A COMPUTER MODEL TO MEASURE THE REQUIREMENTS FOR STUDENT AID IN HIGHER EDUCATION

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In the Spring of 1969 the Office of Program Planning and Evaluation of the Office of Education undertook the task to estimate the Federal resources which will be required to fulfill the increasing aspiration of young Americans for Post-Secondary Education.

Changes in Aspirations in Post-Secondary Education

While college attendance increased proportionately for all income groups between 1940 and 1960, patterns of desire to attend college have changed dramatically between '60 and '69.

> Between 1939 and 1959, young people from all income groups increased their aspirations to attend college at a uniform rate.
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> Between 1960 and 1966, a new trend started manifesting itself. The aspirations of the poor for a college degree began to catch up with those of the rich. Twice as high a proportion of high school seniors from the lowest income quartile hoped to attend college in 1966 as did in 1959. The increase was from 23 percent to 46 percent. The number of children from families in the second income quartile – families whose income is still below the median – who expected to enroll in college rose from 40 percent in 1959 to 52 percent in 1966. This was an increase of 30 percent. The desire to attend college grew more modestly in the upper two income quartiles, from 52 percent to 65 percent of seniors in the third quartile, and from 68 percent to 74 percent of those in the highest quartile in 1966.

These changes in expectations are reflected in enrollments. 230,000 more freshmen enrolled in college full time in the Fall of 1968, than would have been expected if the trend of 1956-65 had been followed. About 65,000 of these freshmen came from families with incomes of less than $5,000 a year, the bottom quartile of the income distribution. Another 61,000 came from the second quartile. Altogether, 217,000 out of the quarter million total increase in enrollments came from other than the traditional sources of college students in the 1950's.

The increasing rate of post-secondary school attendance by students from poorer families became apparent soon after the enactment of the Higher Education Act of 1965. During the academic year that began in 1966, some 900,000 students received financial assistance under one or more of the Federal aid programs administered by the U.S. Office of Education. During 1968-69, the number of young people aided by Office of Education programs alone is expected to exceed 1.5 million students. Meanwhile, considerable additional aid is also available through the Veterans' Administration. The Veterans' Administration will have contributed $323 million to student finances in the academic year 1968-69, and expects to increase this aid to $425 million in the academic year starting in September 1969.

Considerations in Projecting Demand for College Attendance

The key factors which will affect college enrollments in the next few years are: (1) the propensity of high school graduates with different levels of academic achievement and financial resources to enroll in college, (2) the time schedule by which they enroll, i.e., immediately after high school or a number of years later, (3) the persistence rates of different types of students, and (4) the availability of student aid to make their desires come true.

The model takes into account the first three factors, and ignores the fourth. Its purpose is to project the number of students who may wish to attend and, to estimate the demand for student aid.

The estimates of the proportion of freshmen enrolling in colleges are computed taking into account dynamic change in enrollment rates in contrast to more conventional level projections. First-time enrollments by income class vary from year to year according to past trends in the propensities to enroll in college. Thus, the proportion of high school graduates from families in the lowest income quartile in proportion to all seniors who will enroll in college one year after high school graduation is projected to increase to 15 percent in 1976, in comparison with the rate of 10 percent observed by Project Talent for 1960, and an estimated entry rate of 12 percent in the Fall of 1968.

Estimates of attrition rates by ability and income group were also derived from information which has become available from special tabulations of the five-year follow-up interviews of Project Talent. These estimates were checked, and adjusted whenever necessary, to conform with U.S. Bureau of the Census estimates of attendance by age. Together with more refined assumptions about the timing of entry and enrollment rates by income group, the estimates of attrition rates present a much more realistic representation of the social demand for education at the post-secondary level, than past projections.

