DISTRIBUTION FLOW OF EDUCATION IN THAILAND

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with Technical Note
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1. Introduction

Income inequality has been a serious problem in a large number of developing countries including ASEAN members except Singapore. A high degree of inequality between .45 and .50 Gini has persisted in the Philippines, Thailand and Malaysia during a fairly high growth period of the past three decades. Recent attempts to solve the problem mainly through Malaysia's Bumiputra policy and the Philippine's land reform program have not made a perceptive impact so far. It might be argued that without applying drastic and consistent measures the inequality could be expected to remain serious. There are structural givens in underdeveloped economies which tend to perpetuate inequality and the poverty of those in the lower income brackets. The higher the degree of inequality in a low-income country, meaning the poorer are its poor, the more difficult it is to break the problem. The relative and absolute poverty of the lower income groups separates and locks them within their environment. Such environment tends to be socially (and economically) restrictive on individual choices so that opportunities for upward mobility are limited.

This paper is an attempt to describe the process of intergenerational transfer of education capital under specified market condi-

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tions affecting choice in a not atypical LDC country – Thailand. A constrained optimization model in education choice is used as the framework of analysis. The model explains how inequality in income and in education interacts intergenerationally and traces the change (or lack of it) in equality and poverty over time. The model is presented in Section 3 after a discussion of the state of inequality and poverty and their trend in Section 2.

2. Descriptive Analysis of the Distribution of Education

Equity in the distribution of education means equality in educational opportunity. This has been defined in varying degrees of strictness. It means each child of given ability and aptitude has an equal chance to pursue the education and training that suit him best. In strict terms, the reference would be inherent ability and aptitude. There is an assumption that the distribution of inherent or inborn traits among the population is not affected by race, socio-economic, location and other environmental variables. Each child in the population has an equal chance to be born with a particular level of these inherent traits. Education of all forms – formal and non-formal – builds on these traits so that at later stages of life, it is not possible to distinguish inherent from acquired abilities. In fact, performance in IQ tests is found not to be constant over time but improves with acquired knowledge. In the looser sense, equality in educational opportunity is measured in terms of measured ability which has already been affected by environment, socio-economic background and quality of formal schooling. In the absence of information on the distribution of inherent traits in the population, equity in educational opportunities can be judged on the basis only of an *a priori* notion of equality in these traits. The judgment therefore, of degree of equality or inequality of educational opportunity in Thailand is based on this *a priori* distribution. The writers wish to believe that the distribution is equal, i.e., that each child of whatever background has the same probability distribution of possessing inherent traits as the probability distribution of the population to which he belongs. It means that he has a ten percent probability of being of superior scientific talent if the population has the same probability of producing this much scientific talent.

Two sets of data are used to indicate the degree of inequality in the distribution of education in Thailand: a) attendance in school and the highest level of formal schooling attained by those who left the formal school system; b) performance in achievement tests administered to grade III and senior high school pupils. The population was grouped according to variables that are most likely to affect the distribution of opportunity: family income, father's education, location – by region, whether rural (non-municipal) or urban (municipality, metropolis).

a. School Attendance

First some broad indicators of movement of distribution over time are discussed. Table 1 shows that the average level of school attainment has been rising from 1960 to 1975. This results from an increasing rate of attendance at each age group.

Finer indicators of inequality are obtained from several sources: the 1975 survey of youth, the 1973 national achievement test of grade III pupils and the study by Nitongkorn and Vutisart of the achievements of senior high school students who were admitted to college in 1977.

School attendance was very much influenced by location and socio-economic variables as shown by the following cross-tabulations. In Table 2 attendance rate by location for each age range is given. As expected, children in the Bangkok Metropolis had the highest rate at each age range or at its corresponding schooling stage – lower

Table 1 – Attendance Rate by Age Range
1960, 1975

Age Range	1960	Age Range at Any Program	1975
4–6		4–6	6.3
7–10 in grades 1–4	119.3	7–9	71.4
11–13 in grades 5–7	19.8	10–14	72.4
14–18 in high school and lower vocational schools	17.9	15–19	24.3
20–22 in college and technical schools	2.9	20–24	5.1

Source. National Statistical Office *1975 Survey of Youth; Report of the UNESCO Regional Advisory Team for Educational Planning in Asia Bangkok, 1965.*

elementary, upper elementary, high school and post-high school. Attendance rates dropped between upper elementary to high school from 72 percent to 24 percent for all children, 90 percent to 60 percent for municipal children, and 70 percent to 18 percent for non-municipal children. For the last two stages, i.e., high school and post-high school, the corresponding decline was 24 percent. North-east, the poorest region, showed the lowest attendance rate at all levels and for both municipal and non-municipal areas. Only 1.2 per-cent of its 20-24 year old youths attended school, as compared with 22 percent for Bangkok.

Those who stopped schooling are not likely to go back to school so that their highest attainment as per survey time might be taken to be their lifetime attainment. Some of these have completed their

Table 2 – Rate of School Attendance of Children and Youth by Age, by Region, by Municipal/Village, 1975

	Total	4–6	7–9	10–14	15–19	20–24
Kingdom	38.9	6.3	11.4	72.4	24.3	5.1
1) Municipal	58.6	27.4	85.2	89.7	59.3	19.8
2) Non-Municipal	35.7	3.7	69.6	69.7	17.7	2.1
Bangkok	56.8	21.2	83.1	89.8	57.6	21.7
1) Municipal	59.2	25.6	85.0	91.0	61.0	24.0
2) Non-Municipal	46.2	6.1	76.0	84.2	40.5	9.7
Central	42.2	9.8	74.2	76.3	53.3	4.8
1) Municipal	57.1	29.6	84.2	88.2	53.3	11.9
2) Non-Municipal	40.6	8.1	73.2	75.1	23.3	3.9
Northern	39.5	6.9	77.5	71.4	19.2	3.0
1) Municipal	62.6	43.8	89.5	88.2	60.1	15.5
2) Non-Municipal	38.0	5.1	76.9	70.4	16.3	2.0
Northeast	29.9	1.1	63.2	61.6	12.3	1.2
1) Municipal	53.5	8.9	82.4	86.0	55.7	14.1
2) Non-Municipal	30.0	.5	62.5	60.7	10.3	.5
Southern	44.3	6.1	72.2	85.1	33.6	3.8
1) Municipal	58.8	27.6	86.4	89.0	59.4	11.7
2) Non-Municipal	42.5	3.9	70.6	84.6	30.1	2.8

Source: National Statistical Office (NSO), *The Children and Youth Survey*, 1975. Table C_1.

programs such as academic, teacher training and vocational. The highest attainment of the current cohort over their life can therefore be estimated from their attendance rate. This estimate is given directly by the survey (please see Table 3).

It is seen that majority of school leavers, even in the older ages of 20 to 24, completed lower elementary levels only while many very young out-of-school youths aged 7-9 have never attended school. This number amounted to 22 percent of the total population of this age range in 1975.

Family background is another important determinant of school attendance. Tables 4 and 4a show attendance rate by age and by family income which were obtained from the raw data of the National Statistical Office (NSO). The effect of income is strongest in the three lowest income brackets to which 64 percent of Thai youths belonged. The difference in attendance rate increases as age or schooling level rises. The lowest income group, for instance, to which 25 percent of youth population belonged, had attendance rates of 67 percent, 62 percent, 24 percent and 10 percent for ages 6-10, 11-14, 15-19, and 20-24. At the highest income bracket the corresponding rates were 91 percent, 93 percent, 77 percent, and 38 percent. It must be noted that the attendance rate reported by the NSO is lower than in the cross-tabulation since the data consisted of unmarried children of the head of households only. The difference in attendance rate between the two reports reflects the effect of relationship and civil status on school attendance. This effect is shown more precisely in the empirical test of the model. Cross-tabulations with other socio-economic variables are not given here since they should have the same pattern as that of income.

b. Distribution of Learning at Grade III and High School V.

