in the direction of increasing female relative to male enrollment rates. The general direction of income and price effects is not altered by the inclusion of the two religion variables, though the effect of population growth via cohort size is eliminated because of multicollinearity. 21

#### 8. The Shares of National Product Expended on Education

Another dimension of the educational system is the share of national resources (GNP) allocated to the various levels of the public educational system. Pryor (1968) found in his sample of 20 countries few patterns accounting for differences in the share of GNP allocated to education, other than the tendency for nonmarket socialist countries to expend more than market economies on this activity. The proportion of children of school age (5-15) did appear in Pryor's study to be positively associated with the share of GNP spent on public education (1968, p. 193).<sup>22</sup> Table 11 extends his findings to include a larger sample with more low income countries. Per adult real income is positively associated with the share of GNP allocated publicly to primary, secondary, and all educational levels combined, as implied by the earlier estimates of the income expenditure elasticities exceeding one in Tables 4 to 9. A doubling of real income per adult is associated with 0.6, 1.2 and 1.3 percent more of GNP being allocated to primary, secondary, and all levels of public education combined, compared with the sample mean levels of 2.0, 2.5 and 4.0 (recall that the composition of the samples differ by school level). Public Expenditures on secondary schools are a slightly larger share of GNP in

Table 11

Regressions on Share of GNP Expended on Public Schools,  
with Price of Teachers Endogenous<sup>a</sup>

Dependent Variable Schools	Primary System (1)	Secondary System (2)	Total System (3)
<b>Explanatory Variables:</b>			
GNP per adult in 1970 (log)	.00636 (5.47)	.0117 (7.41)	.0131 (5.48)
Relative Price of Teachers (log) <sup>a</sup>	.00286 (1.14)	.00447 (2.31)	.00674 (1.39)
Proportion of Population Urban	-.0143 (2.96)	-.0205 (3.30)	-.0211 (2.16)
Proportion of Pop- ulation in School Age	-.00114 (.03)	-.0895 (1.67)	-.0490 (1.22)
Total Fertility Rate	.00089 (1.27)	.0006 (.73)	.00139 (1.00)
Intercept	-.0231 (2.71)	-.0428 (2.90)	-.0391 (1.91)
F	8.18	18.97	10.79
Sample Size	186	139	132
<b>Dependent Variable</b>			
Mean (Standard Deviation)	.0201 (.0087)	.0253 (.0122)	.0404 (.0166)

<sup>a</sup>The price is treated as endogenous and estimated with instruments of secondary enrollment ratio, GNP per adult and urbanization, lagged ten years. Absolute value of asymptotic t ratio reported in parentheses beneath regression coefficients.

countries where the relative price of teachers is high, perhaps with the objective of increasing the pool of teachers and lowering their relative wage in the future. Urbanization reduces all three shares due presumably to the reduction in teacher wages noted earlier. The relative size of the school aged child population has no noticeable effect on the shares of GNP expended on education. Fertility is also uncorrelated with the share of GNP allocated to public education.<sup>23</sup>

#### 9. Patterns in Residuals

In Table 3 the average characteristics of the primary school sample were presented by region. It is now possible to examine the deviations of regions from the patterns explained by the model. In other words, holding constant for national incomes per adult, prices, urbanization, and age composition, as estimated in Tables 7 and 8 for primary and secondary school systems, how do the regions of the world differ in their level and pattern of school expenditures and enrollments?

Tables 12 and 13 report the regional averages of the residuals or deviations in country level observations from those predicted by the fitted model. Since all of the educational input and enrollment variables are in logarithmic terms, with the exception of the final GNP shares, the average residuals can be interpreted as approximately the proportion a region lies above or below that predicted. Expenditures per primary school aged child are 9 to 14 percent above average in East Asia and Africa, but 24 percent below average in South and West Asia. Enrollment rates at the primary level are also notably above average in Africa and East Asia, but 41 percent below average in South and West Asia and 14 percent below in Latin America. In the East Asian

Table 12

Regional Average Deviation of Primary School Expenditures  
and Outputs From Those Predicted With Prices Endogenous

Region	Africa	Latin America	East Asia	South and West Asia	Europe, Oceania and Canada
(Sample Size)	(62)	(43)	(21)	(24)	(36)
Dependent Variable:					
Total Enrollment Ratio (log)	.172	-.142	.147	-.409	.0605
Male Enrollment Ratio (log)	.151	-.164	.110	-.276	.0558
Female Enrollment Ratio (log)	.227	-.106	.202	-.663	.0601
Teacher-Student Ratio (log)	-.0002	-.0256	-.0599	.0633	.0234
Capital Intensity Index (log)	-.0062	-.0370	.0132	.0632	.0051
Teacher Relative Wage (log)	-.0303	.155	-.0058	.0385	-.155
Total Expenditures per child (log)	.135	-.0492	.0941	-.244	-.0664
Expenditures as Share of GNP	.0019	-.0010	.0011	-.0023	-.0012

Source: Estimates from Tables 7 and 11 and data.

Table 13

Regional Average Deviations of Secondary  
School Expenditures and Outputs from Those Predicted with  
Prices Endogenous

Region	Africa	Latin America	East Asia	South and West Asia	Europe, Oceania and Canada
(Sample size)	(49)	(35)	(18)	(16)	21)
Dependent Variable:					
Total Enrollment Ratio (log)	.299	-.437	.184	-.239	.0555
Male Enrollment Ratio (log)	.292	-.502	.170	-.0742	.0671
Female Enrollment Ratio (log)	.356	-.355	.235	-.615	.0289
Teacher-Student Ratio (log)	-.129	.227	-.188	.0707	.0295
Capital Intensity Index (log)	-.0030	-.0424	.0199	.0966	-.0130
Teacher Relative Wage (log)	-.0123	.0753	.0104	.0338	-.132
Total Expenditures per child (log)	.155	-.177	.0258	-.0383	-.0596
Expenditures as Share of GNP	.0033	-.0040	.0007	-.0007	-.0012

Source: Estimates from Tables 8 and 11 and data.

region, which has invested heavily in basic education for a number of years, the ratio of teachers to students is surprisingly below average, whereas the capital intensity is slightly above average. Teacher wages are higher than expected in Latin American and South and West Asia, but lower in the developed countries. Finally, the share of GNP allocated to the public support of primary education is above average for Africa and less than expected in South and West Asia, controlling for the economic and demographic constraints captured by the model.

At the secondary school level, the equations generally fit enrollments more closely than at the primary level, but do less well in explaining teacher-student ratios and teacher wages. Secondary school expenditures per child are about 16 percent above average in Africa, and some 18 percent below average in Latin America. Enrollment rates show more variation, with Latin America and South and West Asia again reporting rates far below that which is expected. In contrast, Africa and East Asia again exhibit enrollment rates far above expectations. The teacher-student ratio is above average in Latin America, but below in East Asia and Africa. Teacher wages are again higher in regions such as South and West Asia and Latin America which have invested less than the predicted amount in secondary schooling in the past. Overall, the share of GNP spent on secondary schools is below that expected for Latin America and above in Africa.

The primary and secondary school regressions are consistent. They suggest a large and unexplained underinvestment in primary and secondary schooling in the South and West Asian region and in Latin America. Enrollment rates, in particular, are below the expected levels in these regions, while teacher-student ratios remain relatively high in Latin America at the secondary level, while capital intensity is high in South and West Asia. The high level of teacher wages in Latin America and South and West Asia may be traced in part

to the failure to enroll more children at the secondary level in earlier years. The higher current wage paid for teachers contributes to the higher price of educational services today which deters current public expenditures on the school system in these regions.

Deviations from the pattern predicted by the model based on income, price, demographic and distributional characteristics of the population may signal a disequilibrium that might encourage the private sector to provide schooling. I could not obtain sufficient information to test this conjecture, but private schools in Latin America and portions of Asia and Africa are not increasing their share of enrollments in response to the sluggish public sector provision of schooling services (See table A-11). Another hypothesis might be that stagnant economic conditions were not propitious for rewarding education in the workforce, and that depressed social and private rates of returns to education could explain the regional patterns of low investment in schooling. Returns to education may not increase with modern economic growth because of limited regional and occupational mobility rewarding individuals on the basis of their skills and education. Public policies may also have failed to encourage technological change through adaptive research and development. Finally, the absence of competitive domestic factor and product markets, or distorting trade and foreign exchange regimes, may have eroded the incentives to invest in education or skewed the distribution of income so as to discourage broadly based educational programs. Exploring these possibilities would take me far beyond the scope of this paper, but at least in the case of Latin America, studies do not support the view that the underinvestment in secondary schooling is due to a low return to this activity. Indeed, substantial private returns accrue to those in Latin America who manage to get a secondary education (Psacharopoulos, 1981). If the overall framework proposed in this paper is

tenable, then further study of regional and country level deviations from those predicted is warranted, both to discover why expenditures on schooling deviate from the economic pattern estimated here and to determine if these deviations could help to account for the rate and structure of modern economic growth occurring in these countries.