Varying proportions of children from families with different levels of affluence enroll in the year after graduation, and also delay enrollment at different rates. Judging from the five-year follow-up data of Project Talent, as well as follow-up of high school seniors conducted by the U.S. Bureau of the Census in 1959 and 1966, the pattern of delayed enrollments has remained fairly constant over the past few years. Roughly nine out of ten children whose parents are in the top quartile of the population in terms of income are likely to enroll in college in the year following high school graduation. By contrast, only five out of ten children whose families are in the lowest income quartile are likely to enroll in the same year. These tendencies are included in the model.

The basic statistics of high school graduates were taken from the National Center for Educational Statistics series. The freshman class of 1976 is already born, and barring some unforeseen changes in the trend of dropouts from high school, the estimates of high school graduates by year and by sex prepared by the National Center for Educational Statistics, U.S. Office of Education, are likely to be fairly accurate.

Test of the Model in Forecasting Past Enrollments

A test of the predictive accuracy of the estimates underlying the calculations of the model is to compare them with estimates of previous years enrollments presented by the Office of Education. For the period 1960-68, the estimates of the model when compared with those of the National Center never deviate more than 2.5 percent. (See Table 3)

Given the large number of factors taken into consideration in deriving the model, it is highly encouraging that the projections of past

TABLE 1

DEGREE CREDIT FULL-TIME EQUIVALENT ENROLLMENT – OPPE MODEL
BY INCOME QUARTILE
(thousands of students)of

	Low	2nd	3rd	High	Total
1960	335.68	513.64	842.77	1289.77	2981.89
1961	379.58	563.98	916.56	1386.801	3246.93
1962	427.24	612.63	983.77	1472.85	3496.49
1963	478.24	659.65	1047.52	1552.12	3737.53
1964	541.69	723.16	1135.36	1660.15	4060.37
1965	623.37	808.09	1252.57	1805.48	4489.52
1966	712.07	894.38	1368.17	1950.01	4924.63
1967	806.44	981.98	1484.92	2101.56	5374.90
1968	895.90	1062.05	1587.22	2235.66	5780.82
1969	974.77	1131.23	1670.02	2337.54	6113.56
1970	1050.06	1198.66	1755.15	2436.09	6493.97
1971	1128.74	1273.17	1863.63	2569.72	6835.26
1972	1209.03	1350.70	1984.29	2725.39	7269.41
1973	1278.64	1417.82	2084.70	2849.02	7630.18
1974	1339.70	1476.91	2169.55	2947.67	7933.83
1975	1395.04	1530.35	2245.95	3039.32	8210.66
1976	1446.19	1579.32	2320.38	3131.92	8477.81
1977	1493.66	1624.88	2398.87	3225.50	8737.92

Source: Office of Program Planning and Evaluation, U.S. Office of Education Model (OPPE Model).

TABLE 2

DEGREE CREDIT FULL-TIME ENROLLMENT – COMPLETE EGALITY MODEL
BY INCOME QUARTILE
(thousands of students)

Income quartiles	Low	2nd	3rd	High	Total
1970	1129.0	1582.5	2009.5	2436.1	7157.1
1971	1188.8	1667.7	2118.9	2569.7	7545.1
1972	1254.6	1764.3	2244.9	2725.4	7989.2
1973	1311.7	1844.4	2346.8	2849.0	8352.0
1974	1362.4	1912.1	2430.1	2947.7	8652.2
1975	1410.3	1975.6	2507.7	3039.3	3932.9
1976	1456.0	2037.8	2585.1	3131.9	9210.9
1977	1500.8	2099.6	2662.9	3225.5	9288.8

Source: OPPE Model.