The quality of education offered each child differs so that amount learned also differs. It also depends on his total environment. The educational content of environment varies substantially according to location and socio-economic background. Schools differ in quality of instruction and available instructional materials. Family income exerts a further effect on learning by determining the physical and mental health of the child. It is not uncommon in poor situations in LDCs that children have not enough to eat. Hunger must have a direct or immediate impact on the rate of learning in school. Persistent malnutrition would have longer and more pro-

Table 3 – Percentage Distribution of Youth Not Attending School by Age, Highest Level Attained, Municipal/Non-Municipal

	Zero Level	Lower Education	Upper Elementary	Lower Secondary	Upper Secondary	Teacher Training	Academic	Other Post Secondary
Age Range								
Total Kingdom								
7– 9	99.2	.8	–	–	–	–	–	–
10–14	.5	98.4	1.1	–	–	–	–	–
15–19	.2	90.7	5.8	2.6	.1	.3		
20–24	.3	83.8	5.3	5.0	.8	2.4	.3	1.8
Municipal								
7– 9	100.0	–	–	–	–	–	–	–
10–14	2.1	93.6	4.3	–	–	–	–	–
15–19	.2	66.5	19.5	11.3	1.1	.6	–	–
20–24	.9	48.7	15.2	16.3	3.2	3.5	2.1	10.0
Non-municipal								
7– 9	99.2	.8	–	–	–	–	–	–
10–14	.2	98.6	1.0	–	–	–	–	–
15–19	.2	93.0	4.6	1.9	–	.3	–	–
20–24	.3	89.7	3.7	3.1	.4	2.3	–	.5
Total Youth		16,656,570						
7– 9		3,645,810						
% na[a]		28.6						
10–14		5,408,880						
% na		24.9						
15–19		4,412,360						
% na		73.1						
20–24		3,189,520						
% na		91.1						
% in municipal		14.5						

[a] not attending

Source: [illegible]

Table 4 – Attendance Rate by Age, by Family Income, 1975

Family Income (in Baht)	Total	6-10	11-14	15-19	20-24
0– 9,999	43.8	67.1	62.0	24.1	10.1
10,000–14,999	57.2	72.6	75.7	41.8	14.2
15,000–19,999	62.2	77.8	70.2	57.1	20.5
20,000–29,999	65.0	82.4	88.1	59.7	22.6
30,000–39,999	65.4	84.1	90.6	62.2	22.9
40,000–49,999	66.7	88.4	90.8	67.9	24.2
50,000–59,999	64.5	85.8	89.2	63.5	26.6
60,000–69,999	64.8	89.5	88.6	64.2	29.1
70,000 and above	69.2	91.2	92.8	76.7	37.5
Weighted Average	57.9	75.4	75.6	49.3	20.6

Source: Cross-tabulations of raw data of the *NSO 1975 Survey of Youth.*

Table 4a. – Percentage Distribution of Population by Age

Family Income	Total	6-10	11-14	15-19	20-24
0– 9,999	24.77	30.52	24.95	22.18	18.41
10,000–14,999	22.63	25.30	22.89	22.18	18.15
15,000–19,999	17.12	16.69	20.39	16.42	14.30
20,000–29,999	12.85	10.60	12.22	14.56	14.93
30,000–39,999	6.64	5.38	5.95	7.37	8.69
40,000–49,999	4.31	3.24	3.76	4.70	6.38
50,000–59,999	3.24	2.30	2.82	3.57	5.11
60,000–69,999	2.43	1.70	1.98	2.66	4.04
70,000 and above	6.01	4.26	5.02	6.36	9.99
Weighted Average	100.00	100.00	100.00	100.00	100.00

Source: Cross-tabulations of raw data of the NSO *1975 Survey of Youth.*

found effects on the whole process of education, including its effect on the development of brain cells during infancy. This variation in learning environment is reflected in an unequal distribution of measured scholastic achievement among population groups. The paper by Nitongkorn and Vutisart shows this very clearly. Some descriptive statistics used in their analysis are presented. Their cross-tabulations of mean scores by type of institution – whether private, supported by the Ministry of Education, by municipal or by provincial (changwat) government;[1] father's occupation and location are reproduced here.

The distribution of achievement in the tests follows the same pattern as school attendance. Apparently, children in an urban environment whose fathers work as government officials and as professionals learned more (of what the tests measured) than children of farmers. The latter scored about 60 percent of the mean score of urban elite children. There is also substantial differences in scores between changwat and Ministry of Education (MOE) schools, with mean of 51 percent and 83 percent, respectively (please see Tables 5 and 5a).

The distribution of MS5 scores is likely to be subject to selection bias. A much smaller proportion of youth in rural areas and from poorer socio-economic background reached Maw Saw 5. The few to reach this level probably possessed a different set of traits from the typical student for them to be able to survive the disadvantages of their environment. Thus, it is found that variation in mean score by region, father's occupation or by mother's education does not follow the same pattern as for grade III. Farmers' children did as well as professional children. Furthermore, there was not as much regional variation and Bangkok youth did only as well as other students. The southern region did best.

Location is found to be a very strong explanatory variable of school attendance especially at higher levels. This is mainly due to the greater distance to schools of rural populations especially those in the Northeast. Two supplementary tables are presented to show the effect of distance on schooling. Table 6 gives the distribution of students by distance to school. It is shown that 63 percent of students were located within 3 kilometers of their schools. Only 16 percent of students were farther than six kilometers.

1. Changwat schools are provincial government schools while Ministry of Education schools are national government schools.

Table 5 – Distribution of Students by High School Test Scores, by Region and Father's Occupation, 1975

Occupation	Lower than 2.5	(1) 2.50-2.99	(2) 3.0-4.0	(1) + (2)
Professional	43.1	37.1	19.8	56.9
Administrative	37.1	44.0	18.9	62.9
Clerical	42.1	38.6	19.3	57.9
Sales	37.6	38.5	23.9	62.4
Farmers	46.9	35.0	18.1	53.1
Transportation	39.5	41.9	18.6	60.5
Craftsmen	41.7	43.7	14.6	58.3
Services	25.0	37.5	37.5	75.0
Laborers	49.0	31.9	19.1	51.0
Unclassified	46.2	39.1	14.7	53.8
Region				
Bangkok	42.1	38.1	19.8	57.9
Central	41.7	36.9	21.4	58.3
North	29.6	43.0	27.4	70.4
Northeast	42.2	37.8	20.0	57.8
South	47.3	42.7	10.0	52.7
East	34.4	34.4	31.2	65.6

Source: Nitongkorn and Vutisart's Chapter, Tables 15 and 17, pp. 48-49, 52.

Table 7 gives a breakdown of total cost of schooling at various levels including transport and additional living expenses for students from municipal and non-municipal locations. Total cost is, as expected, higher, the higher the educational level. Cost of transport and food taken out of the home formed a very large proportion of the total at every level (56 to 78 percent). Total cost was higher for non-municipal students.

The effect of financial constraint as determined by income and cost of schooling is shown in Tables 4 and 7. Eighty-three percent of

Table 5.a – Mean Test Scores of Grade III Pupils by Type of School, Region, Father's Occupation and Urbanization of Location, 1973

	Scores	Standard Deviation
Average for All	61.1	24.2
A. Type of School		
Private	78.2	20.9
Min. of Education	83.0	18.5
Principal	67.5	20.1
Changwat	50.6	20.8
B. Region		
Bangkok	77.3	23.1
Central	57.6	21.1
North	49.2	20.5
C. Father's Occupation		
Agriculture	49.7	20.0
Services	69.4	24.8
Merchant	73.7	22.5
Industrial Work	65.7	19.5
Government Officer	75.5	21.8
Professional	80.3	25.3
Others and no response	62.4	21.0
D Urbanization		
City Municipality	80.8	21.0
Town Municipality	70.8	20.2
Village	53.2	21.0

Source: Nitongkorn and Vutisart, Tables 1-4, pp. 30-33.

