Projected Demand and Expenditures for Higher Education: the Case of Taiwan*

Charles H. Kao
Professor of Economics
University of Wisconsin—River Fall
Jae-Won Lee
Assistant Professor of Economics
Baruch College of the City University of New York

Projection of demand and expenditures for higher education is important in educational planning which, in turn, is often an integral part of national development planning in many developing countries.[1] Increasing recognition of the importance of education to economic growth, along with the fact that a high percentage of govermental budget is devoted to education, has resulted in creation of economic planning organizations and educational plans in many developing countries including Taiwan.[2]

The objective of this paper is to develop a projection model for demand and expenditures for higher education and apply it to Taiwan as an experiment.

PROJECTION MODEL

1. Demand Function for Higher Education

The demand for higher education in various disciplines depends on many factors including the population age group, real per capita income, relative rate of return, and social attitude toward education. The theoretical demand function for higher education in ith field at time t can be:

(1) $E_{i,t}=f(p_t^*, y_t, r_{i,t}, t, u_{i,t})$

where

$E_{i,t}$: demand for higher education in ith discipline at time t

p_t^* : size of the population of the appropriate age group at time t

y_t : real per capita income at time t

* This study was financially supported by Faculty Research Award No. 0596—270 from the University of Wisconsin. Competent research assistence was rendered by Mr. Moon Y. Han.

1) A comprehensive study was done in 1964 by the Netherlands Economic Institute. Unfortunately, however, of the twenty some developing countries examined, Taiwan was not included. For details read "Financial Aspects of the Educational Expansion in Developing Regions: Some Quantitative Estimates," *Financing of Education for Economic Growth* (Paris: OECD, 1966), pp. 59—72.

2) The government in Taiwan initiated its manpower planning in 1964 by establishing the Manpower Development Committee (MDC) within the Council of International Economic Cooperation and Development (CIECD).

$r_{i,t}$: rate of return in ith discipline at time t

t : time as a proxy for the taste or social attitude toward the education in ith field

$u_{i,t}$: stochastic term for ith discipline at time t.

Since data on rate of return are not available, in our empirical demand function the data on the cost of education per student were used as the proxy for the former. The empirical demand function in general form, then, is

(2) $E_{i,t}=f(p^*_i, y_t, c_t, t, u_{i,t})$

where

c_t : cost of education per student at time t

$E_{i,t}$: size of enrollment as a proxy for the demand for education in ith discipline at time t[3)]

The relationships between the demand for education and the independent variables can either be linear or nonlinear. In order to allow for many possible forms of the relation, the linear as well as nonlinear forms of the relationship such as exponential, semi-logarithmic, double logarithmic, hyperbola and polynomial ones have been estimated in this study, among which the best relation in terms of the adjusted coefficient of determination and the statistical significance as well as the reasonableness of the estimated coefficients have been selected for further analysis. The number of the potential demand functions estimated in our study for the final selection were thirty two for each discipline in various forms of relation with various combinations of the independent variables.

The final selections of the demand functions for higher education in the nine disciplines are listed in table 1.

The estimated demand functions are statistically quite significant in terms of adjusted coefficient of determination and t-statistics for the estimated individual coefficients.

In all of the nine fields, the "cost per student" variable seems to be rather less significant than the various forms of income, population and taste, which is not unexpected since the demand for higher education often exceeds the total number admitted by the institutions of higher education in Taiwan. Consequently all the final selected demand functions do not include the cost variable.

In the fields of Humanities, Medical Sciences and Fine Arts, the educational demand (E) rises at decreasing rate as the population age group (p^*) rises. In Agriculture, Social Sciences and Medical Sciences, the educational demand rises at decreasing rate as the real per capita income (y) rises. The demand in Edu-

3) The number of applicants to higher education would be a better proxy for demand for education, because the number of enrollment represents, in a strict sense, the combined result of demand for and supply of education. Unfortunately, the time series data on the number of applicants are not available by discipline. Therefore, the enrollment data are used as the proxy.