TABLE 3

TOTAL ENROLLMENT – OPPE MODEL, BY INCOME QUARTILE AND TOTAL

(thousands of students)

	Low	2nd	3rd	High	Total	OE[1/]	Difference	Percent
1960	419.0	624.9	1011.5	1529.7	3585.0	3583.0	2.0	.06
1961	474.3	686.7	1100.4	1645.2	3906.6	3861.0	45.6	1.17
1962	534.4	746.4	1181.2	1747.4	4209.3	4175.0	34.3	.81
1963	599.1	804.2	1257.9	1841.3	4502.4	4495.0	7.4	.16
1964	680.3	882.8	1364.2	1970.2	4897.6	4950.0	-52.4	-1.07
1965	785.6	988.5	1506.3	2143.7	5424.1	5526.0	-101.9	-1.88
1966	900.0	1095.8	1646.3	2315.7	5957.8	5885.0	72.8	1.22
1967	1021.8	1204.8	1787.5	2495.2	6509.4	6348.0	161.4	2.48
1968	1137.7	1204.6	1911.6	2654.3	7008.4	6983.0 [2/]	25.4	0.04
1969	1240.7	1391.4	2012.8	2775.9	7420.7			
1970	1339.4	1476.0	2116.8	2893.7	7825.9			
1971	1442.5	1569.4	2248.7	3052.2	8312.7			
1972	1547.4	1666.2	2395.2	3236.4	8845.3			
1973	1638.6	1750.3	2517.6	3383.3	9289.9			
1974	1718.8	1824.4	2621.2	3501.4	9665.7			
1975	1791.5	1891.3	2714.5	3611.1	10008.6			
1976	1858.5	1952.6	2805.4	3721.6	10338.0			

1 National Center for Educational Statistics, *Projections of Educational Statistics to 1977-78,* (Washington, D.C.: Government Printing Office), p. 16 (all except 1968).

2 National Center for Educational Statistics, *Opening Fall Enrollment in Higher Education, 1968,* Washington, D.C.: Government Printing Office), p. 6.

Source: All data except as noted in (1) OPPE model.

experience and estimates made on an independent basis are so close together.

Total Enrollment Projections

The projection of total enrollments derived by the model appear in Table 3. It is estimated that total enrollment may exceed ten million students by 1976, nearly a million students above the NCES estimate of total enrollments. The difference between the two estimates is due to the difference in the methods used to derive them and, more importantly, the purpose for which the estimates are constructed. The NCES projects past trends, while the model presented here predicts future demand for higher education. A word of caution should be injected. Both the model and NCES projections may fail to forecast accurately if drastic shifts in attitudes or economic conditions occur in the next few years.

The projections of enrollment by income quartile indicate that despite the higher first time entry rates into college of lower income students, the participation of lower income students in the total population of higher education is not likely to change drastically in the next few years, with the lowest half of the distribution picking up a few percentage points in the total enrollment moving from 29 percent in 1960, and 35 percent in 1968 to 37 percent in 1976.

Full-Time Equivalent Enrollment Estimates

Total enrollment is an approximate measure of the load placed upon institutions of higher education. The more conventional measure of the burden is the full-time equivalent enrollment for 1976, reproduced in Table 1, of 8.5 million students for the OPPE model. The model projects equal growth in numbers of full-time equivalent students between 1960 and 1968, and 1968 and 1976, but a decline in the rate of growth.[1] The increases of 46 percent for the period 1968 to 1976 is below the 90 percent increase between 1960 and 1968.

Estimates of Graduate and Undergraduate Enrollments

Further estimates were made to separate total enrollment into undergraduate and graduate enrollment, and into full-time enrollment (see Table 4). Different rates of full-time attendance were imputed to each income/achievement quartile. These rates, derived from Project Talent one-year follow-up data were adjusted to conform with observations for the total population collected by NCES in 1964.

There is substantial difference in the proportion of full-time students by income quartile. In the lowest income quartile, it is estimated that only 64 percent of the students attend full time; 90 percent of students in the higher income quartile attend full time.

The number of undergraduate and graduate students by income quartile was estimated on the basis of the trends (1) derived from NCES of the proportion of graduate to undergraduate students, and (2) the estimated number of graduate students. The estimate of expected graduate students by income quartile is based on aspirations for graduate degrees of the Project Talent population. These were compared with data on social origins available in a study of graduate students conducted by NCES in 1965.[2]

The resulting estimates of total graduate and undergraduate students were adjusted for differences in full-time and part-time attendance by income quartiles. It was assumed that income differentials which affected full-time attendance of undergraduates would also apply to graduate students. These factors were applied to the much lower full-time attendance patterns of graduate students.