Table 6 – Percentage Distribution of Children and Youth Attending School by Type of School and Distance to School, 1975

pe of School	Total of Both Sexes	Less than 3 km.	3-6 km.	More than 6-10 km.	More than 10 km.	Unknown
blic School	52.00	33.58	9.39	4.27	4.43	[illegible]
ivate School	48.00	29.81	11.30	4.02	2.46	[illegible]
Total:	100.00	63.39	20.69	8.29	6.89	[illegible]

urce: NSO, *The Children and Youth Survey*, Table 7A.

and Type of Expenditure

	LEVEL OF EDUCATION ATTENDED										
	Elementary & Kindergarten or Equiv.			Secondary or Equivalent			University				
	Kindergarten	Lower Elementary	Upper Elementary	Lower Secondary	Upper Secondary	Upper Higher Vocational	Academic	Technical Vocational	Teacher Training	Short Course Vocational	Unknown
MUNICIPAL											
Public School											
1. Transportation	558	456	494	577	714	841	1,094	909	1,015	2,519	–
2. Food taken outside home	1,317	897	1,238	1,809	2,463	2,698	4,118	3,315	2,573	2,262	–
3. Book, Materials and equipment	79	114	174	240	341	407	572	640	432	200	–
4. School Fees	191	108	107	206	285	494	1,442	971	1,063	358	–
5. Uniform	163	169	220	278	314	371	441	398	394	350	–
6. Other	137	39	64	105	117	291	407	656	224	200	–
7. Total	2,445	1,783	2,297	3,215	4,234	5,102	8,074	6,889	5,701	5,889	–
Private School											
1. Transportation	774	689	606	660	764	888	858	1,086	–	–	–
2. Food taken outside home	1,434	1,345	1,618	2,044	2,812	3,103	3,608	4,304	–	1,560	431
3. Book, Materials and equipment	109	153	210	264	380	446	541	717	–	1,000	35
4. School Fees	745	702	761	857	1,274	2,710	2,865	4,427	–	2,182	128
5. Uniform	183	204	247	288	318	384	382	466	–	400	–
6. Other	73	57	74	99	124	217	377	821	–	–	–
7. Total	3,318	3,150	3,516	4,212	5,672	7,748	8,631	11,821	–	5,142	–

Source: NSO, *The Children and Youth Survey*, 1975, Tables 9A and 9B.

Table 7 (Continued)

	LEVEL OF EDUCATION ATTENDED										
	Elementary & Kindergarten or Equiv.			Secondary or Equivalent			University				
	Kindergarten	Lower Elementary	Upper Elementary	Lower Secondary	Upper Secondary	Upper Higher Vocational	Academic	Technical Vocational	Teacher Training	Short Course Vocational	Unknown
NON-MUNICIPAL											
Public School											
1. Transportation	300	418	526	824	1,481	1,930	1,071	2,236	1,323	600	–
2. Food taken outside home	514	386	649	1,255	2,545	2,584	3,932	2,907	3,220	1,320	–
3. Book, Materials and equipment	33	64	145	250	370	376	1,076	842	687	20	–
4. School Fees	106	61	63	187	205	309	761	1,070	1,246	149	–
5. Uniform	109	110	199	296	399	409	622	582	540	200	–
6. Other	–	36	57	113	147	254	1,392	300	361	500	–
7. Total	1,062	1,075	1,639	2,925	5,147	5,862	8,854	7,937	7,377	2,789	–
Private School											
1. Transportation	661	601	547	651	896	1,020	970	–	–	792	–
2. Food taken outside home	782	730	890	1,123	1,689	1,751	2,629	–	–	1,800	132
3. Book, Materials and equipment	54	106	184	252	305	385	276	–	–	–	50
4. School Fees	426	378	421	468	806	2,638	3,504	–	–	2,500	–
5. Uniform	146	176	233	301	289	328	347	–	–	–	100
6. Other	137	42	68	99	95	262	250	–	–	1,500	–
7. Total	2,206	2,033	2,343	2,894	4,080	6,384	7,976			6,592	–

Source: NSO, *The Children and Youth Survey*, [illegible], Tables [illegible] the sample cited financial reasons for their non-attendance in school. The percentage was higher the higher the schooling level.

The data provide some salient information on the degree of inequality of educational opportunity. It appears that financial constraints explain most of the inequality and how it gets worse, the higher the education level.

3. Constrained Optimization in Education Choice

The model used here was first developed by Tan and Danao in 1976 for the PREPF[2] project. Education is treated as a human capital and conventional investment decision criterion is applied to the choice of pursuing alternative types of education including zero education. Two major constraints are built into the model – financial and informational.

Following Hicks (1973), a choice among relevant alternative capital processes is considered rather than of alternative capital stocks, or capital expenditures. A capital process is a flow of inputs and outputs over a time period. Each process is evaluated by taking its capitalized value, i.e., discounting all input and output flows. No distinction is made between capital and current expenditures. What matters in the valuation of capital is the timing of expenditure and output. A given plant and equipment may be built with different time paths and once built, the flow of inputs and output can still vary. The same physical plant and equipment may involve different capital processes. Using the concept of capital process frees capital choices from the more limited choices of capital goods.

Assuming a number of processes, each process j has a net worth computed from its flow of inputs, C_{jt} and outputs, R_{jt} over T periods:

$$(1)\ NW_j = \sum_{t=0}^{T-1} \frac{R_{jt} - C_{jt}}{(1+r)^t} - \sum_{t=0}^{T-1} \frac{R_{it} - C_{it}}{(1+r)^t},\ j = 1, 2, \ldots, n$$

where r, the rate of interest, is assumed constant over time t = 0, 1, 2, ..., $T - 1$, and i represents other education alternatives. At some rate of interest and other cost, a ranking of the process 1 to n is obtained. The ranking order may change with changes in the cost

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of capital or discount rate so that a process with large capital expenditures and early pay-off or early flow of receipts would become more profitable than one with a longer spread of capital inputs and later output flow at high rates of interest. Once the NW_j's are estimated, choice is easily made with the objective of maximizing NW_j. Constraints on choice may be imposed such as capital rationing and mutually exclusive processes. Net worth from relevant alternatives is to be maximized subject to whatever constraints apply.

Capital choice theory may be applied to education only at great simplification of education options. Education is not clearly observable. It can be defined more meaningfully in a philosophical sense than as an observable capital variable. As a capital good counted at a point in time, education is a whole range of knowledge acquired by an individual consisting of all scientific, linguistic and artistic information absorbed; the discipline to reason, analyze information, and make correct judgment; and the ability to search for new information and create new knowledge. Special skills used in the production of goods and services such as engineering, bookkeeping and surgery have also been included in the definition of education. This multi-faceted nature of education as capital makes it difficult to categorize and to measure. For this reason, very rough categorization has been used in planning and empirical works.

The usual classification used is by type of schooling such as the various grade levels, the various fields of specialization in college, and formal or non-formal education, the latter including skills training and informal campaigns. These, it is to be noted, are extremely rough categorizations since they do not distinguish between levels of actual knowledge.