#### 10. Conclusions

The empirical association between public school expenditures and enrollments, on the one hand, and real incomes per adult and the relative price of teachers, on the other, confirms the view that income and price variables contribute to determining the equilibrium level of expenditures on schooling within a country. The working hypothesis that private demands for educational services explain public expenditures is not rejected. Holding constant for these dominant income and price constraints on the public educational system, urbanization is found to be associated with lower expenditures per school-aged child, and this reduction in outlays on education in more urbanized countries is associated with a lower price of teachers relative to other goods. A plausible interpretation of this pattern would presume that there are economies in using teachers in the larger scale urban schools and perhaps compensating amenities in urban areas that teachers value, such as attractive employment opportunities for teachers when schools are not in session.

The proportion of the population of school age is associated with lower levels of public expenditures per child. Rapid population growth which tends to increase the youthfulness of the population plays an indirect role, therefore, in squeezing public resources allocated to the school system. This demographic squeeze induced by a relatively large birth cohort depresses the



teacher-student ratio at both the primary and secondary school level. But primary school enrollment ratios tend to be higher for relatively large cohorts, leaving public outlays per primary school aged child less severely depressed. Estimates of the demographic effects of cohort size on public sector expenditures on the educational system are smaller, if one relies on ordinary least squares estimates that ignore likely sources of bias arising from the endogeneity of teacher prices within the current market for teacher services.

Disentangling the effect of fertility on school outlays is not a simple task, because fertility and decisions on the schooling of children are approached by parents jointly. Causation cannot be inferred in this case from correlation. In this study the partial correlation between total fertility rates and public educational outlays was not statistically significant.

The separate examination of patterns of enrollment among girls and boys confirms that female enrollments tend to increase more rapidly with income per adult than do male enrollment rates. Correspondingly, the decline in the relative wage of teachers, a measure of the relative price of educational services, is associated with larger gains in schooling for girls than for boys. Thus, the rise in incomes and the declines in relative prices of schooling that appear to occur at the onset of modern economic growth contribute reinforcing gains to the educational attainment of women that exceed those achieved by men. If these cross section patterns estimated here hold over time with development, the relative improvements in women's education is a major and underemphasized concomitant of the development process, with likely consequences for the rate of decline in child mortality and fertility, and the long term decline in population growth rates.

Certain regions have been able to advance educational expenditures and enrollments beyond that which one might have expected, based on incomes, the cost of teachers, population distribution, etc. East Asia and Africa stand out in this regard as 'overachievers', while South and West Asia and Latin America are below the levels expected on the basis of the fitted model. Africa's relative performance, according to the criteria captured in the model, is in striking contrast to the portrayal of a region suffering from administrative inertia, an inability to achieve targets of universal primary schooling, and an overpaid cadre of teachers (Jimenez, 1984; Lee, 1984; Sai, 1984). Since Africa has confronted relatively high prices for teachers, given the described dynamics of expanding their school systems, it appears likely that the decline in teacher relative prices will continue in Africa to help this continent increase enrollments without necessarily increasing outlays per student.

One method for evaluating the overall framework proposed in this paper is to calculate how well the educational changes in the last decade are explained by the cross section estimates of the model and the actual changes in the conditioning variables that occurred in this period. Cross section patterns do not always satisfactorily simulate changes over time. For this purpose only the small number of countries that report sufficient data for the decade of 1965 to 1975 are examined. Actual proportionate changes in public expenditures per child and enrollment ratios are reported in the first column of Table 14. The second column is the sum of columns 3 through 7, which report the predicted changes due to the actual changes in each of the five conditioning variables multiplied by the IV estimates in Tables 7, 8, and 9. The last column of Table 14 indicates how much of the change from 1965 to 1975 is accounted for by the predicted or simulated change. There are several possible reasons for

Table 14

Actual and Predicted Proportionate Changes in  
Expenditures per Child and Enrollment Ratios

School Level (Sample Size) Dependent Variable	Actual Change (1)	Predicted Change (2)	Predicted Change Due to Change in Variable					Predicted to Actual Change (8) = (2)/(1)
			Adult Income (3)	Relative Price (4)	Urban- ization (5)	Relative Cohort Size (6)	Total Fertility (7)	
<u>Primary Schools (63)</u>								
Expenditures/Child	.343	.319	.379	-.027	-.036	.010	-.007	.93
Enrollment Ratio								
--Total	.160	.166	.088	.115	-.023	-.005	-.009	1.04
--Male	.128	.125	.067	.108	-.017	-.003	-.026	.98
--Female	.228	.224	.121	.125	-.030	-.008	.016	.98
<u>Secondary Schools (48)</u>								
Expenditures/Child	.385	.234	.413	-.079	-.038	-.081	.018	.61
Enrollment Ratio								
--Total	.592	.393	.121	.313	-.056	.004	.011	.66
--Male	.504	.323	.086	.294	-.045	-.014	.003	.64
--Female	.663	.528	.183	.347	-.072	.037	.034	.80
<u>Total School System (45)</u>								
Expenditures/Child	.497	.287	.364	-.030	-.027	-.023	.004	.58
Expected Years								
-- Total	.303	.186	.096	.131	-.036	.002	-.008	.61
-- Male	.255	.142	.075	.123	-.028	-.002	-.025	.56
-- Female	.375	.249	.134	.139	-.049	.009	.016	.66

Source: Estimates from Cols. 1, 2, 3, and 7, Tables 7, 8, and 9. Change data from separate tabulation of sample for all countries with complete 1965 and 1975 information. See footnote 24. for list of countries included in secondary school sample.

divergence. First, the model is fit to a pooled combination of cross section data from several time periods, and not to just the 1965-1975 time series changes within countries. Second, the sample of countries for which the 1965-1975 comparisons can be performed is much more restricted than the sample used in estimating the model. A third reason is, of course, the omission or misspecification of explanatory factors.

This parameterized model simulates the changes in expenditures and enrollments quite well for the primary school systems, that is, 93 and 104 percent of the growth is explained from 1965 to 1975 in expenditures and enrollments, respectively. Public expenditures per child at the primary level increased a third in this decade. The decadal increase in incomes per adult of about a quarter would have contributed by itself to an even larger increase in expenditures, but this increase was moderated slightly by the relative decline in primary school teacher salaries and urbanization. The slight decrease in school cohort size increased expenditures marginally, whereas the decline in fertility was associated with a small decrease in school expenditures. Enrollment rates at the primary level responded predominantly to the decline in relative prices (of teachers), but also increased with incomes, particularly for females. Urbanization, relative cohort size, and fertility had relatively minor effects on primary enrollments.

At the secondary school level the model underpredicts the substantial increases in expenditures and enrollments that actually occurred in this sample of 48 countries.<sup>24</sup> Again, income growth alone would have suggested a more rapid increase in expenditures than actually occurred, whereas the decline in prices, urbanization and a small increase in cohort size restrained the growth in secondary school expenditures per child. Enrollments at the secondary level

respond strongly to the decline in relative price of teacher salaries; these price effects are larger at the secondary level than they were at the primary level. Enrollments at the secondary level are not greatly affected by the changing demographic characteristics of the population.

When analysis focuses on the total school system, for which our data is less satisfactory, the underprediction of the fitted model remains substantial. Response patterns lie between those estimated for the primary and secondary school separately. Disaggregating enrollments (expressed as expected years of schooling) by sex indicates again how the increase in income per adult and decline in the relative price of teachers help to account in this decade for the more rapid proportionate increase in the enrollment of girls than of boys.

In concluding, let me stress the need for much further work on these largely unexplored data and issues. There is no substitute for reliable data, be they across countries or across individuals or over time on either countries or individuals. The national observations examined here could undoubtedly be reconstructed from underlying government accounts and records for each country and they might thereby be made more comparable and precise. But I am doubtful that the salient patterns in the published compilations of data that are derived in this paper would thereby be reversed.

The statistical significance of the relationships fit to the country observations may also be misstated somewhat, because the repeated observations from some countries at five year intervals are not independent; the 'true' sample size might thus be viewed as less than that numerically reported. If the observations are restricted to an average for each country, that is we base our analysis on a simple cross section of country averages, the estimated coefficients are not greatly affected, but their standard errors increase

somewhat, and thus significance levels decline.<sup>25</sup> The main finding of this analysis of available international data from educational systems is that public expenditures on schools have conformed to regular patterns with respect to consumer incomes and prices and demographic constraints. Clearly at the secondary level, and probably also at the primary level, rapid population growth has depressed levels of expenditures per child of school age. This has occurred by increasing class size and lowering teacher salaries, but not by restricting notably enrollments. The next step is to clarify the origins for many of the departures from this international standard and to determine the extent to which the decline in public school expenditures per student that is associated with rapid population growth is an inefficient distortion in the allocation of social resources.