〈TABLE 1〉 **FINAL SELECTED DEMAND FUNCTIONS FOR HIGHER EDUCATION[a] IN TAIWAN**

Independent Variable / Discipline	Intercept	Y	P^*	T	$1/Y$	$1/P^*$	log Y	R	R^2
Humanlties	−1087540.04			566.00 (14.32)		−27387756.37 (9.06)		.99	.99
Education	−15145.60	1.58 (7.88)	5.36 (4.45)					.99	.99
Agriculture	13455.59				−51279956.56 (6.70)			.88	.75
Law	−46176.35		1.13 (2.74)	23.26 (1.11)				.90	.77
Social Sciences	−668603.17						79692.15 (9.83)	.94	.87
Natural Sciences	−783766.91		2.36 (7.20)	399.45 (24.15)				.99	.99
Engineering	−59994.67		38.40 (22.41)					.99	.98
Medical Sciences	44671.53				−28279847.11 (2.03)	−63189568.30 (6.74)		.99	.97
Fine Arts	−166421.88			90.58 (4.65)		−17359058.80 (11.64)		.99	.99

Dependent variable is the number of enrollment (E) in all the relations.
Y: Per capita real income P^*: Population age group 15—24 T: Taste or time
a): The value in the parenthesis is t-statistic. R and R^2 are the multiple correlation coefficient and adjusted coefficient of determination.

cation, Law, Natural Sciences and Engineering rises proportionately as population age group rises. The social attitude (t) also raises the demand in the fields of Humanities, Law, Natural Sciences and Fine Arts, while the real per capita income raises the demand in the field of Education proportionately.

2. Projection of the Selected Basic Variables

The independent variables in the selected educational demand functions are real per capita income (y), population age group 15—24 (p^*), taste (t), $1/y$, $1/p^*$ and log y. The projections of the real per capita income and the population will be discussed first.

(a) Projecton of Real Per Capita Income

In order to make a projection of the income figures for 1970—80 period, several trend relations of the income in the linear, logarithmic and polynomial forms were estimated for 1954—68 period, from which the following trend relation was selected as the best one:

(3) $\log y_t = 5.6006 + 0.0497\,T$
(17.44) R=0.98

where T is the year expressed in the last two digit numbers. Equation (3) can be written as follows:

(4) $y_t = e^{(5.6006+0.0497T)}$

By inserting the appropriate values of T, the projected values of y can be generated. This projection of y is based on the assumption that there will be no major disturbance in the growth of the real per capita income.

(b) Projection of the Population Age Group 15—24

The method described above may be used for the projection of the population with age of 15—24. However, since the data for the population with age 1—14 for 1960—69 period are available, we can make a direct projection of the population figure, which is much more reliable than the previous projection method based on the time trend. The age group 5—14 for 1960—69 period will become that of 15—24 by 1970—79. Since a small fraction of the population age group 5—14 will pass away before they reach the age 15—24, the following adjustment has been made: First, the survival rate for the relevant age group over 10 year period has been computed by using the population figures for 1959 and 1969. (Appendix B2). Secondly, this survival rate was multiplied to the population age group 5—14 for each year in the 1960—70 period to project the population age group 15—24 for each year in the 1970—80 period. (Table 2)

〈TABLE 2〉 PROJECTION OF POPULATION AGE GROUP 15—24, 1970—80

Year	Actual Figures in 1,000 (Age 5—14)	Year	Projected Figure in 1,000 (Age 15—24)
1960	2,973	1970	2,949
1961	3,172	1971	3,146
1962	3,323	1972	3,296
1963	3,462	1973	3,434
1964	3,581	1974	3,552
1965	3,682	1975	3,652
1966	3,733	1976	3,703
1967	3,809	1977	3,778
1968	3,879	1978	3,847
1969	3,918	1979	3,886
1970	3,957[a)]	1980	3,925

a): Derived by adding the increase in the age group 5—14 from 1968 to 1969 to the 1969 figure.