Most of the schooling types of capital are additions to basic, i.e., primary education, capital. Consider the case of medical education. An investor in this capital would have to acquire elementary, high school and a few years of general education in college before being able to enroll in medicine itself. The capital is acquired in a certain sequence. In fact, each type of schooling capital could be considered as the sum of a sequence of schooling, or sequences of investment, i.e., completion of grade 1, grade 2, . . . , pth year medical college so that medical schooling capital, K^p_{mp}, valued at time p can be written as

$$(2) \quad K^p_{mp} = \sum_{t=1}^{p-1} (1+r)^{p-t} + I_p$$

since in general

$$(2') \qquad K_t = K_{t-1} + I_t$$

Any change in desired level of schooling capital would be made through a similar sequence of investment. The observable flow of investment is the expenditure in each grade leading to the desired schooling. If the desired number of medical degrees increases at time t everything else constant, investment or enrollment in preparatory schooling for medicine will also increase. Necessarily, there will be a lagged relation between changes in desired schooling capital and its acquisition, the lag depending on the length of the program.

Another important feature of formal schooling is that the curricula for elementary up to sophomore college are usually for general education. Specialization takes place beyond sophomore in college and in subprofessional vocational-technical training. Intensity of specialization in a field increases as one moves from first to second and to third degree programs. The heavy content of general education up to first degree programs permits much flexibility in manpower's adjustment to changes in skill requirements in the labor market. One can easily move up the sequence of formal schooling or change fields of specialization while still in school or after joining the labor force. All these changes can be accomplished in a fairly short time. A shift of specialization in college will take less than four years and may be completed in just one year for related fields. A shift in graduate degree fields may take as much as the full length of a graduate program. Pursuit of medical or a Ph.D. degree takes about four additional years from a first degree. Nevertheless these are short gestation periods relative to worklife, or the lifetime.

Men are born with differing innate characteristics. There is unequal distribution of mathematical, artistic, linguistic, and even physical abilities. The varying historical and cultural backgrounds of families develop dissimilar values and attitudes. There is a distribution of these characteristics among the population of a nation though there may be common relative strength in any one or in a few characteristics *viz.* other nationalities. The cost to an individual, psychic as well as monetary, of acquiring a certain category of education, depends on his innate characteristics given school-related cost. Call this personal cost. Personal cost varies depending on the degree of matching of innate characteristics and those suited or required by the education category pursued. A mismatch will require of the student longer and more intensive input in his studies to overcome his poor ability in the subject. It might also mean psychic cost in the form of smaller satisfaction from the education pursued. The personal cost of pursuing a Ph.D. degree in Physics may be prohibitive for someone who has very poor innate ability in this field and who enjoys and is inclined to music or the stage instead.

Because of differences in innate abilities, attitudes and values, an individual will not be indifferent to education options that give equal monetary returns or an increase in relative monetary returns to an option would not attract everybody to undertake that education process. Instead, an upward sloping enrollment of students in a given option is expected. Monetary return has to compensate for the personal cost of undertaking an education process in which students have weak abilities and inappropriate attitude. At some point, the supply may turn vertical as personal cost becomes prohibitive because of utter lack of talent and dislike for the education of the marginal population. For this reason the supply elasticity is expected to decrease with intensity of specialization and for fields that require special abilities like the arts. There are many areas of education where supply is fairly elastic. Everyone qualifies for the lowest education levels. In fact, many countries have compulsory elementary or even high school enrollment for children of the corresponding schooling ages starting from age six or seven years old. Most first degree college programs containing many courses of general interest should also have fairly elastic supply. First degree graduates of teacher education, business, psychology, liberal arts and even engineering have been more prone to shifting occupations from those which correspond to their majors.

The monetary cost of providing education varies by level and by field of specialization. In general, cost increases with level. Higher levels seem to have larger scale economies. These have led to the establishment of relatively large colleges and universities and their location in population centers. Some fields require more capital stock per pupil. Quality of instruction also depends on level of expenditures for teachers, laboratory and library.

The monetary cost to the student includes cost of instruction charged to him, foregone income and marginal living expenses including transportation in going to school. Geographic access to schools differs among students. There is a concentration of colleges and universities in large cities while primary schools are provided in all towns and large villages. High schools are not yet universally accessible though many larger towns have them. The degree of dispersal of schools determines the distribution of distance among population groups. In most cases, provincial students must bear a higher schooling cost than city students because of distance of their homes to schools. For this reason, cost of distance tends to be higher the higher the level of schooling.

The distribution of schools among geographic areas and the distribution of ability and aptitudes are basic factors determining the supply function of students in each educational program. The more specialized it is, the steeper the supply curve. The derivation of the supply curve is discussed below using the above constrained optimization model. Psychic and distance costs have to be included in the cost parameter used in the optimization problem.

4. Constrained Optimization Model and the Supply of Graduates

In the model, families are assumed to be maximizing the networth of their children's education subject to two constraints, cost and ability (networth is used equivalently with returns to education).

$$(3)\ Max\ NW_j^i = \sum_{t=1}^{j} \frac{R_t^{ij} - C_t^{ij}}{(1+r)^t} - \sum_{t=1}^{e} \frac{R_t^{ie} - C_t^{ie}}{(1+r)^t}$$

subject to

$$C_t^{ij} \leqslant B_t^i,\ C_t^{ie} \leqslant B_t^i$$

for each year of schooling t = 1, 2, . . . j corresponding to age 7, 8 . . . j + 6. For those desiring college

$$A^i \geqslant \bar{A}^j,\ A^i \geqslant \bar{A}^e$$

where R is expected benefit, C is total cost for each year, t in pursuit of education e, j, of child i. The budget B_t for each child of corresponding age a is a function of family income, Y_f.

$$(4)\qquad B_t^i \equiv B_a^i = b_a\,(Y_f^i)$$

A is the minimum ability required for education e, j. Ability A is found to be strongly influenced by family income also. These constraints determine the set of alternatives which are relevant to children of given backgrounds and abilities.

Given a population of children of a certain age range with its distribution by family income, distance to school facilities and abilities, the children may be arrayed by their schooling cost and this distribution can be mapped to the budgets for schooling. Children of age a can go to school so long as $C_a \leqslant B_a$. From this mapping, the children who can and those who cannot pursue each education alternative corresponding to their age a can be identified. The whole set of alternatives over all schooling ages of a child may also be obtained for given values of expected family income. One can find that a given distribution of sets of alternatives. The richer and brighter a child is, the larger the set facing him. The poor bright child in a distant location may face a set that is not significantly larger than that of his dull counterpart. On the other hand, the superior quality of school and home environment in which rich children are brought up can so offset inferior inherent ability as to break the ability constraint for their higher education.

Market adjustment to relative rates of return to education will be made within the defined sets of relevant alternatives. A decreasing proportion of the population is expected to respond to programs with positive net returns. For this reason, disequilibrium in rates of return between costly and inexpensive programs may be expected to persist or to be stable. In fact, this stable disequilibrium situation is frequently observed in many LDCs including Thailand and the Philippines.

In Figure 1, the following supply curves of graduates of different programs A, B, C, which have increasing ability requirements are given. Gross return of A is in relation to B, that of B in relation to C. More specifically, R_t is expected monetary benefits and C_t is cost in tuition, books and supplies at time t, excluding personal cost.

The potential supply curve of graduates in each program is illustrated below with gross return GR and number of graduates on the axes. It is assumed that everbody is qualified to pursue the lowest or basic educational level A. The supply of A is drawn as a horizontal supply from gross return GR_A that is just equal to the total cost of schooling. The supply of education B which requires more ability and involves higher monetary cost is given by $GR_{BO}BS_B$.

