The Transition in Education: Intergenerational Effects

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ABSTRACT

This paper is concerned with linking decision-making about schooling to trends in the level and variance of educational attainment and to intergenerational mobility in educational attainment. A simple transition model is presented in which schooling is determined by the educational attainment of one's parents. Educational attainment of successive generations is tracked with attention to three characteristics--mean attainment, the variance of attainment, and the correlation in attainment between parents and their children. The model is applied to the case of Thailand using the results from analysis of enrollment based on the 1981 Socio-Economic Survey.

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I. Introduction

The Pacific Basin is a fascinating laboratory in which to examine the interaction between education and economic development. Widespread attention to the economic success of Japan and the newly industrializing countries has highlighted the importance of education; observers have argued that the Confucian emphasis on learning has led to an unusually high level of educational attainment and, as a result, to a highly skilled and productive labor force. Remarkably fast demographic change has been linked to education, as well. Fertility in East and Southeast Asian countries has declined more rapidly than elsewhere and the educational attainment of childbearing women and their husbands has been an important factor in lowering fertility and further facilitating economic growth.

Some of my own previous research, in collaboration with others, has attempted to assess the contribution of education to economic development using an econometric model estimated primarily from international cross-section data.[1/] That research examined trends in Thailand, Korea, Indonesia, and Japan, focusing on several important macroeconomic effects of increased schooling: (1) that schooling competes with employment and, thereby, involves opportunity cost; (2) that additional schooling enhances the productivity of the labor force and, thereby, increases output per worker; and, (3) that additional schooling encourages reduced fertility, lower population growth, and a number of related economic benefits.

This paper approaches education in a less traditional direction, focusing on the intergenerational transmission of educational attainment. Instead of looking at the schooling decision strictly as a decision of a future employee judging the returns of a potential investment, schooling is modelled in a household context where the educational attainment of the parents of the potential student is emphasized. The research is rather exploratory at this point. Both the statistical analysis and theoretical model require further development. Moreover, the contribution of other researchers in this field is not acknowledged.

A simple simulation model is proposed that shows how the relationship between a parent and a child's schooling affects three aspects of aggregate educational attainment: the average level of educational attainment, the variance in educational attainment, and the intergenerational correlation in educational attainment. The first and second aspects of educational attainment are important because they bear on the growth and the size distribution of earnings. The third aspect has not been widely investigated, but it is also important since it deals with social and economic mobility within a society.

II. A Model of the Level and Distribution of Educational Attainment

The model presented here describes trends in education between successive generations or cohorts when schooling is affected by the educational attainment of ones' parents. We are concerned with three aspects of educational attainment: (1) the average level of attainment; (2) the variance of attainment; and (3) the intergenerational correlation in attainment, i.e., the correlation between the educational attainment of parents and the completed educational attainment of their children.2/ The educational transition is described by a system of equations that track three levels of attainment from one generation to the next. Defining the following terms as:

α^i_j - the conditional probability that a member of the cohort currently attending school will attain education level i given that their parent attained education level j. The conditional probability is assumed to be constant over time.

b^i - "net reproduction rate" of individuals with educational level i.

N^i_c - number of members of cohort c with educational attainment i.

The number with completed education level i is determined by:

$$N^1_c = \alpha^1_1 b^1 N^1_{c-1} + \alpha^1_2 b^2 N^2_{c-1} + \alpha^1_3 b^3 N^3_{c-1} \tag{1}$$

$$N^2_c = \alpha^2_1 b^1 N^1_{c-1} + \alpha^2_2 b^2 N^2_{c-1} + \alpha^2_3 b^3 N^3_{c-1} \tag{2}$$

$$N^3_c = \alpha^3_1 b^1 N^1_{c-1} + \alpha^3_2 b^2 N^2_{c-1} + \alpha^3_3 b^3 N^3_{c-1} \tag{3}$$

The model can be described more succinctly using matrix notation. Representing vectors and matrices with boldface:

$$\boldsymbol{\alpha} = \begin{pmatrix} \alpha_1^1 & \alpha_2^1 & \alpha_3^1 \\ \alpha_1^2 & \alpha_2^2 & \alpha_3^2 \\ \alpha_1^3 & \alpha_2^3 & \alpha_3^3 \end{pmatrix}$$

$$\mathbf{b}_c = \begin{pmatrix} b^1 & 0 & 0 \\ 0 & b^2 & 0 \\ 0 & 0 & b^3 \end{pmatrix}$$

$$\mathbf{N}_c = \begin{pmatrix} N_c^1 \\ N_c^2 \\ N_c^3 \end{pmatrix}$$

The intergenerational transmission of education can then be represented by:

$$\mathbf{N}_c = \boldsymbol{\alpha}\mathbf{b}_{c-1}\mathbf{N}_{c-1} \tag{4}$$

The matrix α characterizes the intergenerational transmission of education from parent to child and the matrix b captures differential fertility and, less importantly, differential mortality associated with educational attainment of parents. For the moment, we will concentrate on the α matrix by setting the diagonal elements of b to 1, i.e., assuming the stationary population case.

CASE I. No Intergenerational Mobility

This is a polar case in which offspring achieve the same educational attainment as have their parents. The α matrix is equal to:

$$\boldsymbol{\alpha} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

In this case, average educational attainment does not change from generation to generation. The variance in educational attainment is independent of the α matrix and is equal to the variance of the initial educational attainment. The intergenerational correlation is equal to the maximum possible value, 1, because parents and children have identical attainment.

CASE II. Complete Intergenerational Mobility

This is at the opposite end of the spectrum from Case I. The probability of attending school is independent of the educational attainment of one's parent. The α matrix is:

$$\alpha = \begin{pmatrix} \alpha^1 & \alpha^1 & \alpha^1 \\ \alpha^2 & \alpha^2 & \alpha^2 \\ \alpha^3 & \alpha^3 & \alpha^3 \end{pmatrix}$$

In this case, average educational attainment is independent of the initial attainment of parents. In period 2 and all subsequent periods, the proportion with each level of educational attainment is α^i. The variance of educational attainment is determined, as well, by the α matrix, and the intergenerational correlation is equal to zero.

CASE III. Intermediate Cases

We will compare three intermediate cases. In the first case to be described the educational attainment of parents has a substantial impact on the attainment of their offspring. This will be called the "strong link" scenario. The "weak link" scenario is a situation in which the educational attainment of children is relatively independent of the attainment of their parents. The final scenario, called the "upward mobility" case, describes a situation in which offspring achieve at least as much educational attainment as did their parents.

One line of inquiry that might be pursued with respect to the model proposed here is an analytic evaluation of the model, demonstrating the stability characteristics and analyzing the relationship between the transition matrix and characteristics of the equilibrium distribution of educational attainment, including its mean, variance, and the intergenerational correlation coefficient. But this paper will confine itself to the comparison of simulations.

Table 1 shows the results of the "strong link" simulation. The

Table 1. Simulation of Education; "Strong Link" Scenario

Initial Conditions

Transition Matrix

Education of child	Education of parent: Primary	Secondary	Tertiary
Primary	0.7	0.2	0.1
Secondary	0.2	0.6	0.2
Tertiary	0.1	0.2	0.7
mean:	1.4	2	2.6
variance:	0.440	0.400	0.440
NRR	1	1	1
N	0.8	0.13	0.07

Simulation Results

	Education of parents			Attainment		
Cohort	Primary	Secondary	Tertiary	Mean	Variance	r
0	0.800	0.130	0.070	1.27	0.337	0.467
1	0.593	0.252	0.155	1.56	0.556	0.564
2	0.481	0.301	0.218	1.74	0.630	0.589
3	0.419	0.320	0.261	1.84	0.655	0.596
4	0.383	0.328	0.289	1.91	0.663	0.599
5	0.363	0.331	0.306	1.94	0.666	0.600
6	0.351	0.333	0.317	1.97	0.666	0.600
7	0.344	0.333	0.323	1.98	0.667	0.600
8	0.340	0.333	0.327	1.99	0.667	0.600
9	0.337	0.333	0.330	1.99	0.667	0.600
10	0.336	0.333	0.331	2.00	0.667	0.600

first part of the table contains the α or transition matrix and the initial conditions: the net reproduction rate (NRR) set to 1 for each education group and the initial distribution of educational attainment (N).[3/] The mean and variance of the transition values for each education of parent group are also reported. From the values in the transition matrix, it is apparent that parent's education has an enormous impact on the education of offspring. Among offspring of parents with either primary or tertiary education, seventy percent achieved the same education as their parents. Sixty percent of the secondary parents' offspring achieved education identical to their parents.