Footnotes

<sup>1</sup> Pryor (1968) considered for a relatively small number (20) of countries, market and centrally planned socialist, the level of public expenditures on education. In his effort to explain the share of GNP publicly expended on education he observed a significant partial correlation with per capita income levels and share of population age 5-15. Simon and Pilarski (1979) regressed primary and secondary enrollment ratios and educational expenditures against per capita income, the crude birth rate, life expectancy, and several other variables. They found enrollments and expenditures per child positively related to income and inversely related to birth rates. The partial correlation with crude birth rates was statistically significant only for secondary school enrollments. Because fertility and the schooling of children are partially determined by parents in response to similar constraints and related preferences, the covariation of these two choice variables does not confirm or reject the hypothesized causal effect that a relatively large cohort of school aged children depresses the average educational resources and school achievements of that cohort. Lall (1969) and Kelley (1976) also explore patterns of government expenditures across low income countries.

<sup>2</sup>These illustrative figures are drawn from World Development Report 1984, World Bank Staff, Oxford University Press, 1984, Tables 1, 23, and 25. See also Preston's (1980) comparisons of life expectation across more uniform and reliable data from a smaller number of countries.

<sup>3</sup>The population of primary and secondary school age, according to UNESCO

conventions ages 6 to 17, increased by an estimated 131 percent from 1950 to 1980 in the less developed regions of the world, while the total population increased 95 percent (UN, 1982b). From 1960 to 1980 the corresponding figures were 68 and 58 percent.

<sup>4</sup>See Appendix Table A-11 for regional breakdown of existing data on private school enrollments and its limitations as an unweighted average over a relatively small set of reporting countries.

<sup>5</sup>UNESCO Yearbook figures on public expenditures are generally designed to include public sector outlays, including subsidies from the public sector to private schools. Footnotes also indicate, particularly for some African countries, that school fees paid by parents to the public schools are included in public sector expenditures. The data on public expenditures on education that are analyzed in the subsequent regressions are thus designed to include state and local government spending on schools.

<sup>6</sup>The political process may not assign everyone's vote an equal weight, however. For example, urban populations in many low income countries appear to exercise greater influence on public sector decisions than do dispersed rural populations (Lipton, 1977). Without data on the distribution of income, public services, or taxes across subgroups within countries, it is not fruitful to speculate further here on the distributional implications of how this political process works.

<sup>7</sup>Since relatively few studies have estimated the private or social returns to education, it is not possible here to even examine the correlation



between unexplained deviation in public investments in schooling and the level of private and public returns to schooling. The most comprehensive comparison of rate of return studies is that by Psacharopoulos (1981). Differences in methodology across even these summarized country studies undermine the comparability of the return calculations.

<sup>8</sup>For example, urbanization was hypothesized to reduce the unit costs of education for technological reasons. But it might also be associated with higher relative demands for educated labor, and hence higher producer rates of return to schooling. Urbanization, as one variable in  $Z$ , could thus influence education both by altering production technology and by increasing household demands.

<sup>9</sup>Note that if the demand for educational services is relatively inelastic,  $\eta > -1$ , and education is a public good,  $\gamma < 1$ , the 'cohort size effect' could be interpreted as a scale effect of schooling as a public good, i.e.  $(\eta + 1)(\gamma - 1)$ .

<sup>10</sup>Equation (9) may be rewritten in logarithms:

$$\ln(E/P) = \ln(S/P) + \ln(T/S) + \ln(E/C) + \ln(C/T)$$

and regressions would be calculated of the following form at each level of schooling:

$$\ln(E/P) = \beta_{11} + \beta_{12}\ln Y + \beta_{13}\ln P_x + \beta_{14}Z$$

$$\ln(S/P) = \beta_{21} + \beta_{22}\ln Y + \beta_{23}\ln P_x + \beta_{24}Z$$

$$\ln(T/S) = \beta_{31} + \beta_{32}\ln Y + \beta_{33}\ln P_x + \beta_{34}Z$$

$$\ln(E/C) = \beta_{41} + \beta_{42}\ln Y + \beta_{43}\ln P_x + \beta_{44}Z$$

$$\ln(C/T) = \beta_{51} + \beta_{52}\ln Y + \beta_{53}\ln P_x + \beta_{54}Z$$

The adding up of component effects implies that

$$\beta_{1i} = \sum_{j=2}^5 \beta_{ji} \quad \text{for } i = 1, \dots, 4.$$

<sup>11</sup>It may be argued that the use of foreign exchange (FX) rates in 1969-71 to translate GNP from local currencies into the common unit of dollars gives insufficient weight to nontraded commodities. The tendency is to exaggerate differences across countries in real consumer income per adult. Recent work to construct a purchasing power parity (PPP) basis for comparing incomes across countries by Kravis, Heston and Summers (1982) is built on a sample of countries for which price indexes were constructed and then generalized and revised to apply to other countries by Summers and Heston (1984). For example, FX translated GNP per adult is forty-three times larger in the U.S. than in India in 1970, whereas the PPP real income per adult difference is only thirteen to one. Consumer welfare may be better approximated by the PPP income deflator and therefore the PPP deflated figures were used in reestimating the schooling equations reported in this paper. In general, PPP income elasticities of school expenditures increased about a quarter, as would have been expected since the sample variance in log PPP incomes is markedly less than the variance in log FX incomes. Price elasticities were reduced somewhat, suggesting that some of the differences in the relative price of teacher salaries are captured in the PPP adjustment procedure. No systematic changes occurred in the coefficients on relative size of school aged cohorts, nor were the estimated effects of urbanization noticeably changed by this substitution of one measure of real GNP for the other. Substantive conclusions of this paper are not particularly sensitive, therefore, to this choice of procedure for translating GNP across countries into common welfare units.

<sup>12</sup>The disturbances in the equation determining current demands for schooling that would affect today's wages of teachers might also be correlated with the unexplained disturbances in the equation determining enrollment rates ten years earlier, such as might arise from a persistent country-specific unobserved effect. This form of error structure would imply that the lagged enrollment variable was not actually exogenous to the wage equation. The two-stage estimates based on the lagged enrollment instrument would then be subject to the classical simultaneous equation bias and also would be inconsistent. Although I cannot be confident of the direction of this bias on the price elasticity, it would seem likely to bias positively the estimate of the enrollment effect on wages. In fact, the enrollment effect is estimated to be negative and appears statistically significant for both the primary and secondary teacher wage rates as reported in footnote 14.

<sup>13</sup>An analogous errors-in-variable bias arises in the study of labor supply, where earnings are divided by hours worked to obtain a wage rate that is specified by theory as a determinant of hours.

<sup>14</sup>The implicit primary and secondary school logarithmic wage equations for teachers were estimated as conditioned on the secondary school enrollment rate, income per adult and proportion of the population urban, all of which explanatory variables were evaluated ten years earlier:

$$\ln W_{pt} = -1.84 - .349 \ln E_{st-10} + .355 \ln GNP/A_{t-10} - .808U_{t-10}$$

(3.38) (6.22) (4.30) (2.67)

$$n = 186 \quad R^2 = .264$$

$$\ln W_{st} = -.931 - .646 \ln E_{st-10} + .305 \ln GNP/A_{t-10} - 1.25U_{t-10}$$

(1.18) (8.25) (2.61) (3.22)

$$n = 139 \quad R^2 = .601$$

where  $E_{st-10}$  refers to the secondary school enrollment proportion ten years ago,  $GNP/A_{t-10}$  indicates GNP per adult (age 15 to 65) measured ten years earlier,  $U_{t-10}$  is the urban proportion of the population ten years ago, and  $W_{pt}$  or  $W_{st}$  are the school current expenditures per primary or secondary school teacher divided by GNP per adult today.

<sup>15</sup>See footnote 11.

<sup>16</sup>From equation (8) the coefficient on the relative price or teacher wage variable in the expenditure function is  $b_2 = a(\eta + 1)$ , and thus the estimated price elasticity,  $\eta = (b_2/a) - 1$ . The sample mean of  $a$  is .82.

<sup>17</sup> It appears to be generally cheaper to hire teachers in a more urbanized area, though GNP per adult augments teacher wages more than proportionately. Urban amenities including summer employment opportunities may be valued particularly strongly by teachers and thus it is costly to assign them to smaller provincial rural schools where teachers must do without these amenities and relocate during vacations to obtain employment that rewards maximally their educated skills.