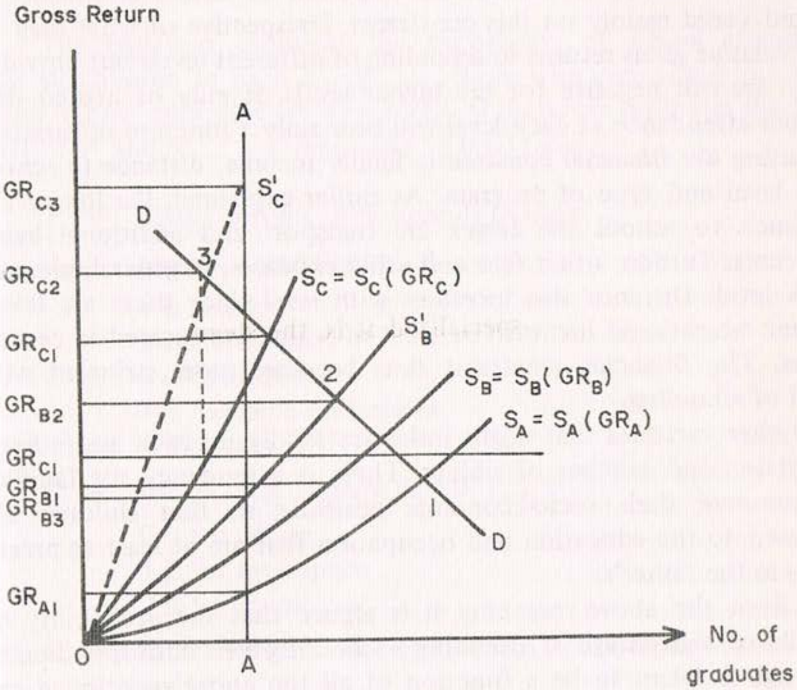

FIGURE 1

The horizontal portion is the total population that has the talent that matches the ability required for education *B*. Beyond point *B*, supply can increase but at higher personal cost as people with no aptitude are drawn to *B*. The highest educational level *C* which costs more and which requires an even higher ability than *B* may be represented by a smaller supply curve $GR_{CO}CS_C$ curve. We impose on these curves some demand curves say $D_A D_A$, $D_B D_B$ and $D_C D_C$. Without financial constraints, the returns to *B* and *C* education will be GR_{A1}, GR_{B1}, and GR_{C1}. With constraints, the returns to *B* and *C* education will be higher at GR_{B2} and GR_{C2}. The equilibrium gross returns GR_{B1} and GR_{C1} are just equal to the marginal cost of education *B* and *C*. With constraints, the equilibrium gross return is greater than the marginal cost by $GR_{B2} - GR_{B0}$, and $GR_{C2} - GR_{C1}$. We may consider the differential to be a return to affluence. We see that financial constraints lead to scarcity of high cost education and in its positive net returns.

The implications of the budget constraints on decision are underscored and a hypothesis of determination of school attendance is tested based mainly on this constraint. Irrespective of what may be the relative gross returns to schooling of different levels but provided they are not negative for the higher levels, it may be argued that school attendance at each level will be mainly a function of variables affecting the financial constraint: family income, distance to school and level and type of program. As earlier explained, the longer the distance to school the larger are transport and additional living expenses. Tuition, other fees and other expenses, in general, increase with level. Distance also increases with level since there are fewer higher educational institutions most of which are located in central cities. The financial constraint thus becomes more stringent with level of schooling.

Other variables that might influence family decision are father's education and number of sibling. There is a tendency for families to preserve their socio-economic positions so that children are directed to the education and occupation that are at least as prestigious as the father's.

Given the above reasoning, it is argued that the probability of a child of a given age of attending a schooling level corresponding to this age is taken to be a function of all the above mentioned explanatory variables. And since the process of education is sequential, a conditional probability function is assumed as follows:

$$(5) \qquad p^{j}_{ia} = p^{j}_{a}\ (Y_{fi}, E_{fi}, L_{fi}, N_i) p^{j-1}_{ia-1}$$

$$p^{j-1}_{ia-1} = p^{j}_{a-1}\ (Y_{fi}, E_{fi}, L_{fi}, N_i)\ p^{j-2}_{ia-2}$$

If a child did not complete the preceding level, the probability of his attending the next level is zero. The probability of his pursuing ther succeedingly higher levels is also zero at a given point in time. The family may decide to let him complete the previous level at a later time. This allows him subsequently to pursue next levels.

4. Empirical Test

Equation (5) above applies to each child i of age a. For testing purposes this equation simplifies to

(6) $$P_{ia} = P_a \; (Y_{fi}, E_{fi}, L_{fi}, N_i)$$

The equation estimates the probability of school attendance by all children in each group, i.e., those who completed and those who did not complete previous levels. It therefore estimates the product of p^a and p^{a-1} corresponding to level j and $j - 1$.

Y = family income in thousands of baht

R_r = regions dummy, $r = 1, 2 \ldots 5$

1 is North
2 is Northeast
3 is Central
4 is Bangkok metropolis
5 is South

C_L = urban/rural dummy, L = 0, 1, 2

0 is for village
1 is for metropolis
2 is for municipal

E_e = father's education, e = 0, 1, 2, . . . 5, 6-7, 8-9

0 is zero schooling
1 is Pratum 1-4
2 is completed Pratum 4
3 is completed Pratum 7
4 is completed Maw Saw 3
5 is completed Maw Saw 5
6-7 is completed college and teacher education
8-9 is technical and other training

Rel_q = relation of youth to head dummy,*2 q = 1, 2 9

1 is spouse of head
2 is unmarried son/daughter
3 is married son/daughter
4 is son/daughter-in-law
5 is nephew/niece
6 is parents of head
7 is relatives
8 is other dependent
9 is servant and employee

N is number of sibling of schooling age 6-24, a continuous variable

The sample population was grouped by age ranges 7-10, 11-13, 14-18 and 19-24 which correspond to Thailand's schooling stages — Pratum 1-4 (primary level), Pratum 5-7 (upper elementary), Maw Saw 1-5 (high school) and post secondary. The latter includes teacher and technical training and university education.

Both regression and logit methods were used in testing the hypothesis. Logit fits the model better as it directly gives an estimate of the probability of attendance in school. Note that the dependent variable is dichotomous, i.e., attendance or non-attendance in school assuming a value of 1 or zero and therefore has a non-normal distribution. This violates an important assumption of least squares estimate rendering interpretation of the estimated regression coefficients and the regression statistics unclear (Please see the technical note on this in the appendix). Nevertheless, regression analysis was applied for two reasons. First, it was desired to compare the results of the two methods to see whether the less expensive (computer timewise) regression estimates approximate closely enough the more suitable but expensive logit model. Some recent studies involving dichotomous dependent variables relied on regression estimates (Encarnación and Canlas, 1976; Canlas and Razak, 1979). Acceptance of their results would depend in part on the findings.

A second reason is expediency. Logit analysis takes more than ten times computer time for the equivalent regression estimate. Regression was used to obtain the "best" independent variable selection in terms of significance and R^2s. The "best" selection was used for the logit analysis. The validity of this approach was not investigated.

The function was tested by regression including all independent variables on each sample group and for a sub-set of independent variables after eliminating those that contributed insignificant value to the R^2 (Please see Appendix table for results of the complete regression runs). Presented in Table 8 are the results that provide the best estimate of the function. Included variables are family income, fathers' education, number of sibling, region and municipal/village location category. Though the coefficients cannot be interpreted in terms of probability values, their significance, sign and

Table 8 – Results of Linear Regressions of Attending or not Attending School

	6-10	7-10	11-13	14-18	19-24
Constant	.7180	.7862	.8170	.5361	.262
Family income	.0004**	.0003**	.0005**	.0007**	–.0000
Region 2 (NE)	–.0581**	–.0353	–.1069**	–.0154	–.0342**
Region 3 (Central)	–.0008	–.0016**	–.0128	.0606**	–.0268*
Region 4 (Bangkok)	.0184	.0302**	.0296**	.0987**	.0815**
Region 5 (South)	–.0693**	–.0381**	.0096	.0949**	.0090
Municipal	.0806**	.0390**	.0610**	.2050**	.1521**
Non-municipal	–.0397**	–.0339**	–.0951**	–.1721**	–.0355**
Number of youth	.0060**	.0031*	–.0069**	–.0143**	–.0021
FE_2 (Father's Education)	.0152*	.0276**	.0193**	.0310**	.0258**
FE_3	.0939**	.0749**	.1365**	.2260**	.1271**
FE_4	.1358**	.0994**	.1022**	.2740**	.2006**
FE_5	.1574**	.1270**	.0758**	.2743**	.2267**
FE_{6-7}	.1899**	.1205**	.1134**	.3108**	.3156**
FE_{8-9}	.1981**	.1181**	.1170**	.2417**	.2828**
$\bar{R}^2$	.055	.036	.098	.240	.132

movement were taken as rough estimates of the relationship. The regression results seem to be very satisfactory. Most of the regression parameters are significant and of the expected sign. Furthermore, they moved in the expected direction as one proceeds from the youngest age group to the oldest.