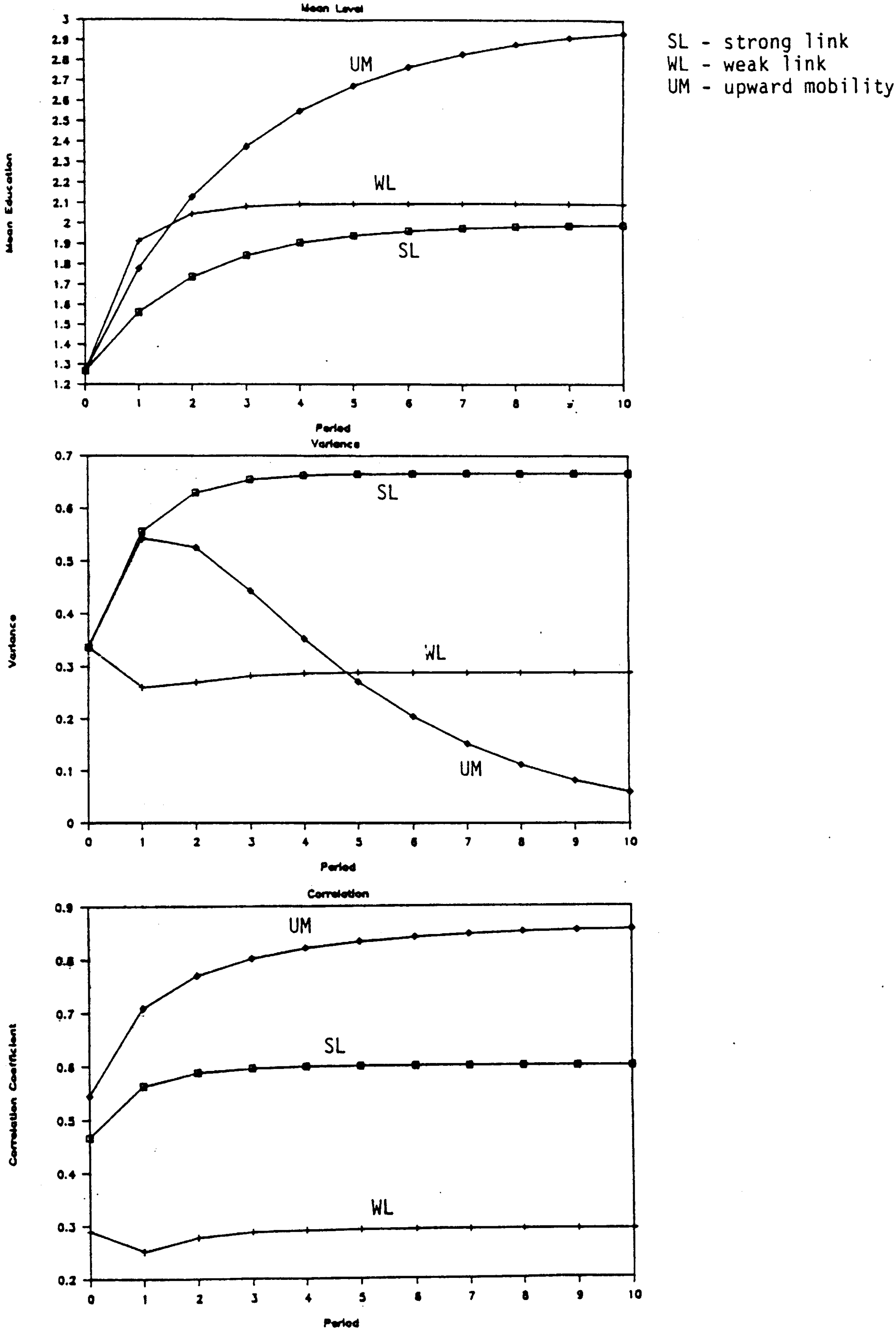
Simulation results are reported in the second part of the table. Each period represents a generation length, i.e., 25 years or more. The level of education increases most rapidly in early periods. The greatest changes in the percent with primary, secondary, and tertiary education occur in the first period. Even so, educational attainment converges rather slowly to the equilibrium value. The mean level of attainment mirrors the trends in primary, secondary, and tertiary attainment. Average attainment increases most rapidly during the first generation and converges rather slowly to a terminal value of 2.

The variance in attainment also increases rapidly in this simulation as the concentration at the primary level erodes. The terminal variance is quite high as the resulting distribution of attainment is essentially uniform. Only a bimodal distribution, with larger numbers having either a primary education or a tertiary education, would have a higher variance than the equilibrium in this simulation. The intergenerational correlation coefficient is also extremely high reflecting the assumed strength of the relationship between the education of parents and the schooling of their children.

Detailed results for the "weak link" and "upward mobility" scenarios are presented in the appendix of this paper, but their means, variances, and intergenerational correlations are compared with the "strong link" scenario in Figure 1.

The most obvious conclusion that one might reach based on Figure 1 is that simple generalizations are few and far between. The weak link and strong link scenarios produce similar terminal values of educational attainment; however, the weak link population gets there much more quickly because all segments of society are participating in

Figure 1. Comparison of Three Scenarios



the expansion of schooling. Attainment of the upwardly mobile population increases most gradually but grows without limit. Parents with a primary or secondary education are not replacing themselves with 1 primary or 1 secondary educated child, on average. Thus, the number with primary or secondary education will eventually decline to zero.

Three completely different trends in variance are generated by the three scenarios. For the strong link case, the variance in educational attainment increases monotonically. For the weak link case, the variance of attainment declines initially and then rises thereafter; however, the terminal variance is still less than the initial variance. And in the upward mobility scenario, the variance increases initially and then declines thereafter (approaching zero in the limit.)

The intergenerational correlation changes as the distribution of parental education changes because the correlation between parent and child varies with the education of the parent. This effect is most prominent in the upward mobility case because for college educated parents the intergenerational correlation is 1. Thus, as more and more parents have a college education, the intergenerational correlation coefficient approaches unity.

Simulations have also been repeated allowing for differential net reproduction by setting the NRR to 2, 1.4, and 1 for primary, secondary, and tertiary educated adults, respectively.[4/] Detailed results are included in the appendix.

So long as child and parent education are positively correlated, differential fertility will retard growth in mean attainment because a larger percent of the school-going population will be the progeny of parents with lower levels of education. The real issue is one of magnitude--how great is the impact of differential ferility on attainment?

The impact of differential fertility is surprisingly small. In no instance is the difference as great as seven percent. The upward mobility and high variance scenarios show very similiar patterns during the first five periods (generations), and fertility differences stabilize at 6.7 percent for the high variance scenario. In the upward mobility case, even with differential fertility, attainment approaches universal college education (in the limit) so that attainment differences will slowly disappear over time.[5/]

The impact of differential fertility on the variance of educational attainment cannot be determined a priori. In the three cases explored here, differential fertility reduced the variance of attainment by modest amounts in both the strong link and weak link cases. In the strong link case, the variance of attainment averaged about 4 percent less, whereas, in the weak link case, the difference never exceeded one percentage point. The upward mobility scenario is quite distinct. Because differential fertility retards the speed with which universal college education is achieved, the variance in attainment is much higher in the population where parents with low education bear more children. These results are summarized in Figure 2.

Differential fertility has a negligible impact on our measure of intergenerational mobility. The correlation coefficient is higher for all three scenarios if fertility varies with educational attainment, but the differences are in the one to two percent range for all simulations.