3. Projection of the Demand for Higher Education, 1970—80

By using the estimated educational demand functions by discipline and the projected values of the relevant independent variables, the demand for higher education by discipline for 1970—80 period has been projected. (Table 3). The projected educational demand or enrollment figures are the ones which are expected to be present during the projected period when no drastic disturbances set in.

The projected figures seemed to be quite reasonable and satisfactory for all the disciplines except the Social Sciences. In the Social Sciences field, an upward bench mark adjustment was made to make the projected figures more con-

〈TABLE 3〉 **PROJECTED DEMAND (ENROLLMENT) FOR HIGHER EDUCATION* IN TAIWAN, 1970—80**

Year	Humanities	Education	Agriculture	Law	Social Sciences	Natural Sciences	Engineering	Medical Sciences	Fine Arts	Total
1970	18,199	14,556	7,611	2,990	67,897	10,082	53,243	20,022	6,141	200,744
1971	19,348	16,322	7,894	3,237	71,858	10,946	60,822	21,523	6,601	218,554
1972	20,309	17,869	8,164	3,430	75,819	11,698	66,574	22,584	6,942	233,392
1973	21,209	19,390	8,420	3,610	79,779	12,422	71,868	23,495	7,244	247,441
1974	22,040	20,844	8,664	3,767	83,740	13,099	76,401	24,241	7,503	260,303
1975	22,817	22,245	8,897	3,903	87,701	13,735	80,248	24,857	7,728	272,134
1976	23,486	23,424	9,118	3,984	91,661	14,253	82,190	25,215	7,883	281,218
1977	24,199	24,782	9,328	4,093	95,622	14,830	85,085	25,672	8,067	291,682
1978	24,896	26,156	9,528	4,195	99,583	15,393	87,751	26,084	8,241	301,831
1979	25,533	27,417	9,719	4,262	103,543	15,884	89,236	26,352	8,376	310,326
1980	26,168	28,731	9,900	4,329	107,504	16,374	90,722	26,612	8,511	318,856

*Including students in Junior Colleges, 4-year Colleges and Universities and Graduate Schools.

sistent with the actual ones (see Append. B3).

One way to test the accuracy of the projection model is to compare the projected figures with the observed ones for a certain period. Since the observed total enrollment figure for 1970 is now avaiable, a comparison was made between the projected and observed figures for the year, which indicates that the discrepancy between them is only 2,729 The former is 200,744 and the latter 203,473.

4. Projection of the Educational Expenditures

Based on the projected educational cost per student and the projected total size of enrollment in higher education, we can extend our analysis to include educational cost.

By multiplying the projected cost and enrollment figures, we can compute the projected "necessary educational expenditure" in order to support the projected enrollment.[4] On the other hand, we can derive the projected "forthcoming educational expenditure" figures based on the projected government expenditure on higher education and its relationships with the educational expenditure and the total government expenditures.[5] (see Appendix B4 for details.)

The comparison of the projected "forthcoming" and the "necessary" educational expenditures in higher education can reveal the potential adequacy or inadequacy of the financial resources allocated to the edueational sector. Table 4 contains

4) This method of computation depends on the assumption that the percentage distribution of the enrollment by discipline is stable over time, which is the case since mid-1960's. However, the percentage distribution shows some changes in the earlier period, which is a qualification on this method.

5) In this method, the government expenditure is treated as an exogenous variable following its own time pattern of growth, and the policy priority for higher education is assumed to be more or less constant over time. For technical details, read Appendix B: 4.