<sup>18</sup>Economies of scale in producing school services might be distinguished at three levels: (1) with the size of the national educational system, (2) with the size of the school measured in terms of its number of full time teachers, and (3) with the size of the teacher's span of control or student-teacher ratio. The importance of (1) in primary and secondary school systems was assumed at the outset to be negligible. The number of primary

schools is reported for some recent years in the UNESCO Yearbook. If the system's average school size (i.e. log of teachers per school) is added to equation (8), one might expect this added scale variable to diminish the coefficient on urbanization, if larger urban schools realized economies that reduced unit costs. In a sample of 60 countries for which these data are recently available, school size is associated with greater expenditures per child due to higher teacher-student ratios and higher current outlays per teacher. The coefficients on urbanization are not reduced in magnitude by the addition of school size. Consolidation economies, however, could remain important at the secondary level, but no data were found to test this conjecture.

<sup>19</sup>Standardized test comparisons do confirm that spending far less per student in low income countries is associated with lower test scores. (Heyneman and Loxley, 1983). What is now needed is estimates of the marginal gains from additions to school quality and quantity that can be purchased with marginal increments in educational expenditures, and what are the effects of these alternative expenditures on the future productivity of students.

<sup>20</sup>The income elasticities are further apart for girls and boys in the low income sample than for the entire sample, whereas price elasticities are closer together for boys and girls in the low income sample at the primary level and further apart at the secondary level. The relatively large standard errors on the estimated income elasticities of male enrollment reduce our confidence that male and female enrollments respond differently, whereas the

price elasticity estimates are sufficiently precise to infer that they differ between sexes at a ten percent confidence level in the low income sample.

<sup>21</sup>It should be noted the religion variables are strongly intercorrelated with incomes, and thus income elasticity estimates are generally reduced by the inclusion of the religion variables. It should also be stressed that religious preference estimates are not precise in many populations. Here I have relied on Russet et.al (1964) and The Encyclopedia Britannica, 15th, Ed. (1983).

<sup>22</sup>Lall (1969) summarizes a study that found a cross country relationship in the share of government expenditures on education and per capita real GNP in 1964. Within strata of low income countries the relationship was positive up to 250 per capita (1964 US dollars), and then declined. The relationship of educational expenditures as a share of GNP was apparently not statistically significant and not reported, though it was positive and significant for public health expenditures.

<sup>23</sup>This finding directly challenges the working assumption of Coale and Hoover (1958) that linked population growth to the share of income allocated by poor countries to 'unproductive' expenditures on education and social welfare programs.

<sup>24</sup>The countries included were: Burundi, Kenya, Mauritius, Rwanda, Somalia, Uganda, Tanzania, Cameroon, Algeria, Morocco, Sudan, Tunisia, Ghana, Liberia, Togo, Sierra Leone, Jamaica, Costa Rica, El Salvador, Guatemala,

Honduras, Mexico, Nicaragua, Panama, Argentina, Bolivia, Colombia, Ecuador, Paraguay, Peru, Venezuela, Hong Kong, South Korea, Singapore, Thailand, Afghanistan, Iran, Nepal, Pakistan, Iraq, Kuwait, Syria, Finland, Ireland, Italy, Portugal, Yugoslavia, and France.

<sup>25</sup>Standard error-component models of time series of cross sections cannot be estimated here, because the number of observations per country varies.

## REFERENCES

- Becker, G.S. (1963) Human Capital, New York: Columbia University Press  
(2nd Edition 1975).
- Becker, G.S. and H.G. Lewis (1974) 'Interactions Between Quantity and Quality of Children', (ed.) T.W. Schultz, Economics of The Family, Chicago, Ill.: University of Chicago Press.
- Behrman, J.R. and N. Birdsall (1983), 'The Quality of Schooling', American Economic Review, 73:5 (December), 928-946.
- Belmont, L. and F.A. Marolla (1973), 'Birth Order, Family Size and Intelligence', Science, 182, pp 1096-1101.
- Bergstrom, T.C. and R.P. Goodman (1973), 'Private Demand for Public Goods', American Economic Review, 63:3 (June), 280-296.
- Bergstrom, T.C., D.L. Rubinfeld and P. Shapiro, (1982). Microbased estimates of Demand Functions for Local School Expenditures', Econometrica, 50:5 (September), 1183-1206.
- Binswanger, H. and V.W. Ruttan (1978) Induced Innovation: Technology: Institutions and Development, Baltimore, MD: Johns Hopkins University Press.
- Borcherding, T.E. and R.T. Deacon (1972), 'The Demand for The Services of Non-Federal Governments', American Economic Review, 62:5 (December) 891-901.
- Bowles S. (1969), Planning Educational Systems for Economic Growth, Cambridge, MA: Harvard University Press.
- Coale, A.J. and E.M. Hoover, (1958), Population Growth and Economic Development in Low Income Countries, Princeton, N.J.: Princeton University Press.



- Easterlin, R. (1980), Birth and Fortune, New York: Basic Books.
- Freeman R. B. (1971) The Market for College-trained Manpower, Cambridge MA: Harvard University Press.
- Freeman, R. (1979), 'The Effect of Demographic Factors on Age-Earnings Profiles', Journal of Human Resources, 14:3, 289-318.
- Gramlich, E.M. and D.L. Rubinfeld, (1982), 'Microestimates of Public Spending Demand Functions and Tests of the Tiebout and Median Voter Hypothesis', Journal of Political Economy, 90:3, (June) 536-560.
- Harbison, F. and C.A. Myers, (1964), Education, Manpower and Economic Growth, New York: McGraw-Hill.
- Hayami, Y. and V.W. Ruttan (1984) 'Population Growth and Agricultural Productivity', mimeo, University of Minnesota.
- Heyneman, S. (forthcoming), 'Research on Education in The Developing Countries', International Journal of Educational Development.
- Heyneman, S. and W. Loxley (1983), 'The Effects of Primary School Quality on Academic Achievement Across 29 High and Low Income Countries', American Journal of Sociology, 88: 6 (May), 1162-94.
- Jimenez, E. (1984) 'Pricing Policy in the Social Sectors: Cost Recovery for Education and Health in Developing Countries,' Mimeo, University of Western Ontario and the World Bank, Washington, D.C.
- Jones, G. (1971), 'Effects of Population Growth on the Attainment of Educational Goals in Developing Countries', in Rapid Population Growth, National Academy of Sciences, Baltimore MD: Johns Hopkins University Press.
- Jones, G. (1975), Population Growth and Educational Planning in Developing Nations, New York: Irvington Publications.

- Kelley, A. C. (1976), 'Demographic Change and Size of the Government Sector,' Southern Economic Journal, 43, 1056-1066.
- Kirk, D. (1966) 'Factors Affecting Moslem Natality', in Family Planning and Population Programs, Chicago: University of Chicago Press.
- Kravis, I.B., A. Heston, R. Summers (1982), World Product and Income, Baltimore, MD: Johns Hopkins University Press.
- Lall, S. (1969), 'A Note on Government Expenditures in Developing Countries, Economic Journal, 79:314 (June), 413-417.
- Lee, R. (1979), 'Causes and Consequences of Age Structure Fluctuations: The Easterlin Hypothesis', in Economic and Demographic Change: Issues for the 1980's, Ordina Publications, Liege, Belgium, IUSSP
- Lee, K.H. (1984) 'Universal Primary Education: An African Dilemma', Mimeo, The World Bank, Washington D.C.
- Leibowitz, A. (1974), 'Home Investment in Children', in (ed.) T.W. Schultz Economics of the Family, Chicago: University of Chicago Press.
- Lipton, M. (1977), Why Poor People Stay Poor: Urban Bias in World Development. Cambridge, MA: Harvard University Press.
- McMahon, W.W. (1970) 'An Economic Analysis of Major Determinants of Expenditures on Public Education,' Review of Economics and Statistics, 52:3, (August), 242-252.
- Preston, S.H. (1980), 'Causes and Consequences of Mortality Declines in LDCs During the Twentieth Century', in Population and Economic Changes in Developing Countries (ed.) R.A. Easterlin, Chicago: University of Chicago Press.
- Pryor, F.L. (1968), Public Expenditures in Communist and Capitalist Nations Homewood, Ill.: Richard Irwin, Inc.