A final issue can be explored using the simple model of educational attainment, namely the impact of compulsory education. A policy to make secondary education compulsory, for example, is easily captured by the transition matrix--the first row of the matrix is set to zero and the second row to the sum of the first two rows of the transition matrix that prevailed in the absence of the policy.[6/] If in the absence of compulsory education, the strong link transition matrix prevailed, for example, the transition matrix after the imposition of compulsory secondary education would be:

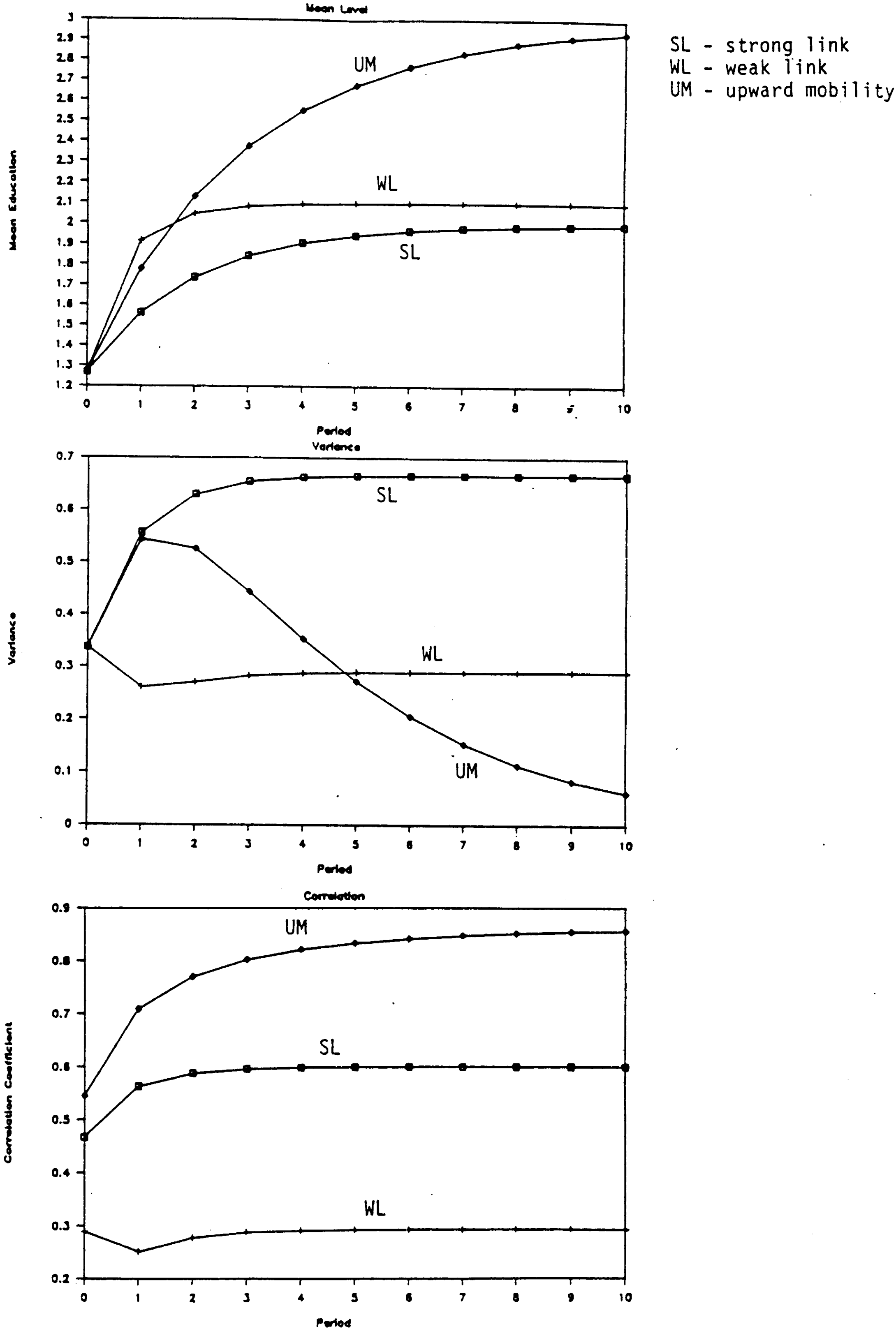
$$\alpha = \begin{pmatrix} 0 & 0 & 0 \\ .9 & .8 & .3 \\ .1 & .2 & .7 \end{pmatrix}$$

instead of:

$$\alpha = \begin{pmatrix} .7 & .2 & .1 \\ .2 & .6 & .2 \\ .1 & .2 & .7 \end{pmatrix}$$

Improvements in educational attainment are obviously accelerated and in two ways. The current school-going population will receive more secondary education by government mandate. But, in addition, successive generations will have higher tertiary attainment because

Figure 2. Comparison of Scenarios with Differential Fertility



the children of parents with secondary education are more likely to attend college. Comparison of simulations detailed in the appendix shows that the impact on the proportion attending college may or may not be substantial. For the strong link case, the equilibrium proportion with tertiary education is 40 percent rather than 31 percent if secondary school is compulsory. But for the weak link case, the equilibrium proportion with tertiary is only 21 percent as compared with 20 percent in the absence of compulsory secondary schooling.

Intuition suggests that compulsory education would always reduce the variance in educational attainment. Quite clearly, the initial impact of a compulsory policy will be to reduce the variance in attainment. After all, the policy merely truncates the lower tail of the distribution. However, as the proportions attending college begin to change it is no longer entirely clear how the variance of attainment will compare to the variance in the absence of the policy. In the simulation experiments carried out here, the variance was reduced for all three scenarios in each period of the simulation and, in some cases, the variance was reduced by a considerable amount.

The impact of compulsory education on the intergenerational correlation of attainment depends on the variation in correlation across the educational attainment of parents. If parents with primary education transmit their attainment more "efficiently" than do parents with secondary or tertiary education, then a reduction in the proportion of parents with primary education will reduce the intergenerational correlation coefficient. Thus, the impact of compulsory education on the correlation coefficient is clearly an empirical matter. The simulation analysis reported in the appendix does indicate that a compulsory policy could have a substantial impact on the intergenerational correlation coefficient.

III. Application to Thailand

The value of the simulation model described above is that it demonstrates how the determinates of schooling bear on trends in both the distribution and level of educational attainment and the degree of social and economic mobility that characterize a society. The intergenerational model of educational attainment has value, however, only to the extent that the determinates of schooling are transmitted within the household rather than on a society-wide basis. Preliminary analysis of survey data from Thailand indicates that the educational attainment of parents has an important bearing on the likelihood of offspring attending school.

a. Statistical results

Analysis is based on the 1981 Socio-Economic Survey of Thailand which interviewed 12,250 sample households over a twelve month period.[7/] Although the survey was devoted primarily to collecting data on income and consumer expenditures, a household register was included that reports age, sex, relationship to head, school and work status, and educational attainment for all household members.

Because primary education is very nearly universal in Thailand, analysis emphasized three educational levels: lower secondary, upper secondary, and tertiary. Three files were constructed which contain records for individual household members of each school age: 12-14 for lower secondary (N=4,070), 15-17 for upper secondary (N=3,712), and 18-24 for tertiary (N=6,875). The probability of being enrolled in school was estimated separately for each age group using logit analysis. A complete list of the independent variables employed and their means are reported in Table 2.

Our principal interest here is in quantifying how educational attainment is transmitted over time from generation to generation, i.e., the correlation between educational attainment of parents and their children. It is not altogether clear how a model of school enrollment should be specified so as to capture the effects of parents' education. The detailed statistical results presented below yield a conservative estimate of the impact of parents' education by estimating the partial effect of education given characteristics of the household which are, in part, also determined by parents' educational attainment. Ideally, we would like to have an estimate of the direct and indirect effects of parents' education on the educational attainment of their children.