The constants declined from .786 to .262 as age (or level of schooling) increased from 7-11 to 19-24. This pattern reflects in part society's attitude to the different levels of schooling. The lower levels are regarded as a basic need required of every citizen for his orderly and satisfactory participation in all types of social interaction, hence the large constant. As one moves up the schooling ladder, the role of education becomes more specialized and there is no longer a common or equal desire for each level or type. Demand partly depends on expected net monetary benefits, partly on matching of perceived ability and required qualification. For these reasons, the value of the constant tends to fall as schooling level increases. On the other hand, mainly because of financial constraints, the influence of cost-related factors tended to rise with level of schoolng. Schooling cost increases with level, hence, the larger absolute value of the coefficient of family income, location, number of sibling and fathers' education. Fathers' education influences more strongly decision to pursue higher levels for two other reasons. One is its positive effect on home education which enhances inherent ability and therefore scholastic performance that is recognized in schools and in the selection of applicants for college or high school. Another influence is on education and occupational identity developed in children. Since lower education levels are regarded as basic for everybody, the influence of identity factor, hence father's education, s likely to be weak.

The coefficients of the independent variables obtained by logit vere practically all significant at the one percent level, similar to he results obtained by OLS. However, their values and movement s one goes up the education ladder were very different. The sign nd value of the intercepts were also very different. The influence of he various variables as reflected in the Beta coefficients increased vith age range but up to the 14-18 age range only. Then their values ropped. In contrast, the movement of the regression coefficient vas upward throughout.

The value of the probability of attendance in school for each ge range can be estimated from the logit Beta coefficients for ifferent values or categories of the independent variables. The xercise was limited to the extreme values of the variables to obtain he range of value of the probability for each age range. The extreme alues for number of youth were taken to be one and five and for ncome B5,000 and B100,000. The probability, P, of the dependent variable, attending or not attending school with value of 1 or , taking on value of 1 is

$$P/_{Y=1} = \frac{1}{1 + e^{-X'B}} = \frac{e^{X'_B}}{1 + e^{X'B}}$$

and B are vectors of independent variables and the β coefficients spectively. The following values of the probability of attending chool were obtained (please see Table 9). To be noted from able 10 are the rapid drop of the value of the probability of school ttendance as schooling level increases and its wide range for the fferent socio-economic and location classes. For the possibly worst-

Table 9 – Range of Values of Probability of Attending School by Age, 1975

	AGE RANGE			
	7-10	11-13	14-18	19-24
1. Lowest				
$X'\beta$	.912	.137	−1.787	−1.374
$P/_{Y=1}$	.7134	.5342	.1435	.2020
2. Highest				
$X'\beta$	4.030	4.807	3.358	.257
$P/_{Y=1}$	.9825	.9919	.9664	.5639

off children the probability drops successively from .7134 to .5342, to .1435, to .2020 for ages 7-10, 11-13, 14-18 and 19-24. The corresponding figures for the possibly "best-off" children are .9825, .9919, .9664 and .5639.

Attendance rate at each age range can be predicted for different population groups and from this the distribution of formal schooling. Attendance rate is determined by the set of characteristics of each group. The model indicates further the importance of financial variables on schooling decision and provides one with an intergenerational link in the acquisition of education capital. An increase in a group's income or a change in location would have a permanent impact on all its future generations. The link is through future fathers' education and their subsequent income. Finally, the model explains why distribution tends to be more unequal as level of schooling rises. The policy implications seem to be obvious since financial factors are not difficult to change. It is clear that the resulting error variance is not constant for all observations.

Table 10 – Value of Beta in Logit

Independent Variable	AGE RANGE			
	7-10	11-13	14-18	19-24
›nstant	1.193	1.462	– .472	–1.042
ımily income	.009**	.011**	.006**	–.0003
	(39.82)	(43.35)	(85.12)	(0.144)
›gion 2 (Northeast)	– .229**	– .620**	– .130*	– .115**
	(8.70)	(54.69)	(4.47)	(3.01)
›gion 3 (Central)	– .053	– .132	.251**	– .084**
	(0.37)	(2.01)	(15.99)	(2.18)
›gion 4 (Bangkok)	.294**	.358**	.434**	.221**
	(9.67)	(11.64)	(51.69)	(6.19)
›gion 5 (South)	– .283**	.099	.445**	.027
	(8.34)	(0.74)	(32.74)	(0.554)
ınicipal city	.253	.446**	.867**	.454**
	(11.36)	(28.88)	(284.90)	(12.99)
›n-municipal	– .137	– .405**	– .800**	– .185**
	(3.42)	(26.14)	(178.38)	(4.74)
ımber of youth	.008	– 071**	– .083**	– .006
	(0.30)	(20.39)	(66.49)	(1.01)
ıther's Education 2	.200**	.156**	.151**	.796**
	(13.10)	(6.77)	(13.67)	(3.29)
ıther's Education 3	.603**	1.696**	1.149**	.361**
	(13.55)	(39.18)	(121.84)	(6.27)
ıther's Education 4	.967**	1.175**	1.542**	.563**
	(48.78)	(41.66)	(290.20)	(13.41)
ıther's Education 5	2.020**	.848**	1.747**	.576**
	(11.84)	(3.90)	(63.34)	(6.16)
ıther's Education 6-7	1.382*	1.512**	2.012**	.660**
	(19.31)	(16.85)	(110.94)	(10.29)
ıther's Education 8-9	1.380**	1.602**	1.335**	.672**
	(19.33)	(14.33)	(58.06)	

*.05 significance level.
**.01 significance level (chi-square values with one degree of freedom) are in parenthesis except : age 19-24 where asymptotic *t*-values are given.

Appendix A

Table A.1 Regression Results on Alternative Selection of Independent Variables, Age 7-10

Independent Variables	REGRESSION COEFFICIENTS					
Intercept	0.0807	0.7854	0.7899	0.7850	0.7862	0.7838
Income	0.0004 (6.1568)	0.0004 (6.0977)	0.0003 (4.6406)	0.0004 (5.0815)	0.0003 (4.5598)	0.0003 (5.0162)
Reg 2	−0.0445 (−4.3451)	−0.0447 (−4.3670)	−0.0350 (−3.3993)	–	−0.0353 (−3.4276)	–
Reg. 3	0.0046 (0.4165)	0.0041 (0.3718)	−0.0010 (−0.0930)	–	−0.0016 (−0.1400)	–
Reg 4	0.0522 (4.8310)	0.0519 (4.8053)	0.0305 (2.7662)	–	0.0302 (2.7373)	–
Reg 5	−0.0327 (−2.4800)	−0.0324 (−2.4595)	−0.0383 (−2.9097)	–	−0.0381 (−2.8911)	–
C1	–	–	0.0388 (4.0643)	0.0426 (4.5103)	0.0390 (4.0851)	0.0428 (4.5314)
C0	–	–	−0.0342 (−3.3435)	−0.0510 (−5.1378)	−0.0339 (−3.3128)	−0.0507 (−5.1075)
N Youth	0.0029 (1.6666)	0.0031 (1.7543)	0.0029 (1.6700)	0.0029 (1.6332)	0.0031 (1.7665)	0.0030 (1.7144)