〈TABLE 4〉 **PROJECTED EDUCATIONAL EXPENDITURES IN HIGHER EDUCATION** (in million NT$)

Year	(1) Forthcoming expenditure	(2) Necessary expenditure	(3) Difference (1)−(2)	(4)=[(1)−(2)]/(1) Percentage deficit as forthcoming expenditure
1969	1592.0932	1786.5171	−194.4239	8.8
1970	1827.7060	2036.7486	−209.0426	11.4
1971	2064.8279	2315.3611	−250.5332	12.1
1972	2300.3169	2577.3479	−277.0301	12.0
1973	2531.9288	2843.0971	−311.1683	12.3
1974	2758.1170	3107.7575	−349.6404	12.7
1975	2977.9206	3371.1960	−393.2754	13.2
1976	3190.7975	3609.7142	−418.9167	13.1
1977	3396.5151	3874.7037	−478.1886	14.1
1978	3595.0463	4145.0451	−549.9989	15.3
1979	3786.4979	4400.7330	−614.2351	16.2
1980	3971.0708	4664.5444	−693.4736	17.5

such comparison along with the difference (or educational deficit) between them for the period 1969—80. The projected educational deficit as the percentage of "forthcoming" expenditure is steadily rising from 8.8 in 1969 to 17.5 in 1980, indicating a need for a change in the government's priority in spending in favor of higher education for the projection period.

According to our projected demand for higher education, student enrollment in 1970—80 will witness a 59 percent increase requiring the educational expenditure to rise from 2,037 million N.T. dollars in 1970 to 4,665 million in 1980. As shown in Table 4, the shortage of funds in higher education in 1980 will reach 693 million N.T. dollars. The financial implication is a rather serious one: unless an increasing share of government budget is allocated to higher education, either a ceiling has to be set on the enrollment or the quality of education will deteriorate.

SUMMARY AND CONCLUSION

In this paper, an attempt to provide a projection model for demand and expenditures for higher education was made, which was subsquently applied to Taiwan.

For the projection, the educational demand functions by discipline were estimated first by introducing some socio-economic independent variables. The projections for the independent variables were made next. Then, the future educational demands were projected by introducing the projected independent variables into the demand functions. Finally, educational expenditures were projected, which would show future adequacy or inadequacy of government expenditures on higher education if the government maintains its past budget priority on higher education.

The projections made in this way depend on the assumption that there will be no major external disturbances which may destabilize the educational demand functions and the relationship between total government expenditures and government expenditures on higher education. The disturbances would include the changes in educational policies, social as well as natural disasters, etc.

In the case of Taiwan, the projections indicate that the gap between the forthcoming and the necessary educational expenditures in higher education for the projection period is rising, which suggests two important policy implications. First, the economic as well as the educational planners in Taiwan should compare the projected enrollment in higher education with the society's high level manpower requirements. Should there be an imbalance between the two, some corrective measures, including the manipulation of the independent variables in the educational demand functions as well as the conventional employment policies, are called for. Secondly, the planners should change the policy priority in favor of higher education as long as they would like to meet the projected enrollments. Their policy adjustments in the suggested direction would reduce some of the manpower imbalances and misallocation of funds in the educational sector.

APPENDIX

A. Basic Data

y : real per capita income series from *Taiwan Statistical Data Book*, 1970 (Taipei: CIECD, 1971), Table 3-4, p. 16.

p^* : population age group, 15-24, series from *ibid.*, Table 2-7, p. 10.

c : average cost of education per student series from *Manpower Development Series*, No. 31 (Taipei: MDC, December 1969), Table 6, p. 48. Since the data are available for 1960-68 period only, the series was extrapolated backward for 1954-59 period by using the procedure shown in Appendix B1.

E : size of enrollment as a proxy for the demand for education in various disciplines. The data are from CIECD, *op. cit.*, Table 13-6, p. 168.

G and G_e : total government expenditure and government expenditure on higher education data for 1959-68 period are from MDC, *op. cit*, Tables 3 and 1.