The resulting estimates of total undergraduate and graduate enrollments, and the number of full-time undergraduate and graduate students appears in Table 4.

The "Complete Equality" Projection

An alternative projection which, from 1970 on, ascribed propensities to enroll high school seniors and retention rates of college students from families in the highest income quartile is reproduced in Table 5. It estimates total enrollments of 11.2 million in 1976; 870,000 more than the enrollments produced by the OPPE model. If these patterns are followed, enrollment of children from the lowest half of the income distributions could constitute some 40 percent of the total enrollment.

TABLE 5

DEGREE CREDIT TOTAL ENROLLMENT – COMPLETE EGALITY MODEL BY INCOME QUARTILE
(thousands of students)

	Low	2nd	3rd	High	Total
1970	1129.04	1582.48	2009.46	2436.09	7157.06
1971	1188.77	1667.70	2118.87	2569.72	7545.05
1972	1254.61	1764.28	2244.93	2725.39	7989.21
1973	1311.70	1844.44	2346.83	2849.02	8351.99
1974	1362.35	1912.09	2430.05	2947.67	8652.17
1975	1410.04	1975.57	2507.67	3039.32	8932.84
1976	1456.04	2037.78	2585.12	3131.92	9210.86
1977	1500.84	2099.62	2662.85	3225.50	9488.82

Source: OPPE Model.

The assumption underlying this projection assumes that in 1976 52.5 percent of the graduating class will enroll in college the year following graduation as compared to a little over 40 percent in 1968. The dropout rate is also reduced drastically, with the assumption made that 66 percent of the entering class will receive a B.A. within five years of high school graduation, as compared to about 50 percent, the rate observed in the late 1960's. The figures presented in Table 5 can thus be taken as an upper limit of possible enrollments under conditions of availability of adequate student aid and drastic shifts in attitudes towards college attendance.

The reason why children from families in the lower income quartiles are projected to attend only at .8 the rate of children of those in the upper quartile is their poorer high school records. Since propensity to persist in one's post-secondary education is directly related to high school performance, even with the removal of financial constraints, some inequalities still remain.

The Effect of Financial Limitations on Attendance Patterns

A comparison of projected total enrollment, full-time equivalent enrollment, and full-time enrollment highlights the impact of the difference in financial circumstances on attendance patterns. Table 6 shows that the relationship of total enrollment between the demand projection and the complete equality projection is slightly over 8 percent for 1976. Full-time equivalent enrollment increases also by 8 percent, and full-time enrollment by 9 percent.

TABLE 6

RELATIONSHIP OF COMPLETE EGALITY TO OPPE MODEL
(Complete Egality as a Percent of OPPE Model)

	Total enrollment Percent	Full-time enrollment Percent	Full-time equivalent Percent
1970	111.15	111.11	111.13
1971	111.65	110.43	110.38
1972	109.74	110.01	109.90
1973	109.24	109.61	109.46
1974	108.80	109.22	109.04
1975	108.50	108.90	108.79
1976	108.33	108.85	108.64

Source: OPPE Model.

The removal of all financial constraints has only a moderate effect on the number of students likely to attend institutions of higher education. By contrast, the effect is somewhat pronounced for students who are likely to attend full time. In other words, if the assumptions underlying the projections are correct, the removal of financial constraints is likely to have a more pronounced effect upon the intensity of studies than they have upon the numbers attending.

Summary and Conclusions

The projections above have indicated that if the trends of the past few years have been modeled realistically, the rate of growth in enrollments is likely to taper off. Nevertheless, it is quite likely that the absolute increases in the number of students will be as large in the next eight years as they have been in the past eight.