- Psacharopoulos, G. (1973). Returns to Education, San Francisco: Jossey Bass-Elsevier Pub.
- Psacharopoulos, G. (1981). 'Returns to Education: An Updated International Comparison'. Comparative Education Review, 17:3, 321-341.
- Ram, R. and T.W. Schultz (1979) 'Life Span, Health, Savings and Productivity', Economic Development and Cultural Change, 27:3 (April), 399-421.
- Robinson, W.C. (1975). Population and Development Planning, New York: The Population Council.
- Robinson, W.C. and D.H. Horlacher, (1971). Population Growth and Economic Welfare, Report on Population/Family Planning, No. 6 (February), New York: Population Council.
- Rosenzweig, M.R. (1982). 'Educational Subsidy, Agricultural Development and Fertility Change', Quarterly Journal of Economics, 97:1 (February), 67-88.
- Rosenzweig, M.R. and K.I. Wolpin, (1980) 'Testing the Quantity Quality Model of Fertility. The Use of Twins as a Natural Experiment', Econometrica, 48:1, (January), 227-240.
- Russett, B.M., R.A. Hayward, K.W. Deutsch, and H.D. Lasswell (1964), World Handbook of Political and Social Indicators, New Haven, CT: Yale University Press.
- Sai, F.T. (1984) 'The Population Factor in Africas Development Dilemma,' Science, 226, (16 November), 801-805.
- Schultz, T.P. (1971), 'An Economic Perspective on Population Growth', in Rapid Population Growth, National Academy of Sciences, Baltimore, MD: Johns Hopkins University Press.
- Schultz, T.P. (1981). Economics of Population, Reading, MA: Addison Wesley Publication Co.

- Schultz, T.P. (1984), 'Studying the Impact of Household Economic and Community Variables on Child Mortality', Population and Development Review, 10, Supp. (August), 215-235.
- Schultz, T.W. (1961), 'Investment in Human Capital', American Economic Review, 51:1 (March).
- Simon, J.L. and A.M. Pilarski (1979), 'The Effect of Population Growth Upon the Quantity of Education Children Receive', Review of Economics and Statistics 61:4 (November) 572-584.
- Simmons, J. and L. Alexander, (1978), 'The Determinants of School Achievement in Developing Countries', Economic Development and Cultural Change, 26:2 (January) 341-58.
- Summers, R. and A. Heston (1984), 'Improved International Comparisons of Real Product and Its Composition, 1950-80,' Review of Income and Wealth, Series 30: 2 (June), 207-262.
- Tan, J.P. and M. Haines, (1983), 'Schooling and Demand for Children: Historical Perspective' mimeo, World Bank, Washington, D.C.
- Terhune, K.W. (1974), A Review of the Actual and Expected Consequences of Family Size, Report to the Center for Population Research, NICHD, Washington, D.C.
- United Nations, Department of International Economic and Social Affairs (1982a), Model Life Tables for Developing Countries, Population Studies, No. 77, New York: United Nations.
- United Nations, Department of International Economic and Social Affairs, (1982b), Demographic Indicators of Countries: Estimates and Projections as Assessed in 1980, New York.
- United Nations, (various years) Demographic Yearbook, New York.

United Nations Education and Social Commission, (various years) UNESCO

Statistical Yearbook, New York.

Welch, F. (1979) 'The Baby Boom Babies' Financial Bust', Journal of Political Economy, 87:5, pt. 2 (October) 568-598.

Williamson, J.G. and P.H. Lindert, (1980) American Inequality, New York, Academic Press.

World Bank Staff (1974), Population Policies and Economic Development, Baltimore, MD: Johns Hopkins University Press.

World Bank Staff, (1980), Education Sector Policy Paper, 3rd. Edition, Washington D.C., (April).

World Bank Staff (1981), World Development Report 1981, New York: Oxford University Press.

World Bank Staff (1984), World Development Report 1984, New York: Oxford University Press.

Wray, J.D. (1971), 'Population Pressure on Families', Rapid Population Growth, National Academy of Science, Baltimore, MD, Johns Hopkins University Press.

## DATA APPENDIX

Data were initially compiled at five year intervals from 1955 to 1980 for 155 countries with an estimated population of one million or more in 1983. Ten of these countries were eliminated for lack of numerous data series. Eleven non-market economies of Eastern Europe were also not examined, in part because they did not have convertible currencies and thus a free exchange rate with which to express their national income or educational expenditures (where available) in common currency units (1970 U.S. Dollars). Yugoslavia is included. Since the basis for many demographic indicators such as age composition and literacy are population censuses which occur approximately every ten years, data were linearly interpolated for up to ten years and extrapolated for up to five years. Out of a possible 930 observations for all countries and years, complete data were obtained for only about 328 observations for primary schooling systems (see Table A-1) and about 264 observations for secondary school systems and 255 observations for combined systems including primary, secondary and higher. Many countries have anomalous gaps in their published data that might be eliminated with further research, such as the omission of Taiwan because of the proscription of data from this country in recent U.N. data compilations and the absence of GNP figures for the U.S. and U.K. in The World Bank data file.

---

\* Mozambique, Lesotho, Namibia, Guinea-Bissau, China, Mongolia, North Korea, Kampuchea, Laos and Viet Nam. The omission of particular series for the U.S. and Taiwan will be corrected in future work, and aggregations of early data for portions of Malaysia were compiled. Several countries were eliminated because of instability in its domestic GNP deflator over time, such as Chile and Argentina, although it should be possible to include these countries in the future.

More serious than these idiosyncratic gaps in the sample, which probably do not distort substantially the patterns I wish to describe, are the poor quality and incomparability of some of the reported data. Biases are obviously present in most school systems that work to overstate enrollments or at a minimum contribute to a variable gap between enrollment and attendance rates. But attendance rates are not available from most countries, precluding reasonable adjustments. Enrollment is associated with changing numbers of days attendance over time and across countries. Expenditure data is probably still less reliable, with changes in administrative regimes leading to some unlikely year-to-year variations. Series for only recurrent or current educational expenditures appear more stable and reliable compared with capital account expenditures that embody year to year variations that are not readily explained by the economic and demographic constraints emphasized here.

Total educational expenditures are often divided among primary, secondary (academic, vocational and normal schools combined) and higher educational institutions. Those expenditures not allocated among these three levels, such as central administrative expenses, are proportionately distributed to the three levels according to their relative shares in the total. Current and capital expenditure shares of this total are also assumed constant at the three levels, for lack of cross-tabulations of capital expenditures. The consolidation of educational expenditures at various levels of government may introduce further error, for in federal governmental structures, state and local expenditures on schools may not always be reported uniformly to the central government and hence not consistently included as intended in UNESCO figures across countries. The role of the private sector in providing educational services may also be an important factor in determining the amount and quality of public sector support for education and vice versa. Figures on

the numbers of teachers by level are also available for many countries, but the treatment of part- and full-time teachers may not be consistent across countries (Pryor, 1968) nor how many days per year they are required to teach. With all these misgivings, it is not possible in this background paper to more than summarize existing data as reported by governments on their educational systems and published in the UNESCO Statistical Yearbooks. The wide range and variety of UNESCO data appear, nonetheless, to warrant more comparative study than they have received.

The second major source of data is the World Bank Data Tape (version dated April 1984). From this source, I extract data on GNP, both in current market, constant local prices, the implicit GNP deflator (price index), and the foreign exchange rate into U.S. dollars (official IMF figure). Real GNP in constant U.S. dollars is then defined as the constant local price GNP converted at the average exchange rate prevailing in 1969, 1970, and 1971. The GNP deflator and exchange rate are also used to derive estimates of the U.S. dollar equivalent of government educational expenditures. To approximate the 'price' of public sector educational services, I have divided the current educational expenditures per teacher by the current value of GNP per adult age 15 to 64. This relative 'price' of teachers is defined for the primary and secondary public school systems separately, and averaged for the total system. UNESCO figures for educational expenditures are not always expressed in the same local currency units employed in the national income accounts reported by The World Bank. In some countries with substantial inflation and foreign exchange revaluations, such as Chile and Argentina, comparable expenditure and national income figures were not reconstructed, and these observations are omitted from this analysis.

Population figures are drawn from the UN Demographic Indicators of



Countries: Estimates and Projections as Assessed in 1980, and are linearly interpolated across decades as required or across ages to obtain the population of children age 6 to 11 for primary school, 12 to 17 for secondary school and 20 to 24 for higher education. These age groupings of potential students might differ from country to country given local schooling systems, but are standardized here to match with the average definition of UNESCO enrollment ratios. Since children outside of a specific school age group may enroll in such schools, these ratios may exceed 100 percent. Enrollment ratios may also exceed 100 percent due to the upward reporting bias referred to earlier. To summarize school enrollments at all levels, a synthetic measure of cohort expected years of exposure to schooling is calculated. It is defined, as stated in the text, as the weighted sum of primary, secondary and higher school enrollment rates, where the weights are 6, 6 and 5. The proportion of the population living in urban areas is drawn from the World Bank Data Tape. Educational attainment of the parents of school-age children is not readily available from standardized sources. Adult literacy rates are often published, but can be of doubtful reliability and are rarely disaggregated by age or sex. The adult literacy rates considered here are interpolated from the 1983 World Development Report, and augmented from early UN Demographic Yearbooks.