Independent Variables	REGRESSION COEFFICIENTS					
E 2	0.0249 (3.0635)	0.0278 (3.6362)	0.0244 (3.0119)	0.0211 (2.6078)	0.0276 (3.6201)	0.0238 (3.1276)
E 3	0.0886 (4.9342)	0.0908 (5.0984)	0.0724 (4.0250)	0.0695 (3.8644)	0.0749 (4.1963)	0.0717 (4.0128)
E 4	0.1189 (8.8941)	0.1219 (9.3172)	0.0961 (7.0873)	0.0915 (6.7537)	0.0994 (7.4886)	0.0943 (7.1132)
E 5	0.1442 (4.7208)	0.1477 (4.8644)	0.1231 (4.0302)	0.1242 (4.0639)	0.1270 (4.1834)	0.1275 (4.1971)
E 6-7	0.1339 (6.0064)	0.1370 (6.2075)	0.1172 (5.2573)	0.1172 (5.2541)	0.1205 (5.4581)	0.1200 (5.4304)
E 8-9	0.1331 (5.7265)	0.1358 (5.8850)	0.1152 (4.9560)	0.1113 (4.7774)	0.1181 (5.1151)	0.1137 (4.9163)
Rel 2	−0.0114 (−0.1602)	–	0.0009 (0.0129)	0.0029 (0.0411)	–	–
Rel 5-7	−0.0209 (−0.2922)	–	−0.0096 (−0.1349)	−0.0061 (−0.0852)	–	–

Table A.2 Regression Results on Alternative Selection of Independent Variables, Age 11-13

Independent Variables	REGRESSION COEFFICIENTS					
Intercept	0.5393	0.8049	0.5256	0.5073	0.8246	0.8181
Income	0.0007 (8.4062)	0.0007 (8.3688)	0.0004 (5.2454)	0.0006 (6.2330)	0.0004 (5.2220)	0.0006 (6.1996)
Reg 2	−0.1269 (−10.6863)	−0.1270 (−10.6808)	−0.1065 (−9.0183)	–	−0.1069 (−9.0413)	–
Reg 3	−0.0037 (−0.2960)	−0.0026 (−0.2057)	−0.0140 (−1.1283)	–	−0.0128 (−1.0315)	–
Reg. 4	0.0741 (6.1338)	0.0740 (6.1187)	0.0292 (2.3948)	–	0.0296 (2.4247)	–
Reg 5	0.0233 (1.5710)	0.232 (1.5618)	0.0095 (0.6462)	–	0.0096 (0.6559)	–
C1	–	–	0.0627 (5.8432)	0.0691 (6.4853)	0.0610 (5.6788)	0.0672 (6.3018)
C0	–	–	−0.0955 (−8.1969)	−0.1309 (−11.5173)	−0.0951 (−8.1474)	−0.1308 (−11.4886)
N Youth	−0.0062 (−2.9530)	−0.0063 (−3.0064)	−0.0070 (−3.3790)	−0.0078 (−3.7898)	−0.0069 (−3.3838)	−0.0078 (−3.7638)
E 2	0.0166 (1.8851)	0.0146 (1.7052)	0.0206 (2.3746)	0.0073 (0.8328)	0.0193 (2.2806)	0.0065 (0.7688)

Independent Variables	REGRESSION COEFFICIENTS				
E 3	0.1696 (8.5087)	0.1683 (8.4338)	0.1374 (6.9525)	0.1208 (6.0697)	0.1365 (6.9018)	0.1200 (6.0224)
E 4	0.1459 (9.4242)	0.1434 (9.2839)	0.1038 (6.7085)	0.0867 (5.5711)	0.1022 (6.6184)	0.0853 (5.4952)
E 5	0.1181 (3.2723)	0.1143 (3.1620)	0.0792 (2.2204)	0.0697 (1.9367)	0.0758 (2.1194)	0.0661 (1.8351)
E 6-7	0.1476 (5.8824)	0.1383 (5.5214)	0.1230 (4.9613)	0.1106 (4.4280)	0.1134 (4.5794)	0.1010 (4.0420)
E 8-9	0.1591 (5.5600)	0.1544 (5.3987)	0.1209 (4.2705)	0.1072 (3.7540)	0.1170 (4.1302)	0.1034 (3.6235)
Rel 2	0.2634 (5.2717)	–	0.2977 (6.0340)	0.3102 (6.2329)	–	–
Rel 5-7	0.2748 (5.4189)	–	0.3055 (6.1010)	0.3145 (6.2269)	–	–

Table A.3 Regression Results on Alternative Selection of Independent Variables, Age 14-18

Independent Variables	REGRESSION COEFFICIENTS					
Intercept	0.1671	0.4125	0.0654	0.0893	0.3897	0.4351
Income	0.0012	0.0011	0.0007	0.0008	0.0007	0.0007
	(16.6221)	(16.0596)	(10.7090)	(11.2777)	(9.9985)	(10.5833)
Reg 2	–0.0582	–0.0591	–0.0125	–	–0.0154	–
	(–4.8486)	(–4.9160)	(–1.0920)		(–1.3353)	
Reg 3	0.0817	0.0848	0.0564	–	0.0606	–
	(6.4410)	(6.6656)	(4.6782)		(4.9995)	
Reg 4	0.2059	0.2087	0.0928	–	0.0987	–
	(17.4918)	(17.6885)	(8.0937)		(8.5658)	
Reg. 5	0.1465	0.1464	0.0953	–	0.0949	–
	(9.4852)	(9.4599)	(6.4843)		(6.4316)	
C1	–	–	0.2108	0.2249	0.2050	0.2194
			(20.0142)	(21.6315)	(19.3857)	(21.0029)
CO	–	–	–0.1759	0.2023	–0.1721	–0.2009
			(–15.0737)	(–17.7692)	(–14.6757)	(–17.5474)
N Youth	–0.0160	–0.0153	–0.0157	-0.0150	–0.0143	–0.0135
	(–7.7982)	(–7.5370)	(–8.1126)	(–7.7873)	(–7.3931)	(–7.0138)
EDH 2	0.0192	0.0186	0.0302	0.0249	0.0310	0.0253
	(2.2528)	(2.1808)	(3.7323)	(3.0749)	(3.8333)	(3.1204)

Independent Variables	REGRESSION COEFFICIENTS					
E 3	0.3041 (15.9341)	0.2968 (15.5506)	0.2364 (13.0275)	0.2298 (12.6162)	0.2260 (12.4129)	0.2182 (11.9347)
E 4	0.3865 (26.3810)	0.3762 (25.7111)	0.2866 (20.3581)	0.2749 (19.5050)	0.2740 (19.4096)	0.2604 (18.4300)
E 5	0.3588 (12.3052)	0.3530 (12.1182)	0.2857 (10.3222)	0.2911 (10.4928)	0.2743 (9.8902)	0.2801 (10.0690)
E 6-7	0.3960 (15.9075)	0.3856 (15.5369)	0.3282 (13.8877)	0.3221 (13.5861)	0.3108 (13.1446)	0.3032 (12.7826)
E 8-9	0.3320 (11.7189)	0.3190 (11.2806)	0.2623 (9.7573)	0.2536 (9.3877)	0.2417 (8.9772)	0.2312 (9.5509)
Rel 2	0.2505 (9.0156)	–	0.3365 (12.7457)	0.3561 (13.4621)	–	–
Rel 5-7	0.2493 (8.6342)	–	0.3091 (11.2888)	0.3288 (11.9751)	–	–

Table A.4. – Regression Results on Alternative Selection of Independent Variables, Age 19-24