A liberal estimate of the impact of parents' education is yielded by a simple cross-tabulation of school enrollment against educational attainment of the head such as reported in Table 3. A strong

Table 2. Definitions of Variables

Variable	Definition
SEX	Sex of member (0=male)
AGE	Age of member
HHTYPE1	Household intact (1=intact)
HDSEX	Sex of head (0=male)
HDAGE	Age of head
HDEDEM	Head, elementary education
HDEDSEC	Head, secondary education
HDEDCOL	Head, college education
LNEXP	Log expenditure per capita
LNEXP2	Square log expenditure per capita
SC1	Farm owners, small
SC2	Farm owners, medium
SC3	Farm owners, large
SC4	Farm renters
SC5	Fishing, forestry, etc.
SC6	Entrepeneurs, no employees
SC7	Entrepeneurs, employees
SC8	Professional, technical, managerial
SC9	Laborers
SC10	Clerical, sales workers
SC11	Production, construction workers
SC12	Economically inactive
P0T2	Number of members, 0-2
P3T5	Number of members, 3-5
P6T11	Number of members, 6-11
P12T17	Number of members, 12-17
P18T24	Number of members, 18-24
P25-59	Number of members, 25-59
P60UP	Number of members, 60 and over

Table 2. Definitions of Variables
(continued)

For ages 12 to 14 (No single person HH)
Logistic regression procedure

Dependent variable: D6T24

4070	Observations
950	D6T24 = 0
3120	D6T24 = 1
4263.11	Sum of weights
1	Observations deleted due to missing values or weight<=0

Variable	Mean	Minimum	Maximum	S. D.
SEX	0.49306	0	1	0.500013
AGE	12.9	12	14	0.803594
HHTYPE1	0.807957	0	1	0.393955
HDSEX	0.842737	0	1	0.364093
HDAGE	46.5328	13	95	9.85033
HDEDEM	0.778436	0	1	0.41535
HDEDSEC	0.0481245	0	1	0.214056*
HDEDCOL	0.0207032	0	1	0.142406*
LNEXP	6.27182	4.51634	9.27367	0.607514
LNEXP2	39.7047	20.3973	86.001	7.80838
SC2	0.316042	0	1	0.464986
SC3	0.0778633	0	1	0.267989
SC4	0.0810418	0	1	0.272933
SC5	0.016047	0	1	0.125672*
SC6	0.0255447	0	1	0.157792*
SC7	0.11432	0	1	0.318239
SC8	0.0309586	0	1	0.173227*
SC9	0.0734558	0	1	0.260915
SC10	0.0577677	0	1	0.233332
SC11	0.0596959	0	1	0.236952
SC12	0.0438084	0	1	0.204694*
P0T2	0.182139	0	3	0.417716
P3T5	0.274171	0	3	0.511851
P6T11	1.13348	0	6	0.978369
P12T17	1.9419	1	7	0.857574
P18T24	0.613259	0	6	0.884875
P25T59	1.90626	0	6	0.628027
P60UP	0.191569	0	3	0.471002

* Warning: Variable has limited dispersion.

Table 2. Definitions of Variables
(Continued)

For ages 15 to 17 (No single person HH)
Logistic regression procedure

Dependent variable: D6T24

3712	Observations
2258	D6T24 = 0
1454	D6T24 = 1
3773.09	Sum of weights
1	Observations deleted due to missing values or weight<=0

Variable	Mean	Minimum	Maximum	S. D.
SEX	0.490412	0	1	0.499975
AGE	16.0072	15	17	0.810672
HHTYPE1	0.796814	0	1	0.402424
HDSEX	0.840301	0	1	0.366376
HDAGE	48.0337	15	90	10.1461
HDEDEM	0.770326	0	1	0.42068
HDEDSEC	0.0483821	0	1	0.214601*
HDEDCOL	0.0182927	0	1	0.134026*
LNEXP	6.35577	4.51634	9.76494	0.62514
LNEXP2	40.7866	20.3973	95.3541	8.13117
SC2	0.316544	0	1	0.465191
SC3	0.0945299	0	1	0.292604
SC4	0.0823808	0	1	0.274981
SC5	0.0156185	0	1	0.124011*
SC6	0.0257614	0	1	0.158444*
SC7	0.113522	0	1	0.317273
SC8	0.0274497	0	1	0.163412*
SC9	0.0630836	0	1	0.243146
SC10	0.0610031	0	1	0.239368
SC11	0.0697704	0	1	0.254794
SC12	0.0396492	0	1	0.19516*
P0T2	0.155954	0	3	0.392733
P3T5	0.206462	0	4	0.460753
P6T11	0.899788	0	6	0.966047
P12T17	2.01493	1	7	0.864072
P18T24	0.829339	0	6	0.943005
P25T59	1.87468	0	7	0.729094
P60UP	0.22885	0	3	0.498589

* Warning: Variable has limited dispersion.

Table 2. Definitions of Variables
(continued)

For ages 18 to 24 (No single person HH)
Logistic regression procedure

Dependent variable: D6T24

6875	Observations
5573	D6T24 = 0
1302	D6T24 = 1
6764.77	Sum of weights
1	Observations deleted due to missing values or weight<=0

Variable	Mean	Minimum	Maximum	S. D.
SEX	0.456602	0	1	0.498149
AGE	20.7783	18	24	2.03224
HHTYPE1	0.771411	0	1	0.419954
HDSEX	0.818179	0	1	0.385725
HDAGE	45.7368	17	88	14.5877
HDEDEM	0.731268	0	1	0.443332
HDEDSEC	0.0618868	0	1	0.240967
HDEDCOL	0.0303159	0	1	0.171468*
LNEXP	6.46068	4.51634	9.76167	0.673341
LNEXP2	42.1937	20.3973	95.2903	8.90652
SC2	0.277464	0	1	0.44778
SC3	0.0806295	0	1	0.272285
SC4	0.071862	0	1	0.258278
SC5	0.0146879	0	1	0.120309*
SC6	0.0247518	0	1	0.155379*
SC7	0.107152	0	1	0.309329
SC8	0.0415107	0	1	0.199483*
SC9	0.07567	0	1	0.264489
SC10	0.0844419	0	1	0.27807
SC11	0.0868204	0	1	0.281592
SC12	0.0395535	0	1	0.194922*
POT2	0.328369	0	3	0.549916
P3T5	0.202269	0	4	0.47224
P6T11	0.515822	0	6	0.824509
P12T17	0.848975	0	6	0.986875
P18T24	1.7856	1	6	0.833655
P25T59	1.56438	0	7	1.01416
P60UP	0.276929	0	4	0.566414

* Warning: Variable has limited dispersion.

intergenerational relationship is evident. Children of a head with secondary or tertiary educational attainment are much more likely to be enrolled in either upper or lower secondary or tertiary levels than children of a head with primary educational attainment or less. Whether the head has a secondary or a tertiary attainment appears only to affect the probability of being enrolled at the tertiary level.

Multivariate analysis of the determinants of school enrollment includes a number of additional characteristics of potential students and the households in which they reside. Age and gender are expected to influence enrollment because (1) the opportunity cost of schooling increases with age and (2) the returns to schooling are lower for women because they have lower rates of labor force participation.[8/]

The age and sex of the household head and a variable that distinguishes intact households from households with single heads are included because they may bear on the opportunity cost of the time of household members. For similar reasons, the number of household members under age 2, 3-5, 6-11, 12-17, 18-24, 25-59, and 60+ are included. Additional young household members are expected to discourage enrollment by increasing the opportunity cost of the time of potential students but older members are expected to encourage enrollment by decreasing the opportunity cost of the time of other household members.

Table 3. Education of the Head and Enrollment of Members

Age of child	Education of head		
	Primary or less	Secondary	Tertiary
12 - 14	.743	.940	.959
15 - 17	.343	.753	.352
18 - 24	.149	.352	.501

The natural log of expenditure per household member and its square are included as proxies for permanent income. Socio-economic status of the household is included using a series of dummy variables closely tied to the occupation that accounted for the largest share of household income. Finally, the educational attainment of the head is included.

A complete report of estimates are presented in Table 4. In general, the results are quite consistent with our expectations and the independent variables explain a substantial portion of the variation in the dependent variable. The pseudo-R^2 varies from 0.187 for those 12-14 up to 0.352 for those 18-24. Among the independent variables, sex, age, head's educational attainment, socio-economic status, and household composition have statistically significant effects for all three age groups. Income has a significant effect for those 15-17 and 18-24. Sex of head is statistically significant only for those 18-24 and household type is not statistically significant.