79  
Appendix Table A-1  
Countries Included in Samples, by Region,  
School Level and Time Period\*

Continent	Country Code	Name	Number of Observations					
			Primary		Secondary		Total	
			(a) (105)	(b) (62)	(a) (90)	(b) (49)	(a) (84)	(b) (45)
AFRICA	1	Burundi	5	3	5	3	5	3
	3	Ethiopia	3	2	2	1	2	0
	4	Kenya	4	2	4	2	4	2
	5	Madagascar	4	2	3	1	3	1
	6	Malawi	4	3	3	2	2	2
	7	Mauritius	5	3	4	2	4	2
	10	Rwanda	4	3	4	3	4	3
	11	Somalia	4	2	4	2	4	2
	12	Uganda	5	3	4	2	4	2
	13	Tanzania	5	3	4	2	3	2
	14	Zambia	3	2	2	1	2	1
	15	Zimbabwe	2	2	3	3	2	1
	17	Ctrl. Af. Rep	2	0	2	0	1	0
	18	Chad	1	0	1	0	0	0
	19	Congo Rep.	4	2	4	2	4	2
	22	Cameroon	3	2	3	2	3	2
	24	Algeria	5	3	3	2	4	2
	27	Morocco	5	3	5	3	5	3
	28	Sudan	5	3	5	3	5	2
	29	Tunisia	4	2	4	2	4	2
	38	Ghana	4	2	4	2	4	2
	41	Ivory Coast	4	2	2	1	2	1
	42	Liberia	4	3	3	2	3	2
	43	Mali	2	2	1	1	1	1
	44	Mauritania	2	1	1	0	0	0
	45	Niger	1	0	1	0	0	0
	46	Nigeria	2	1	2	1	2	1
	47	Senegal	2	2	1	1	1	1
	48	Togo	4	3	3	2	3	2
49	Sierra Leone	3	1	3	1	3	1	
CENTRAL AND SOUTH AMERICA			(76)	(43)	(67)	(35)	(66)	(32)
	53	Dominican Rep.	3	2	1	1	1	1
	55	Haiti	1	1	0	0	0	0
	56	Jamaica	4	2	4	2	4	2
	59	Trinidad/Tobago	3	2	2	1	2	1
	62	Costa Rica	5	3	5	3	5	2
	63	El Salvador	5	3	5	3	5	3
	64	Guatemala	5	3	4	2	4	2
	65	Honduras	4	2	3	1	3	1
	66	Mexico	5	3	4	2	4	2
	67	Nicaragua	5	3	4	2	4	2
	68	Panama	5	3	5	3	5	3
	69	Argentina	4	2	4	2	4	2
	72	Bolivia	4	3	3	2	3	2
73	Brazil	4	2	3	1	3	1	

Continent	Country Code	Name	Number of Observations					
			Primary		Secondary		Total	
			(a)	(b)	(a)	(b)	(a)	(b)
	74	Colombia	5	3	5	3	5	2
	75	Ecuador	3	1	3	1	3	1
	77	Paraguay	3	1	4	2	3	1
	78	Peru	4	2	4	2	4	2
	80	Venezuela	4	2	4	2	4	2
ASIA			(71)	(45)	(60)	(34)	(59)	(34)
	82	Japan	2	2	2	2	2	2
	83	Hong Kong	5	3	5	3	5	3
	86	S. Korea	5	3	4	2	4	2
	88	Burma	3	1	3	1	3	1
	93	Malaysia	3	3	2	2	2	2
	94	Philippines	3	3	3	3	3	3
	95	Singapore	5	3	5	3	5	3
	96	Thailand	5	3	4	2	4	2
	98	Afghanistan	4	2	4	2	4	2
	99	Bangladesh	3	3	2	2	2	2
	101	India	4	2	3	1	3	1
	102	Iran	3	2	4	2	3	2
	103	Nepal	5	3	4	2	4	2
	104	Pakistan	4	2	4	2	4	2
	105	Sri Lanka	3	2	0	0	0	0
	108	Iraq	4	2	4	2	4	2
	110	Kuwait	0	0	0	0	0	0
	111	Lebanon	0	0	0	0	0	0
	115	Syria	5	3	4	2	4	2
	119	Israel	0	0	0	0	0	0
	120	Turkey	5	3	3	1	3	1
OCEANIA			(8)	(4)	(2)	(0)	(2)	(0)
	121	Australia	3	1	1	0	1	0
	122	New Zealand	5	3	1	0	1	0
NORTH AMERICA	125	Canada	3	1	0	0	0	0
EUROPE			(58)	(31)	(39)	(21)	(39)	(21)
	134	Denmark	4	2	0	0	0	0
	135	Finland	5	3	5	3	5	3
	137	Ireland	5	3	5	3	5	3
	138	Norway	4	2	3	1	3	1
	139	Sweden	4	2	3	2	3	2
	142	Greece	3	2	0	0	0	0
	143	Italy	4	2	4	2	4	2
	145	Portugal	4	2	4	2	4	2
	146	Spain	4	2	3	1	3	1

Continent	Country		Number of Observations					
	Code	Name	Primary		Secondary		Total	
			(a)	(b)	(a)	(b)	(a)	(b)
	147	Yugoslavia	4	3	4	3	4	3
	148	Austria	3	2	2	1	2	1
	149	Belgium	4	2	2	1	2	1
	150	France	4	2	4	2	4	2
	151	W. Germany	1	0	0	0	0	0
	153	Netherlands	4	2	0	0	0	0
	154	Switzerland	1	0	0	0	0	0
TOTAL SAMPLE SIZE			321	186	258	139	250	132

---

\*

(a) refers to entire sample that may not have included the ten year lagged value of the instruments. This larger sample was the basis for only exploratory OLS estimations and tends to include a substantial number of observations from the 1960s for which the lagged instruments are not available.

(b) refers to the restricted sample for which the lagged instruments (secondary school enrollment rates, GNP per adult and urbanization) are available. These smaller samples are used for all of the OLS and IV estimates reported in this paper.

Table A-2

Estimates of Primary School Expenditures and Components,  
with the Price of Teachers Exogenous, Excluding Fertility<sup>a</sup>

Dependent Variables in Logarithms	Enrollment Ratio			Teacher- Student Ratio	Capital Intensity Index	Teacher Salary	Total Expenditure per Child Age 6-11
	Male	Female	Total				
	(S/P)	(S/P)	(S/P)	(T/S)	(E/C)	(C/T)	(E/P)
Explanatory Variables:	(1)	(2)	(3)	(4)	(5)	(6)	(7)
GNP per Adult in 1970 (log)	.165 (4.10)	.384 (5.98)	.248 (5.33)	.158 (4.24)	-.0077 (.28)	0.0 (32.7)	1.40 (27.9)
Relative Price of Teachers (log) <sup>a</sup>	-.193 (5.45)	-.195 (3.44)	-.213 (5.19)	-.168 (5.10)	-.0369 (1.53)	1.0	.582 (13.2)
Proportion of Population Urban	.102 (.62)	.0854 (.32)	.0864 (.45)	-.283 (1.85)	-.107 (.96)	0.0	-.304 (1.48)
Proportion of Pop- ulation Age 6-11	1.93 (2.12)	3.60 (2.47)	2.28 (2.16)	-5.08 (6.00)	-.620 (1.00)	0.0	-3.43 (3.01)
Intercept	-1.39 (4.33)	-3.32 (6.46)	-2.07 (5.57)	-3.51 (11.7)	.411 (1.88)	0.0	-5.17 (12.9)
R <sup>2</sup>	.429	.493	.501	.535	.024	1.0	.951
Sample Size is 186							
Dependent Variable							
Mean (Standard Deviation)	-.126 (.355)	-.365 (.604)	-.229 (.440)	-3.49 (.366)	.192 (.184)	7.39 (1.10)	3.87 (1.51)

<sup>a</sup>Price treated as exogenous and estimated with ordinary least squares. Absolute value of t ratio reported in parentheses beneath regression coefficients.

Table A-3

Estimates of Secondary School Expenditures and Components,  
with the Price of Teachers Exogenous, Excluding Fertility<sup>a</sup>

Dependent Variables in Logarithms	Enrollment Ratio			Teacher- Student Ratio	Capital Intensity Index	Teacher Salary	Total Expenditure per Child Age 12-17
	Male	Female	Total				
	(S/P)	(S/P)	(S/P)	(T/S)	(E/C)	(C/T)	(E/P)
<b>Explanatory Variables:</b>	(1)	(2)	(3)	(4)	(5)	(6)	(7)
GNP per Adult in 1970 $\int$ (log)	.460 (5.77)	.877 (9.93)	.604 (7.91)	.0113 (.21)	-.0198 (.58)	0.0	1.60 (28.7)
Relative Price of Teachers (log) <sup>a</sup>	-.394 (7.70)	-.478 (8.41)	-.441 (8.99)	-.0750 (2.19)	-.0181 (.83)	1.0	.466 (13.0)
Proportion of Population Urban	-.0426 (.14)	-.250 (.72)	-.152 (.51)	-.0953 (.46)	-.0959 (.72)	0.0	-.343 (1.58)
Proportion of Pop- ulation Age 12-17	-2.04 (.84)	3.65 (1.36)	-.268 (.12)	-8.06 (4.96)	-1.73 (1.67)	0.0	-10.1 (5.94)
Intercept	-3.29 (4.68)	-6.98 (8.96)	-4.50 (6.69)	-1.81 (3.85)	.623 (2.08)	0.0	-5.69 (11.6)
R <sup>2</sup>	.748	.846	.819	.242	.035	1.0	.955
Sample Size is 139							
<b>Dependent Variable</b>							
Mean (Standard Deviation)	-1.33 (.882)	-1.78 (1.25)	-1.49 (.999)	-2.99 (.341)	.192 (.193)	8.42 (.903)	4.14 (1.47)

<sup>a</sup>Price treated as exogenous and estimated with ordinary least squares. Absolute value of t ratio reported in parentheses beneath regression coefficients.