Description of the Enrollment Model for 1960-1976

The model used to allocate past enrollments for the period 1960-67 by ability and income quartiles and to project enrollments for the years 1968-76 was built up by: (1) using projections of high school graduates in each year, (2) allocating them to four ability and four socioeconomic quartiles, (3) applying estimated probabilities to the entry into the post-secondary system from each of 16 cells in the year of graduation and during subsequent years, and (4) differential survival rates from year to year were then applied to the enrollees. The total enrollment estimated by the model is a summing of these calculations:

$$1.\quad E_t = \sum_{snij}\sum\sum\sum d_{s,i,j} \cdot f_{s,i,j} \cdot r_{s,i,j} \cdot P_{s,n,i,j}$$

$$G_{s,(t-n+1),i,j}$$

The sources used for the estimates were: (1) NCES estimates of high school graduates, (2) Project Talent data from the one-year and five-year follow-ups of the high school class of 1960, (3) U.S. Bureau of the Census attendance by age information for the period 1964-66, and (4) information about college-going intentions from two surveys conducted by Talent in the one-year follow-up survey.

TABLE 4

TOTAL, UNDERGRADUATE, AND GRADUATE DEGREE CREDIT STUDENTS – BY INCOME QUARTILE AND YEAR

(thousands of students)

Income quartile: Low				2nd			3rd			4th			All Students		
	Total	Under-graduate	Graduate	Total	Under-graduate	Graduate	Total	Under-graduate	Graduate	Total	Under-graduate	Graduate	Total	Under-graduate	Graduate
1960	419.0	362.5	56.4	624.9	518.6	106.3	1011.5	887.2	124.2	1530.0	1313.3	216.3	3585.0	3081.6	503.4
1961	474.3	412.2	62.1	687.0	570.0	117.1	1100.4	963.4	137.0	1645.3	1407.0	239.0	3906.6	3351.8	554.8
1962	534.4	466.8	67.6	746.3	618.7	127.6	1181.2	1032.0	149.2	1747.3	1487.3	260.0	4209.3	3604.8	604.4
1963	599.1	525.9	73.2	804.1	6666.2	138.0	1257.9	1096.6	161.4	1841.3	1460.1	281.1	4502.4	3848.8	653.6
1964	680.3	599.9	80.5	882.8	730.9	151.9	1365.3	1186.6	177.7	1970.1	1660.5	309.7	4897.6	4177.8	719.7
1965	785.5	695.2	90.3	988.5	817.9	170.6	1506.4	1306.7	199.7	2143.7	1795.7	348.1	5424.1	4615.4	808.8
1966	900.0	799.3	100.6	1095.9	905.8	190.1	1646.3	1423.7	222.6	2315.7	1927.7	387.9	5957.8	5056.6	901.2
1967	1021.8	910.2	111.6	1204.8	994.1	210.7	1878.5	1540.8	246.7	2495.3	2065.3	430.0	6509.4	5510.4	999.0
1968	1137.8	1016.0	121.7	1304.6	1074.8	229.8	1911.6	1642.7	269.0	2654.3	2185.6	468.7	7008.3	5919.2	1089.2
1969	1240.7	1110.6	130.2	1391.3	1145.7	245.7	2012.8	1725.2	287.5	2775.9	2274.9	501.0	7420.7	6256.4	1164.4
1970	1339.4	1200.9	138.5	1476.1	1214.7	261.4	2116.8	1810.9	305.9	2893.7	2360.7	533.0	7825.9	6587.2	1238.7
1971	1442.5	1293.6	148.9	1569.4	1288.6	280.8	2248,7	1920.2	328.5	3052.2	2480.0	572.2	8312.8	6982.4	1330.4
1972	1547.4	1386.8	160.6	1666.3	1363.7	302.6	2395.2	2041.6	353.6	3236.4	2620.5	615.9	8845.3	7412.6	1432.7
1973	1638.6	1468.5	170.2	1750.3	1429.7	320.6	2517.5	2143.0	374.5	3383.4	2731.1	652.3	9289.8	7772.3	1517.5
1974	1718.9	1540.7	178.1	1824.4	1488.8	335.6	2621.2	2229.1	392.1	2501.4	2818.5	682.9	9665.7	8077.0	1588.7
1975	1791.5	1606.1	185.4	1891.4	1542.0	349.4	2714.6	2306.4	408.2	3611.1	2900.0	711.0	10008.5	8354.5	1654.0
1976	1858.5	1665.8	192.7	1952.6	1589.7	362.9	2805.4	2381.4	424.0	3721.6	2983.1	738.4	10338.0	8620.0	1718.0