Adjusted means, used to show the effect of selected independent variables, are summarized in Table 5.[9/] The most important household characteristic is the educational attainment of the household head. The break between primary and secondary education, apparent in the simple cross-tabulations, is important in the multivariate analysis, as well. In all three age groups, children living in households headed by a person who attended secondary school are substantially more likely to be enrolled. The impact of the head's having a tertiary education cannot be estimated with sufficient accuracy to reach any firm conclusions for the 12-14 and 15-17 age groups.[10/] For 18-24 year olds the probability of enrollment for those whose household head has a tertiary education is nearly twice as high as for those whose household head has a secondary education, and three to four times as high as for those whose household head has a primary education or less.

b. Aggregate implications

Both analyses described above show that the educational attainment of the head has an important bearing on the schooling of household members. The implications of the findings can be further assessed using the simulation model. Two transition matrices have

Table 4. Logit Estimates of School Enrollment

For age 12 to 14 (No single person HH)
Logistic regression procedure

Dependent variable: D6T24

-2 LOG Likelihood for model containing intercept only= 4794.35

Model chi-square= 848.22 with 28 D.F. (score stat.) P=0.0:
Convergence in 6 iterations with 0 step halvings R=0.432:
Max absolute derivative=0.3899D-04. -2 LOG L= 3842.08:
Model chi-square= 952.27 with 28 D.F. (-2 LOG L.R.) P=0.0:

Variable	Beta	Std. Error	Chi-Square	P	R
INTERCEPT	19.11147567	3.96168896	23.27	0.0000	
SEX	0.48045840	0.08077288	35.38	0.0000	0.083
AGE	-1.22239527	0.05446382	503.74	.	-0.324
HHTYPE1	0.33696488	0.20278359	2.76	0.0966	0.013
HDSEX	-0.33717654	0.21330732	2.50	0.1139	-0.010
HDAGE	-0.01038008	0.00526883	3.88	0.0488	-0.020
HDEDEM	0.03775491	0.11691050	0.10	0.7467	0.000
HDEDSEC	0.59045930	0.30220053	3.82	0.0507	0.019
HDEDCOL	0.72844137	0.55874665	1.70	0.1923	0.000
LNEXP	-1.46921722	1.24473629	1.39	0.2379	0.000
LNEXP2	0.16848335	0.09959797	2.86	0.0907	0.013
SC2	-0.34731649	0.13755543	6.38	0.0116	-0.030
SC3	-0.40883656	0.18422672	4.92	0.0265	-0.025
SC4	-0.59125381	0.17650195	11.22	0.0008	-0.044
SC5	0.33645954	0.37174791	0.82	0.3654	0.000
SC6	0.44901619	0.38581209	1.35	0.2445	0.000
SC7	0.35907837	0.18348015	3.83	0.0503	0.020
SC8	0.59739598	0.39994503	2.23	0.1353	0.007
SC9	-0.53720457	0.18028320	8.88	0.0029	-0.038
SC10	0.78371406	0.25574784	9.39	0.0022	0.039
SC11	0.32251298	0.22073635	2.13	0.1440	0.005
SC12	1.08611230	0.29183664	13.85	0.0002	0.050
P0T2	-0.25057963	0.09434747	7.05	0.0079	-0.032
P3T5	-0.05842145	0.08033095	0.53	0.4671	0.000
P6T11	-0.03386812	0.04427595	0.59	0.4443	0.000
P12T17	0.11314478	0.04867786	5.40	0.0201	0.027
P18T24	0.07520397	0.04826313	2.43	0.1192	0.009
P25T59	0.24084799	0.07877191	9.35	0.0022	0.039
P60UP	0.39441982	0.10944157	12.99	0.0003	0.048

C=0.801 SOMER DYX=0.602 GAMMA=0.603 TAU-A=0.215

Table 4. Logit Estimates of School Enrollment
(continued)

For ages 15 to 17 (no single person HH)
Logistic regression procedure

Dependent variable: D6T24

-2 LOG Likelihood for model containing intercept only= 4443.76

Model chi-square= 957.19 with 28 D.F. (score stat.) P=0.0:
Convergence in 6 iterations with 0 step halvings R= 0.463:
Max absolute derivative=0.5974D-06. -2 LOG L=3434.84:
Model chi-square= 1008.92 with 28 D.F. (-2 LOG L.R.) P=0.0:

Variable	Beta	Std.Error	Chi-Square	P	R
INTERCEPT	-23.68852490	4.04038132	34.37	0.0000	
SEX	0.35416199	0.08579265	17.04	0.0000	0.058
AGE	-0.28865370	0.05320357	29.44	0.0000	-0.079
HHTYPE1	0.10347571	0.19162060	0.29	0.5892	0.000
HDSEX	-0.07741411	0.20247398	0.15	0.7022	0.000
HDAGE	0.00585435	0.00515490	1.29	0.2561	0.000
HDEDEM	0.08473470	0.12930802	0.43	0.5123	0.000
HDEDSEC	0.84149779	0.23510907	12.81	0.0003	0.049
HDEDCOL	0.26571627	0.36655501	0.53	0.4685	0.000
LNEXP	6.65900853	1.17768604	31.97	0.0000	0.082
LNEXP2	-0.41616085	0.08794142	22.39	0.0000	-0.068
SC2	0.03777749	0.18070989	0.04	0.8344	0.000
SC3	-0.22210276	0.21848684	1.03	0.3094	0.000
SC4	-0.06828923	0.22614720	0.09	0.7627	0.000
SC5	0.44371770	0.36144995	1.51	0.2196	0.000
SC6	1.29723241	0.30102586	18.57	0.0000	0.051
SC7	0.87311727	0.19555395	19.93	0.0000	0.054
SC8	2.03226837	0.35969812	31.92	0.0000	0.082
SC9	-0.29473247	0.26643076	1.22	0.2686	0.000
SC10	1.46365298	0.22550440	42.13	0.0000	0.095
SC11	0.39184661	0.21608080	3.29	0.0698	0.017
SC12	1.44224511	0.24691115	34.12	0.0000	0.085
P0T2	-0.02740797	0.12530075	0.05	0.8269	0.000
P3T5	-0.28215963	0.10925500	6.67	0.0098	-0.032
P6T11	-0.08781509	0.05096930	2.97	0.0849	-0.015
P12T17	0.18704785	0.05191966	12.98	0.0003	0.050
P18T24	0.11309738	0.04606659	6.03	0.0141	0.030
P25T59	0.24710644	0.06756870	13.37	0.0003	0.051
P60UP	0.18189258	0.09971081	3.33	0.0681	0.017

C=0.820 SOMER DYX=0.640 GAMMA=0.641 TAU-A=0.305

Table 4. Logit Estimates of School Enrollment
(continued)

For ages 18 to 24 (no single person HH)
Logistic regression procedure

Dependent variable: D6T24

-2 LOG Likelihood for model containing intercept only= 5250.57

Model chi-square=1721.49 with 28 D.F. (score stat.) P=0.0:
Convergence in 8 iterations with 0 step halvings R= 0.593:
Max absolute derivative=0.2497D-10. -2 LOG L= 3349.56:
Model chi-square= 1901.01 with 28 D.F. (-2 LOG L.R.) P=0.0:

Variable	Beta	Std. Error	Chi-Square	P	R
INTERCEPT	-38.92427006	4.84126682	64.64	0.0000	
SEX	0.35733525	0.08995875	15.78	0.0001	0.051
AGE	-0.47174166	0.02680054	309.83	.	-0.242
HHTYPE1	-0.05245609	0.16178957	0.11	0.7458	0.000
HDSEX	-0.35981518	0.17198968	4.38	0.0364	-0.021
HDAGE	0.01741861	0.00482897	13.01	0.0003	0.046
HDEDEM	0.17636311	0.12962839	1.85	0.1737	0.000
HDEDSEC	0.80991684	0.19086723	18.01	0.0000	0.055
HDEDCOL	1.47016173	0.25221766	33.98	0.0000	0.078
LNEXP	11.59511464	1.37452751	71.16	0.0000	0.115
LNEXP2	-0.75133020	0.09775953	59.07	0.0000	-0.104
SC2	0.06750779	0.25786632	0.07	0.7935	0.000
SC3	-0.67806894	0.32246472	4.42	0.0355	-0.021
SC4	0.23220000	0.30342418	0.59	0.4441	0.000
SC5	-0.72478896	0.66848183	1.18	0.2783	0.000
SC6	1.47901256	0.31242724	22.41	0.0000	0.062
SC7	1.03291570	0.25883345	15.93	0.0001	0.051
SC8	1.42964410	0.30054577	22.63	0.0000	0.063
SC9	-0.33536857	0.37895042	0.78	0.3762	0.000
SC10	1.26124656	0.26681270	22.35	0.0000	0.062
SC11	0.43738295	0.27828022	2.47	0.1160	0.009
SC12	1.76284461	0.28408645	38.51	0.0000	0.083
P0T2	-0.67660173	0.13479978	25.19	0.0000	-0.066
P3T5	-0.23974824	0.13590877	3.11	0.0777	-0.015
P6T11	-0.04249250	0.06625434	0.41	0.5213	0.000
P12T17	0.13252513	0.04828637	7.53	0.0061	0.032
P18T24	0.29053674	0.05017540	33.53	0.0000	0.077
P25T59	0.37094567	0.05256366	49.80	0.0000	0.095
P60UP	0.21186854	0.09609236	4.86	0.0275	0.023