B. Statistical Procedures

1. A number of trend relations in linear as well as polynomial forms have been estimated, among which the following linear trend relation was selected as the best one in terms of the adjusted coefficient of determination and the reason-

ableness of the extrapolated figures:

$$c=5214.0278+448.35t'' \qquad R^2=0.80$$
$$(5.67)$$

where

c : cost per student

t'' : time

year	t''
1960	1
1961	2
1962	3
.	.
.	.
.	.
1968	9

2.

Year	Population by Age Group	
	(5—14)	(15—24)
1959	2,765	
1969		2,741

Since age group 5—14 in 1959 will become age group 15—24 in 1969, preliminary mortality rate for the age group can be computed in the following way:

$$m^*=\frac{p_{(5-14),1959}-p_{(15-24),1969}}{p_{(5-14),1959}}=\frac{2,765-2,741}{2,765}=0.0087$$

where m^* : preliminary mortality rate over ten year period

$p_{(5-14),1959}$: age group of 5—14 in 1959

$p_{(15-24),1969}$: age group of 15—24 in 1969

In general, as the mortality rate tends to decrease over time, an adjustment for such a decreasing trend should be made on the computed preliminary mortality rate, m^*. The adjustment steps are shown below.

Step 1

In order to make such adjustment, the rate of decrease in the mortality rate of the entire population from 1958—59 to 1968—69 has been computed in the following way:[6]

Year	Mortality Rate for the Entire Population (%)
1958—59	0.72
1968—69	0.51

The computed rate of decrease from 1958—59 to 1968—69 is

6) Source of the data: *Taiwan Statistical Data Book*, (Taipei: CIECD, 1970), Table 2—3, p. 5.

$$\frac{0.72-0.51}{0.72} \fallingdotseq 0.292\%$$

Step 2

The adjustment for the preliminary mortality rate, i.e. m^*, by using the computed rate of decrease in the mortality has been made in the following way:

$$m = m^*(1-0.00292) \fallingdotseq 0.00867$$

where

m : adjusted mortality rate for age group 5—14 until they reach the age of 15—24.

Step 3

The survival rate has been computed in the following way:

$$s = 1-m \fallingdotseq 0.992$$

where

s : survival rate for the age group.

3. The educational demand function for the Social Science discipline shown in Table 1 seemed to be quite satisfactory. Nevertheless, the projected figure for 1970, for instance, was 54,969 while the actual figure for 1969 was 67,301, which called for some adjustment. In order to make a reasonable adjustment, the figure for 1969 has been projected by using the demand function and compared with the observed one for the same year, which indicated that the former was lower than the latter by 12,928. Consequently, this discrepancy was used to make the upward bench mark adjustment for the projected figures for 1970—80, raising them by the discrepancy.

4. In order to project the forthcoming educational expenditure, the following steps are followed:

Step 1

Future total government expenditures have been projected by extrapolating its past trend for 1959—68 period, where the time trend has been selected from several alternative linear and nonlinear ones. The selected trend relation is,

$$G = -6538811.9101 + \underset{(2.617)}{321156.1966t} - \underset{(2.723)}{5267.1744t^2} + \underset{(2.847)}{28.9094t^3}$$

$$R^2 = 0.994$$

where

G : total government expenditure in million NT \$

t : time or year expressed as the last two digit figure

The numbers in the parenthesis are the abvolute values of the t-statistics.

Step 2

The relaionship between total government expenditure (G) and the government expenditure on higher education (G_e) for 1959—68 period has been estimated. The selected relation is,

$$\log G_e = -11.224 + 1.7276 \log G$$
$$(34.469)$$
$$R^2 = 0.993$$

Step 3

By inserting the projected G in step 1 into the relation in step 2, the projected G_e can be generated.

Step 4

The relationship between G_e and the educational expenditure (CE) for 1959—68 period has been estimated. The selected relation is,

$$CE = -3886.0675 + 769.0642 \log G_e$$
$$(13.2389)$$
$$R^2 = 0.985$$

Step 5

By inserting the projected G_e into the above relation in step 4, the projected CE series can be generated.