Source: OPPE model

Estimates of the Number of High School Graduates

The number of high school graduates, separately for males and females, was taken from National Center for Educational Statistics data and estimates from the years from 1949 to 1976, published in U.S. Department of Health, Education, and Welfare, U.S. Office of Education, *Projections of Educational Statistics, 1976-77,* (Government Printing Office, Washington, D.C.: 1968), Table 17.

Estimates of High School Graduates by Ability and Income Quartile

The distribution of high school graduates by income and ability quartiles was established by splicing information from Project Talent one-year follow-up data with U.S. Bureau of the Census information.

Adjustments to Project Talent Data

Data from Project Talent were classified by grouping them four groups according to the socioeconomic index and another four groups based on aptitude test scores. Table 7 shows the tabulation of March 1960 tenth-grade males taken from the December 1963 reinterview and classified by these two variables.

TABLE 7

PERCENTAGE OF TENTH-GRADE MALES BY APTITUDE AND SOCIOECONOMIC INDEXES: MARCH, 1960

Socioeconomic Index Percentile	Aptitude Index Percentile 0-25.2	25.3-46.2	46.3-71.3	71.4-100.0	Total
0-31.5	13.9	8.2	6.0	3.4	31.5
31.6-58.61	6.3	6.3	7.9	6.6	27.1
58.7-81.4	3.5	4.4	6.9	8.0	22.8
81.6-100.0	1.5	2.1	4.3	10.7	18.6
Total	25.2	21.0	25.1	28.7	100.0

Two kinds of adjustments were made before the data were used for the enrollment model: (1) the data were adjusted to represent more precisely characteristics of students quartile by quartile, and (2) occasional statistical anomalies were smoothed.

Rates of enrollment and rates of attainment were obtained directly from Project Talent tabulations at the cumulative percentile points on the socioeconomic and aptitude indexes which were near the desired points. Langrangian interpolation procedures were then used to estimate the corresponding ratios for the desired boundaries by quartile for each of the two classifying variables independently.

TABLE 8

APPROXIMATE FAMILY INCOME DISTRIBUTION OF 1960 HIGH SCHOOL GRADUATES

Family Income Class	Family Income Percentile	Percent of 1960 High School Graduates
Under $3,337	0- 25.0	22.4
$3,338-5,625	25.1- 50.0	24.9
$5,626-8,378	50.1- 75.0	26.7
$8,398 and over	75.1-100.0	26.0
		100.0

First-year enrollments for 1960 in the year following graduation were calculated from Project Talent. This distribution by the 16 income-aptitude cells for each sex appears in Tables 9 and 10.

For previous and subsequent years to 1960, the first-time enrollment rate was adjusted on the basis of information described in Section 2 which indicated that the propensity to enroll in college had increased roughly proportionately for all income groups for the period 1939 to 1960 and had grown at different rates between 1960 and 1966. A further assumption was made that the pattern of change between 1960 and 1966 would continue for ten years to 1976; namely, that by 1973 enrollments in the first, second, and third quartile would reach the levels experienced in the next higher quartile. It was assumed that enrollment propensities in the fourth quartile would asymptotically reach 80 percent; thus the gap between current enrollments and 100 percent enrollment would be closed at the rate observed between 1960 and 1966.