C=0.879 SOMER DYX=0.758 GAMMA=0.760 TAU-A=0.233

Table 5. Adjusted Mean Enrollment Rates

Independent Variables	Age of Potential Student		
	12-14	15-17	18-24
Gender			
Male	0.823	0.264	0.042
Female	0.742	0.201	0.030
Age of head			
30	0.812	0.212	0.027
40	0.796	0.222	0.032
50	0.778	0.232	0.037
60	0.760	0.243	0.044
70	**0.741**	0.254	0.052
Education of head			
None	0.772	0.211	**0.028**
Primary	0.779	0.226	**0.033**
Secondary	0.859	**0.383**	0.061
Tertiary	0.875	**0.259**	0.111

Additional household members	Age of Potential Student		
	12-14	15-17	18-24
None	0.785	0.230	0.035
Under 3	0.739	0.225	0.018
3 to 5	0.775	0.184	0.028
6 to 11	0.779	0.215	0.033
12 to 17	0.803	0.265	0.040
18 to 24	0.797	0.251	0.046
25 to 59	0.822	0.277	0.050
60 and older	0.844	0.264	0.043

Boldface values indicate significant difference at 5% level been constructed based on the cross-tabulation and the logit estimates of the impact of the heads education, and the simulation exercises have been completed allowing for no differential net reproduction.

The simulation based on the narrow concept of the impact of head's attainment is not a realistic picture of likely trends in educational attainment in Thailand, because other factors that will influence schooling are held constant at the means observed in 1981. The proportion with primary education declines very modestly. And, although the proportion with secondary education rises, the proportion with a tertiary education actually falls.

The simulation based on the cross-tabulations implies a fairly rapid change in the mean and variance of educational attainment. The proportion with primary schooling drops from 80% to 58% for the next generation to 48% for the following generation. The proportion with secondary increases from 13% to stabilize at about one-quarter of the population; and, the proportion with tertiary increases from 7% among the initial generation to reach 20% for the next generation and, after some passage of time, just over 30%. The variance in educational attainment is quite high. Rising from an initial value of 0.337 the variance eventually stabilizes at 0.721, a value that is higher than any of the scenarios described above. The intergenerational correlation coefficient is a moderate value throughout the simulation period.

IV. Toward a Richer Model

The model examined above has several desirable attributes—in particular, it focuses attention on the link between intergenerational mobility and trends in the level and distribution of educational attainment. The model, on the other hand, is a highly simplified view of the world which requires considerable elaboration if it is to capture equally important factors that bear on the transition in educational attainment.

a. Other determinants of schooling

In thinking about other determinants of schooling, the best approach is to return to the basic human capital model. The human capital model views schooling as a means by which individuals invest in themselves so as to maximize their lifetime wealth. Additional schooling generates economic gain by increasing earnings over the individual's workspan, but entails economic loss, as well. The costs include both the direct cost of schooling borne by the student and the opportunity cost associated with delayed entry to the workforce. The maximizing student will remain in school so long as the financial return to additional schooling exceeds the prevailing interest rate. Thus, the simplest human capital model posits that the demand for additional schooling is directly related to the earnings premium and inversely related to tuition and other direct costs, the wage available to those of school age, and the rate of interest.

How does this model of individual behavior relate to aggregate trends in educational attainment observed in developing countries? Basic to any argument of educational transition is the idea that technological innovation and industrialization involve production processes that are relatively intensive in human capital. As economic development proceeds, the returns to human capital exceed the returns to physical capital at prevailing levels of educational attainment. And because the financial return to schooling exceeds the prevailing rate of interest, more students are induced to remain in school.

Taken at face value, the human capital model is consistent with the degenerate polar case of the transition model (Case II) in which schooling is independent of the educational attainment of parents. Moreover, rather than remain fixed, the elements of the transition matrix change from year to year in response to factors isolated by the human capital model. Of course, if this interpretation is correct, the transition model has no value at all.

If the transition model does indeed capture important elements of the transition in education, how can it be broadened to incorporate the important features of the human capital model? In principle, such an undertaking seems simple enough. The transition matrix would no longer be fixed; rather, the transition probabilities would vary with *circumstances external to the household that bear on the returns* to education. Whether a model can be properly specified and estimated so that trends in education can be forecast is a question that will be answered in the future.

b. The education of parents

There are two ways in which the educational attainment of parents may affect the probability of going to school that should be distinguished. One could imagine a situation in which the number attending school is entirely independent of the educational attainment of parents, but the education of parents has considerable impact on whomever is receiving the additional schooling. Were this the case, the link between parent and child education would have important implications for the distribution of education and income and for intergenerational mobility, but would have no impact on average educational attainment. On the other hand, if the educational attainment of parents affects the individual demand for schooling, both the level of education and distributional concerns would be influenced.

What are the theoretical grounds that bear on this issue? The literature on schooling, extensions of the simple human capital model, have focused on two issues. The first is that all students are not equally well endowed with personal characteristics that affect the impact of schooling on future earning. If these characteristics are transmitted, in part, from parent to child, then the returns to schooling and the probability of attending school will be determined in part by the educational attainment of one's parents. Second, because capital markets are imperfect, interest rates will vary from individual to individual. Particularly, those from low income families may not be able to finance additional schooling. This is another vehicle by which the educational attainment of parents bears on the probability of continuing in school.[11/]

c. Fertility, schooling and the education of parents

The economic model of fertility provides an altogether different explanation about the link between educational attainment of parents and the schooling of children. The model emphasizes the tradeoff between child quality (schooling) and child quantity. As parents become wealthier, in part by virtue of their higher educational attainment, they substitute child quality for child quantity because the income elasticity of child quality is believed to be high. Furthermore, as the education of women increases, the opportunity cost of childrearing rises causing a decline in the number of children, a decline in the price of child quality, and an increase in child quality. In addition, school time is substitutible for mother's time, to some extent. Thus, as the opportunity cost of the time of women increases, they are encouraged to raise children in a more school intensive fashion.

The economic model of fertility is relevant to the dependence of transition probabilities on educational attainment of parents, but also to the way in which differential fertility should be treated. In particular, the model implies that transition probabilities depend on the education of the child, as well as the education of the parents.

Notes

1. See Mason, et al., "Population Growth and Economic Development: Lessons from Selected Asian Countries", <u>Policy Development Studies</u>, Number 10 (New York: UNFPA, 1986).

2. The mean, variance, and correlation coefficients are all based on the assignment of numerical values of 1, 2, and 3 to primary, secondary, and tertiary education, respectively. This is arbitrary but facilitates comparison across simulations. An alternative would be to assign weights on the basis of earnings differentials or average years of school attended.

3. The initial distribution is roughly the 1981 distribution for Thai males in their late twenties.

4. An NRR of 2 implies that each adult is replaced by two adults in a generation's time. An NRR of 2 is consistent with a population growth rate of somewhat more than 2.5 percent per year depending on the generation length.

5. This conclusion depends on the particular values in the transition matrix. Upward mobility cases with differential fertility may generate equilibrium attainment at below universal college education.