Table A-4

Estimates of Total School System Expenditures and Components,  
with the Price of Teachers Exogenous, Excluding Fertility<sup>a</sup>

Dependent Variables in Logarithms	Enrollment Ratio			Teacher- Student Ratio	Capital Intensity Index	Teacher Salary	Total Expenditure per Child Age 6-17
	Male	Female	Total				
	(S/P)	(S/P)	(S/P)	(T/S)	(E/C)	(C/T)	(E/P)
Explanatory Variables:	(1)	(2)	(3)	(4)	(5)	(6)	(7)
GNP per Adult in 1970 (log)	.283 (5.46)	.543 (6.96)	.355 (6.52)	.106 (3.15)	-.0177 (.51)	.892 23.8	1.43 (25.7)
Relative Price of Teachers (log) <sup>a</sup>	-.279 (5.58)	-.308 (4.10)	-.295 (5.62)	-.0979 (3.01)	-.0451 (1.34)	1.19 (33.0)	.471 (8.79)
Proportion of Population Urban	-.0043 (.02)	-.165 (.54)	-.0564 (.27)	-.180 (1.36)	-.132 (.97)	-.131 .90	-.283 (1.30)
Proportion of Pop- ulation Age 6-17	.326 (.48)	1.17 (1.13)	-.0430 (.06)	-2.66 (5.95)	-.696 (1.51)	.414 (.84)	-3.54 (4.81)
Intercept	.458 (1.02)	-1.69 (2.50)	-.0182 (.04)	-3.05 (10.4)	.619 (2.05)	.680 (2.09)	-4.93 (10.2)
R <sup>2</sup>	.648	.664	.701	.525	.037	.946	.955
Sample Size is 132							
Dependent Variable							
Mean (Standard Deviation)	2.05 (.483)	1.74 (.743)	1.90 (.551)	-3.31 (.271)	.195 (.196)	8.80 (.886)	3.89 (1.45)

<sup>a</sup>Price treated as exogenous and estimated with ordinary least squares. Absolute value of t ratio reported in parentheses beneath regression coefficients.

Table A-5

Estimates of Primary School Expenditures and Components,  
with Price of Teachers Endogenous, Excluding Fertility<sup>a</sup>

Dependent Variables in Logarithms	Enrollment Ratio			Teacher- Student Ratio	Capital Intensity Index	Teacher Salary	Total Expenditure per Child Age 6-11
	Male	Female	Total				
	(S/P)	(S/P)	(S/P)	(T/S)	(E/C)	(C/T)	(E/P)
<b>Explanatory Variables:</b>	(1)	(2)	(3)	(4)	(5)	(6)	(7)
GNP per Adult in 1970 (log)	.211 (4.09)	.447 (5.27)	.304 (4.86)	.184 (4.82)	-.0054 (.20)	.863 (35.0)	1.35 (22.1)
Relative Price of Teachers (log) <sup>a</sup>	-.547 (5.24)	-.809 (4.73)	-.669 (5.31)	-.228 (2.96)	.0075 (.13)	1.07 (21.6)	.181 (1.48)
Proportion of Population Urban	-.266 (1.15)	-.533 (1.41)	-.382 (1.37)	-.363 (2.13)	-.0689 (.56)	.199 (1.81)	-.615 (2.26)
Proportion of Pop- ulation Age 6-11	3.51 (3.07)	5.42 (2.89)	4.07 (2.96)	-3.92 (4.65)	-.415 (.68)	-6.65 (12.2)	-6.92 (5.15)
Intercept	-1.50 (3.74)	-3.26 (4.95)	-2.15 (4.44)	-3.77 (12.7)	.313 (1.46)	1.78 (9.31)	-3.83 (8.10)
F	23.08	29.43	28.75	46.13	.50	1638.	571.
Sample Size is 186							
<b>Dependent Variable</b>							
Mean (Standard Deviation)	-.126 (.355)	-.365 (.604)	-.229 (.440)	-3.49 (.366)	.192 (.184)	7.39 (1.10)	3.87 (1.51)

<sup>a</sup>Price treated as an endogenous and estimated with instruments of secondary enrollment ratio, urbanization, and GNP per adult, all lagged ten years. Absolute value of asymptotic t ratio reported in parentheses beneath regression coefficients.



Table A-6

Estimates of Secondary School Expenditures and Components, with  
Price of Teachers Endogenous, Excluding Fertility<sup>a</sup>

Dependent Variables in Logarithms	Enrollment Ratio			Teacher- Student Ratio	Capital Intensity Index	Teacher Salary	Total Expenditure per Child Age 12-17
	Male	Female	Total				
	(S/P)	(S/P)	(S/P)	(T/S)	(E/C)	(C/T)	(E/P)
<b>Explanatory Variables:</b>	(1)	(2)	(3)	(4)	(5)	(6)	(7)
GNP per Adult in 1970 (log)	.303 (2.74)	.667 (5.02)	.434 (3.87)	.107 (1.61)	-.0114 (.32)	.946 (53.8)	1.48 (21.4)
Relative Price of Teachers (log) <sup>a</sup>	-.899 (7.56)	-1.14 (8.00)	-.989 (8.20)	.183 (2.55)	.0026 (.07)	1.01 (53.1)	.202 (2.73)
Proportion of Population Urban	-.778 (1.79)	-1.22 (2.32)	-.953 (2.16)	.242 (.92)	-.0704 (.50)	.148 (2.14)	-.633 (2.33)
Proportion of Pop- ulation Age 12-17	-2.00 (.63)	3.44 (.90)	-.163 (.05)	-6.51 (3.39)	-1.54 (1.49)	-5.64 (11.1)	-13.9 (6.96)
Intercept	-1.02 (.98)	-3.93 (3.14)	-2.05 (1.94)	-3.27 (5.21)	.493 (1.47)	1.03 (6.23)	-3.79 (5.84)
F	62.33	96.37	83.59	8.28	1.04	1683.	482.
Sample Size is 139							
<b>Dependent Variable</b>							
Mean (Standard Deviation)	-1.33 (.882)	-1.78 (1.25)	-1.49 (1.00)	-2.98 (.341)	.192 (.193)	8.42 (.903)	4.14 (1.47)

<sup>a</sup>Price treated as an endogenous and estimated with instruments of secondary enrollment ratio, urbanization, and GNP per adult, all lagged ten years. Absolute value of asymptotic t ratio reported in parentheses beneath regression coefficients.

Table A-7

Estimates of Total School System Expenditures and  
Components with Price of Teachers Endogenous, Excluding Fertility<sup>a</sup>

Dependent Variables in Logarithms	Enrollment Ratio			Teacher- Student Ratio	Capital Intensity Index	Teacher Salary	Total Expenditure per Child Age 6-17
	Male	Female	Total				
	(S/P)	(S/P)	(S/P)	(T/S)	(E/C)	(C/T)	(E/P)
<b>Explanatory Variables:</b>	(1)	(2)	(3)	(4)	(5)	(6)	(7)
GNP per Adult in 1970 (log)	.283 (4.29)	.529 (5.31)	.350 (4.77)	.127 (3.60)	-.0086 (.25)	.769 (14.5)	1.35 (21.6)
Relative Price of Teachers (log) <sup>a</sup>	-.689 (5.73)	-.942 (5.19)	-.792 (5.92)	.0228 (.35)	.0023 (.04)	1.38 (14.2)	.155 (1.36)
Proportion of Population Urban	-.471 (1.67)	-.863 (2.03)	-.613 (1.964)	-.0763 (.51)	.0921 (.62)	.279 (1.23)	-.514 (1.93)
Proportion of Pop- ulation Age 6-17	1.12 (1.33)	1.96 (1.54)	.768 (.82)	-2.26 (5.00)	-.516 (1.16)	-3.69 (5.45)	-5.35 (6.70)
Intercept	.936 (1.60)	-.745 (.84)	.633 (.97)	-3.50 (11.1)	.432 (1.40)	2.26 (4.81)	-3.41 (6.14)
F	39.13	42.20	45.06	29.64	.75	188.	513.
Sample Size is 132							
<b>Dependent Variable</b>							
Mean (Standard Deviation)	2.05 (.483)	1.74 (.743)	1.90 (.547)	-3.31 (.271)	.195 (.196)	8.08 (.886)	3.89 (1.45)

<sup>a</sup>Price treated as an endogenous and estimated with instruments of secondary enrollment ratio, urbanization, and GNP per adult, all lagged ten years. Absolute value of asymptotic t ratio reported in parentheses beneath regression coefficients.