Independent Variables	REGRESSION COEFFICIENTS					
Intercept	0.0607	0.1660	–0.0479	–0.0649	0.0972	0.1030
Income	0.0000	0.0002	0.0000	0.0001	–0.0000	0.0000
	(3.0133)	(2.5304)	(0.3623)	(0.8243)	(–0.2008)	(0.2242)
Reg 2	–0.0476	–0.0496	–0.0306	–	–0.0342	–
	(–3.2148)	(–3.3500)	(–2.0858)		(–2.3273)	
Reg 3	–0.0236	–0.0231	–0.0281	–	–0.0268	–
	(–1.5423)	(–1.5068)	(–1.8646)		(–1.7747)	
Reg 4	0.1346	0.1367	0.0773	–	0.0815	–
	(9.9737)	(10.1230)	(5.6635)		(5.9660)	
Reg 5	0.0446	0.0431	0.0118	–	0.0090	–
	(2.3182)	(2.2464)	(0.6211)		(0.4717)	
C1	–	–	0.1567	0.1823	0.1521	0.1782
			(11.7715)	(13.9036)	(11.4406)	(13.6015)
C0	–	–	–0.0381	–0.0564	–0.0355	–0.0554
			(–2.5193)	(–3.7716)	(–2.3404)	(–3.6966)
N Youth	–0.0040	–0.0039	–0.0027	–0.0021	–0.0021	–0.0014
	(–1.8583)	(–1.8152)	(–1.2775)	(–0.9853)	(–0.9806)	(–0.6778)
E 2	0.0178	0.0162	0.0285	0.0244	0.0258	0.0209
	(1.8495)	(1.6890)	(3.0115)	(2.5699)	(2.7223)	(2.2014)

Independent Variables	REGRESSION COEFFICIENTS					
E 3	0.1537 (7.1557)	0.1509 (7.0485)	0.1331 (6.2869)	0.1347 (6.3300)	0.1271 (6.0139)	0.1279 (6.0200)
E 4	0.2483 (15.3223)	0.2415 (15.1225)	0.2122 (13.2027)	0.2075 (12.8702)	0.2006 (12.6157)	0.1937 (12.1482)
E 5	0.2510 (8.4495)	0.2480 (8.3865)	0.2351 (8.0439)	0.2604 (8.8971)	0.2267 (7.7800)	0.2526 (8.6515)
E 6-7	0.3457 (14.5063)	0.3420 (14.5469)	0.3262 (13.8953)	0.3355 (14.2609)	0.3156 (13.6002)	0.3243 (13.9349)
E 8-9	0.3226 (12.1829)	0.3163 (12.1959)	0.2991 (11.4655)	0.0351 (11.6370)	0.2828 (11.0463)	0.2872 (11.1579)
Rel 2	0.1054 (4.4762)	–	0.1481 (6.3605)	0.1699 (7.3042)	–	–
Rel 5-7	0.1126 (4.5602)	–	0.1379 (5.6689)	0.1607 (6.5977)	–	–

Appendix B

Technical Note on Logistic Model
by
Fe Lisondra

In a multiple linear regression model,

$$y_i = \beta X_i + \mu_i$$

y_i = dependent variable for the ith observation
x_i = $(X_{i1}, X_{i2}, \ldots, X_{ip})$, vector of p independent variables for the ith observation
β_i = $(\beta_1, \beta_2, \ldots, \beta_p)$, vector of p regression parameters
μ_i = ith uncorrelated disturbance term

y_i is normally distributed for fixed X_i in which the following assumptions are made:

1. $E(\mu_i) = 0$
2. $E(\mu_{i\,j}) = \sigma^2 \qquad i = j$
   $= 0 \qquad i \neq j$

In actual practice, it is not always reasonable to assume y_i to be normally distributed. Although X_i in some cases may not be normal, i.e., when some of its components are dummy variables, y_i for fixed X_i could be assumed normal and the variance-covariance matrix for y_i given X_i does not depend upon X_i. But in situations where the dependent variable y_i is dichotomous, i.e., 0 or 1, the ordinary least squares method will yield $E(\mu_i) = 0$ but with var (y_i) = Var $(\mu_i) = X_i'\beta\,(1 - X_i'\beta)$ since y_i is a Bernoulli random variable. It is clear that the resulting error variance is not constant for all observations. Thus, regression of y_i on X_i is heteroscedastic and should not be estimated using the ordinary least squares since it violates one of the basic assumptions generally made in a linear model. This heteroscedasticity (unless necessary corrections or transformations are made) will generate inefficient estimators of

3. Standard errors of the sample regression coefficients would therefore be incorrect and, as a result, tests of significance and confidence ntervals for regression coefficients may be seriously misleading. Furthermore, in OLS, estimators of $X_i'\beta$ can have any numerical value lespite the fact that $E(y_i) = X_i'\beta$ and $0 \leqslant y_i \leqslant 1$, $0 \leqslant X_i'\beta \leqslant 1$. This neans that y_i, being a probability, rules out the linear model because y_i may not be bounded by 0 or 1.

The logistic model provides an appropriate analysis of binary response data. The model in a logistic cumulative distribution function form,

$$P_{y\,i=1} \equiv P(X_i'\beta) = (1 + \exp(-X_i'\beta))^{-1}\ {}^{[a]}$$

has a curve similar to the cumulative curve of the normal distribution. Its likelihood function is

$$L = \mathop{\pi}_{i=1}^{n} \left[\frac{1}{1+\exp(-X_i\beta)}\right]^{y_i} \left[1 - \frac{1}{1+\exp(-X_i\beta)}\right]^{1-y_i}$$

where the maximum likelihood estimator[b] of β is obtained by differentiating the logarithm of the likelihood function, setting the esult equal to 0 and solving for β.

This method using the logistic *cdf* in solving regression problems with qualitative dependent variable is called logit analysis. The chi-square statistic for testing the hypothesis that a parameter is zero is calculated by computing the square of the parameters estimate divided by its standard error.

a. This nonlinear function represents the relationship between the probability of attending school $P_{y_{i=1}}$ and the socio-economic and demographic characteristics represented by vector X_i. β represents the vector of regression parameters.

b. In this paper, the maximum likelihood estimates (MLE) were computed using the Newton-Raphson method.

REFERENCES

Canlas, D. B. and Rozak, M. (1979), "Education and the Labor Force Participation of Married Women: West Malaysia 1970," Discussion Paper 7910. Quezon City: IEDR, School of Economics, University of the Philippines.

Chatterjie and Price (1977), *Regression Analysis by Example,* New York: Willey.

Encarnación, J., Jr., and Canlas, D. B. (1976), "Income, Education, Fertility and Employment: Philippines 1973," Discussion Paper 7628. Quezon City: IEDR, School of Economics, University of the Philippines.

Hicks, J. R. (1973), *Capital and Time,* Oxford.

Jorgenson, D. W. (1963), "Capital Theory and Investment Behavior," *American Economic Review, Papers and Proceedings.*

National Statistical Office of Thailand (1965), *Report of the UNESCO Regional Advisory Team* for Educational Planning in Asia, Bangkok.

——— (1975), *1975 Survey of Youth,* Bangkok.

——— (1975), *The Children and Youth Survey,* Bangkok.

Nerlove and Press (1973), *Univariate and Multivariate Log-linear and Logistic Models,* Rand.

Nitongkorn and Vutisart (1980), "The Distribution Flow of Education in the Formal System in Thailand; An Analysis of Factors Affecting Scholastic Achievement of Students at Different Levels of Education," Research Report Series No. 23, Faculty of Economics, Thammasat University, Bangkok.

Pernia, E. M. (1979), "An Intersectoral and Sequential Analysis of Migration Decision: The Philippines," *The Philippine Review of Business and Economics.*

Press, J. (1972), *Applied Multivariate Analysis,* New York: Holt, Rinehart and Winston.

Wesolowsky (1976), *Multiple Regression and Analysis of Variance,* New York: Wiley.