6. This translation of the policy assumes that, for any cohort, increasing the number in secondary school will have no impact on the number continuing on to college.

7. Material in this is drawn from an unpublished report Mathana Phananiramai and Andrew Mason, "Enrollment and Educational Cost in Thailand", <u>HOMES Research Report</u>, No.5 (December 1987).

8. In Thailand, however, women have unusually high participation so that the effect of gender should be less than in many other countries.

9. Adjusted means, used to determine the partial effect of a variable, are calculated values of the dependent variable with one independent variable set to selected values and all other independent variables set to their sample means.

10. This is not too surprising because only about 2 percent of the heads of family members in these age groups had a tertiary education.

11. If parents have less education then, other things being equal, children should find better employment to the extent that children and parents compete in the same labor force. However, this phenomenon cannot be readily captured through analysis of microdata.

A P P E N D I X

Scenario 1
Transition matrix: strong link

Initial Conditions

Transition Matrix

Education of child	Education of parent Primary	Secondary	Tertiary
Primary	0.7	0.2	0.1
Secondary	0.2	0.6	0.2
Tertiary	0.1	0.2	0.7
mean:	1.4	2	2.6
variance:	0.440	0.400	0.440
NRR	1	1	1
N	0.8	0.13	0.07

Simulation Results

Cohort	Education of parents Primary	Secondary	Tertiary	Attainment Mean	Variance	r
0	0.800	0.130	0.070	1.27	0.337	0.467
1	0.593	0.252	0.155	1.56	0.556	0.564
2	0.481	0.301	0.218	1.74	0.630	0.589
3	0.419	0.320	0.261	1.84	0.655	0.596
4	0.383	0.328	0.289	1.91	0.663	0.599
5	0.363	0.331	0.306	1.94	0.666	0.600
6	0.351	0.333	0.317	1.97	0.666	0.600
7	0.344	0.333	0.323	1.98	0.667	0.600
8	0.340	0.333	0.327	1.99	0.667	0.600
9	0.337	0.333	0.330	1.99	0.667	0.600
10	0.336	0.333	0.331	2.00	0.667	0.600

Scenario 2
Transition matrix: weak link

Initial Conditions

Transition Matrix

Education of child	Education of parent Primary	Secondary	Tertiary
Primary	0.2	0.1	0.05
Secondary	0.75	0.75	0.5
Tertiary	0.05	0.15	0.45
mean:	1.85	2.05	2.4
variance:	0.227	0.248	0.340
NRR	1	1	1
N	0.8	0.13	0.07

Simulation Results

Cohort	Education of parents Primary	Secondary	Tertiary	Attainment Mean	Variance	r
0	0.800	0.130	0.070	1.27	0.337	0.289
1	0.177	0.733	0.091	1.91	0.260	0.252
2	0.113	0.727	0.160	2.05	0.271	0.278
3	0.103	0.710	0.187	2.08	0.283	0.288
4	0.101	0.703	0.196	2.09	0.288	0.292
5	0.100	0.701	0.199	2.10	0.289	0.293
6	0.100	0.700	0.200	2.10	0.290	0.293
7	0.100	0.700	0.200	2.10	0.290	0.293
8	0.100	0.700	0.200	2.10	0.290	0.293
9	0.100	0.700	0.200	2.10	0.290	0.293
10	0.100	0.700	0.200	2.10	0.290	0.293

Scenario 3
Transition matrix: upward mobility

Initial Conditions

Transition Matrix

Education of child	Education of parent Primary	Secondary	Tertiary
Primary	0.5	0	0
Secondary	0.4	0.75	0
Tertiary	0.1	0.25	1
mean:	1.6	2.25	3
variance:	0.440	0.188	0.000
NRR	1	1	1
N	0.8	0.13	0.07

Simulation Results

	Education of parents			Attainment		
Cohort	Primary	Secondary	Tertiary	Mean	Variance	r
0	0.800	0.130	0.070	1.27	0.337	0.544
1	0.400	0.418	0.183	1.78	0.535	0.708
2	0.200	0.473	0.327	2.13	0.511	0.768
3	0.100	0.435	0.465	2.37	0.432	0.799
4	0.050	0.366	0.584	2.53	0.349	0.819
5	0.025	0.295	0.680	2.66	0.276	0.832
6	0.013	0.231	0.757	2.74	0.215	0.841
7	0.006	0.178	0.816	2.81	0.167	0.847
8	0.003	0.136	0.861	2.86	0.128	0.852
9	0.002	0.103	0.895	2.89	0.098	0.856
10	0.001	0.078	0.921	2.92	0.075	0.858

Scenario 4
Transition matrix: strong link
Differential fertility

Initial Conditions

Transition Matrix

Education of child	Education of parent Primary	Secondary	Tertiary
Primary	0.7	0.2	0.1
Secondary	0.2	0.6	0.2
Tertiary	0.1	0.2	0.7
mean:	1.4	2	2.6
variance:	0.440	0.400	0.440
NRR	2	1.4	1
N	0.8	0.13	0.07

Simulation Results

Cohort	Education of parents (Number) Primary	Secondary	Tertiary	Mean	Variance	r
0	0.800	0.130	0.070	1.27	0.337	0.467
1	1.163	0.443	0.245	1.50	0.515	0.549
2	1.777	0.887	0.529	1.61	0.569	0.569
3	2.789	1.562	0.974	1.66	0.590	0.576
4	4.440	2.622	1.677	1.68	0.600	0.579
5	7.118	4.314	2.796	1.70	0.605	0.581
6	11.452	7.030	4.589	1.70	0.607	0.581
7	18.461	11.404	7.471	1.71	0.608	0.582
8	29.785	18.458	12.115	1.71	0.608	0.582
9	48.079	29.841	19.606	1.71	0.609	0.582
10	77.626	48.219	31.695	1.71	0.609	0.582

Cohort	Education of parents (Proportion) Primary	Secondary	Tertiary
0	0.800	0.130	0.070
1	0.628	0.239	0.133
2	0.557	0.278	0.166
3	0.524	0.293	0.183
4	0.508	0.300	0.192
5	0.500	0.303	0.197
6	0.496	0.305	0.199
7	0.494	0.305	0.200
8	0.493	0.306	0.201
9	0.493	0.306	0.201
10	0.493	0.306	0.201

Scenario 5
Transition matrix: weak link
Differential fertility

Initial Conditions

Transition Matrix

Education of child	Education of parent: Primary	Secondary	Tertiary
Primary	0.2	0.1	0.05
Secondary	0.75	0.75	0.5
Tertiary	0.05	0.15	0.45
mean:	1.85	2.05	2.4
variance:	0.227	0.248	0.340
NRR	2	1.4	1
N	0.8	0.13	0.07

Simulation Results

Cohort	Education of parents (Number) Primary	Secondary	Tertiary	Mean	Variance	r
0	0.800	0.130	0.070	1.27	0.337	0.289
1	0.342	1.372	0.139	1.89	0.247	0.241
2	0.336	2.022	0.385	2.02	0.262	0.270
3	0.437	2.819	0.631	2.05	0.272	0.279
4	0.601	3.930	0.920	2.06	0.276	0.282
5	0.837	5.488	1.299	2.06	0.276	0.283
6	1.168	7.667	1.821	2.06	0.277	0.283
7	1.632	10.712	2.546	2.06	0.277	0.283
8	2.280	14.969	3.559	2.06	0.277	0.283
9	3.185	20.916	4.973	2.06	0.277	0.283
10	4.451	29.226	6.949	2.06	0.277	0.283

Cohort	Education of parents (Proportion) Primary	Secondary	Tertiary
0	0.800	0.130	0.070
1	0.185	0.741	0.075
2	0.122	0.737	0.140
3	0.112	0.725	0.162
4	0.110	0.721	0.169
5	0.110	0.720	0.170
6	0.110	0.720	0.171
7	0.110	0.719	0.171
8	0.110	0.719	0.171
9	0.110	0.719	0.171
10	0.110	0.719	0.171

Scenario 6
Transition matrix: upward mobility
Differential fertility

Initial Conditions

Transition Matrix

Education of child	Education of parent Primary	Secondary	Tertiary
Primary	0.5	0	0
Secondary	0.4	0.75	0
Tertiary	0.1	0.25	1
mean:	1.6	2.25	3
variance:	0.440	0.188	0.000
NRR	2	1.4	1
N	0.8	0.13	0.07