Table A-8

Estimates of Primary School Expenditures and Components only in  
Low Income Countries, with Price of Teachers Endogenous<sup>a</sup>

Dependent Variables in Logarithms	Enrollment Ratio			Teacher- Student Ratio	Capital Intensity Index	Teacher Salary	Total Expenditure per Child Age 6-11
	Male	Female	Total				
	(S/P)	(S/P)	(S/P)	(T/S)	(E/C)	(C/T)	(E/P)
Explanatory Variables:	(1)	(2)	(3)	(4)	(5)	(6)	(7)
GNP per Adult in 1970 (log)	.195 (2.54)	.401 (3.44)	.270 (3.06)	.0936 (1.81)	-.026 (.62)	1.067 (55.9)	1.40 (15.5)
Relative Price of Teachers (log) <sup>a</sup>	-.559 (4.73)	-.667 (3.70)	-.621 (4.56)	-.236 (2.95)	.0012 (.02)	1.02 (34.5)	.162 (1.16)
Proportion of Population Urban	-.147 (.52)	-.399 (.92)	-.249 (.76)	-.239 (1.23)	-.0575 (.37)	-.211 (2.95)	-.756 (2.23)
Proportion of Pop- ulation Age 6-11	-.918 (.37)	2.50 (.65)	.266 (.09)	-2.74 (1.62)	.475 (.35)	-6.23 (9.97)	-8.23 (2.27)
Total Fertility Rate	.0524 (1.44)	-.0193 (.35)	.024 (.57)	-.0234 (.95)	.0007 (.03)	.0099 (1.10)	.0111 (.26)
Intercept	-1.02 (2.13)	-2.57 (3.53)	-1.56 (2.83)	-3.31 (10.3)	.286 (1.10)	.613 (5.14)	-3.97 (7.01)
F	16.25	21.29	20.49	10.46	.92	1527.	146.
Sample Size is 148							
Dependent Variable							
Mean (Standard Deviation)	-.167 (.387)	-.465 (.639)	-.296 (.470)	-3.599 (.289)	.190 (.198)	7.009 (.823)	3.305 (1.076)

<sup>a</sup>Price treated as an endogenous and estimated with instruments of secondary enrollment ratio, urbanization, and GNP per adult, all lagged ten years. Absolute value of asymptotic t ratio reported in parentheses beneath regression coefficients.

Table A-9

Estimates of Secondary School Expenditures and Components only in  
Low Income Countries, with Price of Teachers Endogenous<sup>a</sup>

Dependent Variables in Logarithms	Enrollment Ratio			Teacher- Student Ratio	Capital Intensity Index	Teacher Salary	Total Expenditure per Child Age 12-17
	Male	Female	Total				
	(S/P)	(S/P)	(S/P)	(T/S)	(E/C)	(C/T)	(E/P)
<b>Explanatory Variables:</b>	(1)	(2)	(3)	(4)	(5)	(6)	(7)
GNP per Adult in 1970 (log)	.206 (1.40)	.622 (3.76)	.348 (2.41)	.0534 (.59)	-.0083 (.17)	1.14 (53.3)	1.53 (17.5)
Relative Price of Teachers (log) <sup>a</sup>	-.858 (6.25)	-1.04 (6.72)	-.923 (6.86)	.175 (2.09)	-.0103 (.23)	1.02 (51.2)	.259 (3.17)
Proportion of Population Urban	-.405 (.73)	-1.14 (1.83)	-.674 (1.24)	.347 (1.03)	-.160 (.89)	-.343 (4.27)	-.830 (2.52)
Proportion of Pop- ulation Age 12-17	-2.90 (.47)	-.0433 (.01)	-1.62 (.27)	-4.50 (1.18)	-1.04 (.51)	-7.31 (8.11)	-14.5 (3.91)
Total Fertility Rate	.0153 (.26)	-.0678 (1.12)	-.0162 (.28)	-.0071 (.20)	.0011 (.06)	-.0232 (2.71)	-.0453 (1.29)
Intercept	-.620 (.51)	-3.03 (-2.21)	-1.47 (1.23)	-3.19 (4.29)	.456 (1.15)	.385 (2.19)	-3.82 (5.27)
F	30.56	57.64	44.87	1.85	.99	1030.	150.
Sample Size is 116							
<b>Dependent Variable</b>							
Mean (Standard Deviation)	-1.540 (.809)	-2.076 (1.156)	-1.738 (.911)	-3.046 (.323)	.188 (.201)	8.265 (.867)	3.670 (1.046)

<sup>a</sup>Price treated as an endogenous and estimated with instruments of secondary enrollment ratio, urbanization, and GNP per adult, all lagged ten years. Absolute value of asymptotic t ratio reported in parentheses beneath regression coefficients.

Table A-10

Estimates of Total School System Expenditures and Components only in  
Low Income Countries, with Price of Teachers Endogenous<sup>a</sup>

Dependent Variables in Logarithms	Enrollment Ratio			Teacher- Student Ratio	Capital Intensity Index	Teacher Salary	Total Expenditure per Child Age 6-17
	Male	Female	Total				
	(S/P)	(S/P)	(S/P)	(T/S)	(E/C)	(C/T)	(E/P)
<b>Explanatory Variables:</b>	(1)	(2)	(3)	(4)	(5)	(6)	(7)
GNP per Adult in 1970 (log)	.194 (1.96)	.454 (3.21)	.251 (2.36)	.091 (1.70)	-.0067 (.13)	1.08 (15.1)	1.41 (15.0)
Relative Price of Teachers (log) <sup>a</sup>	-.686 (5.12)	-.824 (4.31)	-.746 (5.20)	.0059 (.08)	-.0160 (.22)	1.39 (14.3)	.181 (1.43)
Proportion of Population Urban	-.152 (.42)	-.709 (1.39)	-.300 (.78)	.0120 (.06)	-.167 (.87)	.591 (2.29)	-.735 (2.18)
Proportion of Pop- ulation Age 6-17	-.198 (.11)	.493 (.19)	-.428 (.22)	-1.84 (1.88)	-.389 (.40)	-3.35 (2.56)	-5.39 (3.16)
Total Fertility Rate	.0396 (.93)	-.0321 (.53)	.0162 (.36)	-.0010 (.04)	.0030 (.13)	-.0382 (1.25)	-.0190 (.48)
Intercept	1.51 (2.15)	.124 (.12)	1.32 (1.76)	-3.40 (8.97)	.414 (1.11)	.780 (1.54)	-3.56 (5.38)
F	22.31	26.42	25.86	3.55	.88	88.28	149.
Sample Size is 109							
<b>Dependent Variable</b>							
Mean (Standard Deviation)	1.954 (.481)	1.591 (.734)	1.777 (.531)	-3.385 (.219)	.192 (.206)	7.866 (.770)	3.417 (1.067)

<sup>a</sup>Price treated as an endogenous and estimated with instruments of secondary enrollment ratio, urbanization, and GNP per adult, all lagged ten years. Absolute value of asymptotic t ratio reported in parentheses beneath regression coefficients.

Table A-11

Unweighted Average of Percentages of Students Enrolled  
in Private Schools, by Level and Region, in 1965 and 1975

Region	Primary Schools			Secondary Schools		
	(Number of Countries)	1965	1975	(Number of Countries)	1965	1975
East Africa	(8) <sup>a</sup>	23	12	(8) <sup>b</sup>	33	23
West Africa	(11)	29	19	(9)	42	30
Latin America	(18) <sup>c</sup>	13	12	(17) <sup>c</sup>	39	30
Asia (East)	(5.)	14	13	(4)	42	29
N. Africa and Middle East	(9)	7.4	6.2	(10)	18	8.2
Total	(51)	17	13	(48)	34	24

a Excluding high levels in Lesotho, Swaziland and Burundi as small unrepresentative countries.

b Excluding high levels in Lesotho and Swaziland as unrepresentative.

c Excluding high levels in Haiti as a small unrepresentative country, where private shares have actually increased.

Source: Annex 16, Education Sector Policy Paper, World Bank, Washington, D.C., April 1980.