Simulation Results

Cohort	Education of parents (Number) Primary	Secondary	Tertiary	Mean	Variance	r
0	0.800	0.130	0.070	1.27	0.337	0.544
1	0.800	0.777	0.276	1.72	0.501	0.684
2	0.800	1.455	0.707	1.97	0.508	0.735
3	0.800	2.168	1.377	2.13	0.483	0.761
4	0.800	2.916	2.295	2.25	0.453	0.778
5	0.800	3.702	3.476	2.34	0.423	0.790
6	0.800	4.527	4.932	2.40	0.396	0.799
7	0.800	5.394	6.677	2.46	0.372	0.805
8	0.800	6.303	8.724	2.50	0.351	0.811
9	0.800	7.259	11.091	2.54	0.332	0.815
10	0.800	8.262	13.791	2.57	0.315	0.819

Cohort	Education of parents (Proportion) Primary	Secondary	Tertiary
0	0.800	0.130	0.070
1	0.432	0.419	0.149
2	0.270	0.491	0.239
3	0.184	0.499	0.317
4	0.133	0.485	0.382
5	0.100	0.464	0.436
6	0.078	0.441	0.481
7	0.062	0.419	0.519
8	0.051	0.398	0.551
9	0.042	0.379	0.579
10	0.035	0.362	0.603

Scenario 7
Transition matrix: strong link, compulsory secondary

Initial Conditions

Transition Matrix

Education of child	Education of parent Primary	Secondary	Tertiary
Primary	0	0	0
Secondary	0.9	0.8	0.3
Tertiary	0.1	0.2	0.7
mean:	2.1	2.2	2.7
variance:	0.090	0.160	0.210
NRR	1	1	1
N	0.8	0.13	0.07

Simulation Results

Cohort	Education of parents (Number) Primary	Secondary	Tertiary	Mean	Variance	r
0	0.800	0.130	0.070	1.27	0.337	0.391
1	0.000	0.845	0.155	2.16	0.131	0.404
2	0.000	0.723	0.278	2.28	0.200	0.473
3	0.000	0.661	0.339	2.34	0.224	0.490
4	0.000	0.631	0.369	2.37	0.233	0.496
5	0.000	0.615	0.385	2.38	0.237	0.498
6	0.000	0.608	0.392	2.39	0.238	0.499
7	0.000	0.604	0.396	2.40	0.239	0.500
8	0.000	0.602	0.398	2.40	0.240	0.500
9	0.000	0.601	0.399	2.40	0.240	0.500
10	0.000	0.600	0.400	2.40	0.240	0.500

Scenario 8
Transition matrix: weak link, compulsory secondary

Initial Conditions

Transition Matrix

Education of child	Education of parent		
	Primary	Secondary	Tertiary
Primary	0	0	0
Secondary	0.95	0.85	0.55
Tertiary	0.05	0.15	0.45
mean:	2.05	2.15	2.45
variance:	0.048	0.128	0.247
NRR	1	1	1
N	0.8	0.13	0.07

Simulation Results

	Educatiion of parents			Attainment		
Cohort	Primary	Secondary	Tertiary	Mean	Variance	r
0	0.800	0.130	0.070	1.27	0.337	0.347
1	0.000	0.909	0.091	2.09	0.083	0.226
2	0.000	0.823	0.177	2.18	0.146	0.285
3	0.000	0.797	0.203	2.20	0.162	0.296
4	0.000	0.789	0.211	2.21	0.166	0.299
5	0.000	0.787	0.213	2.21	0.168	0.300
6	0.000	0.786	0.214	2.21	0.168	0.300
7	0.000	0.786	0.214	2.21	0.168	0.300
8	0.000	0.786	0.214	2.21	0.168	0.300
9	0.000	0.786	0.214	2.21	0.168	0.300
10	0.000	0.786	0.214	2.21	0.168	0.300

Scenario 9
Transition matrix: upward mobility, compulsory secondary

Initial Conditions

Transition Matrix

Education of child	Education of parent Primary	Secondary	Tertiary
Primary	0	0	0
Secondary	0.9	0.75	0
Tertiary	0.1	0.25	1
mean:	2.1	2.25	3
variance:	0.090	0.188	0.000
NRR	1	1	1
N	0.8	0.13	0.07

Simulation Results

Cohort	Education of parents Primary	Secondary	Tertiary	Attainment Mean	Variance	r
0	0.800	0.130	0.070	1.27	0.337	0.550
1	0.000	0.818	0.183	2.18	0.149	0.595
2	0.000	0.613	0.387	2.39	0.237	0.733
3	0.000	0.460	0.540	2.54	0.248	0.786
4	0.000	0.345	0.655	2.66	0.226	0.814
5	0.000	0.259	0.741	2.74	0.192	0.831
6	0.000	0.194	0.806	2.81	0.156	0.841
7	0.000	0.145	0.855	2.85	0.124	0.848
8	0.000	0.109	0.891	2.89	0.097	0.853
9	0.000	0.082	0.918	2.92	0.075	0.857
10	0.000	0.061	0.939	2.94	0.058	0.859

Scenario 10
Thailand, Logit estimates

Initial Conditions

Transition Matrix

Education of child	Education of parent Primary	Secondary	Tertiary
Primary	0.774	0.617	0.617
Secondary	0.193	0.322	0.272
Tertiary	0.033	0.061	0.111
mean:	1.259	1.444	1.494
variance:	0.258	0.369	0.472
NRR	1	1	1
N	0.8	0.13	0.07

Simulation Results

Cohort	Education of parents Primary	Secondary	Tertiary	Attainment Mean	Variance	r
0	0.800	0.130	0.070	1.27	0.337	0.146
1	0.743	0.215	0.042	1.30	0.294	0.151
2	0.734	0.224	0.042	1.31	0.298	0.152
3	0.732	0.225	0.043	1.31	0.299	0.153
4	0.732	0.225	0.043	1.31	0.299	0.153
5	0.732	0.225	0.043	1.31	0.299	0.153
6	0.732	0.225	0.043	1.31	0.299	0.153
7	0.732	0.225	0.043	1.31	0.299	0.153
8	0.732	0.225	0.043	1.31	0.299	0.153
9	0.732	0.225	0.043	1.31	0.299	0.153
10	0.732	0.225	0.043	1.31	0.299	0.153

Scenario 11
Thailand, Crosstab estimates

Initial Conditions

Transition Matrix

Education of child	Education of parent Primary	Secondary	Tertiary
Primary	0.657	0.247	0.244
Secondary	0.194	0.401	0.255
Tertiary	0.149	0.352	0.501
mean:	1.492	2.105	2.257
variance:	0.548	0.588	0.679
NRR	1	1	1
N	0.8	0.13	0.07

Simulation Results

Cohort	Education of parents (Number) Primary	Secondary	Tertiary	Mean	Variance	r
0	0.800	0.130	0.070	1.27	0.337	0.326
1	0.575	0.225	0.200	1.63	0.634	0.393
2	0.482	0.253	0.265	1.78	0.700	0.396
3	0.444	0.263	0.294	1.85	0.715	0.394
4	0.428	0.266	0.306	1.88	0.719	0.393
5	0.422	0.268	0.311	1.89	0.720	0.392
6	0.419	0.268	0.313	1.89	0.720	0.392
7	0.418	0.269	0.314	1.90	0.720	0.392
8	0.417	0.269	0.314	1.90	0.721	0.391
9	0.417	0.269	0.314	1.90	0.721	0.391
10	0.417	0.269	0.314	1.90	0.721	0.391

Cohort	Education of parents (Proportion) Primary	Secondary	Tertiary
0	0.800	0.130	0.070
1	0.575	0.225	0.200
2	0.482	0.253	0.265
3	0.444	0.263	0.294
4	0.428	0.266	0.306
5	0.422	0.268	0.311
6	0.419	0.268	0.313
7	0.418	0.269	0.314
8	0.417	0.269	0.314
9	0.417	0.269	0.314
10	0.417	0.269	0.314