TABLE 9

FIRST-TIME ENROLLMENT OF HIGH SCHOOL GRADUATES IN COLLEGE IN THE YEAR FOLLOWING GRADUATION

MALE

Income	Low	2	3	High
Low	.078	.168	.333	.536
2	.142	.245	.399	.698
3	.163	.366	.514	.753
High	.209	.362	.640	.793

TABLE 10

FEMALE

Income	Low	2	3	High
Low	.085	.125	.219	.429
2	.095	.157	.283	.565
3	.165	.249	.451	.639
High	.269	.447	.630	.854

Mathematically, this was represented as follows: upper and lower asymtotes K_1 and K_2 were chosen for each income quartile—the upper asymtote K_2 to represent the limits of growth indicated above and the lower asymtote K_1 to represent the proportions of first-time enrollment in 1944. The values of K_1 and K_2 were chosen as follows:

TABLE 11

RATE OF CHANGE IN THE PROPENSITY TO ENROLL IN COLLEGE (1944 to 1976)

Year of H.S. Graduation	Income Quartile Low	2	3	High
1944	.160	.321	.415	.572
1945	.161	.321	.416	.574
1946	.161	.321	.417	.577
1947	.161	.322	.418	.580
1948	.162	.322	.420	.584
1949	.162	.323	.423	.588
1950	.163	.324	.426	.592
1951	.165	.326	.429	.596
1952	.167	.328	.433	.601
1953	.169	.330	.438	.607
1954	.173	.334	.444	.612
1955	.177	.339	.451	.619

(TABLE 11 (Continued)

Year of H.S. Graduation	Low	2	3	High
1956	.184	.345	.459	.625
1957	.193	.353	.469	.632
1958	.204	.363	.480	.640
1959	.219	.376	.493	.648
1960	.239	.392	.506	.656
1961	.263	.412	.522	.664
1962	.293	.435	.539	.673
1963	.327	.461	.557	.682
1964	.365	.490	.576	.691
1965	.405	.520	.595	.700
1966	.445	.550	.614	.709
1967	.483	.579	.633	.718
1968	.517	.605	.651	.727
1969	.547	.628	.668	.736
1970	.571	.647	.684	.744
1971	.591	.664	.698	.752
1972	.606	.677	.710	.760
1973	.617	.687	.721	.768
1974	.626	.695	.730	.775
1975	.633	.701	.739	.781
1976	.637	.706	.746	.788

In application of these factors, the enrollment was never allowed to exceed the ever-enrolled rate in any quartile.

TABLE 12

Income Quartile	$K_{i,1}$	$K_{i,2}$
Low	.16	.65
2	.32	.72
3	.41	.75
High	.57	.80

A logistic curve of the form

$$2.\quad y_{i,t} = K_{i,1} + \frac{C_i}{1+\ell^{a+bx}}$$

x=year and y=propensity to enroll was fitted to a pair of known points of each income quartile. The pairs of points described in Section 2 are given below:

TABLE 13

Income Quartile	1960	1966
Low	.23	.46
2	.40	.52
3	.52	.65
High	.68	.74

First-time enrollments for each year from 1960 to 1967 were weighted in the model by the ratio of

$$3.\quad r_{t,i} = \frac{y_{t,i}}{y_{1960,i}}$$

Enrollments of students in years other than the year following graduation was estimated by using the ratios published by the U.S. Bureau of the Census, the proportion of high school graduates who enrolled in college one year after graduation with those aspiring to enroll. These ratios were used in preference to Project Talent ratios of ever-enrolled because of anomalies in the Project Talent data probably due to inflation problems in the five-year follow up.

TABLE 14

RATE OF FIRST-TIME ENROLLMENT IN COLLEGE BY YEARS AFTER HIGH SCHOOL GRADUATION

(Census)

Income Quartile	1	2	3	4	5	6	7
Low	.5	.21	.13	.06	.05	.04	.02
2	.7	.13	.07	.04	.03	.02	.01
3	.8	.08	.05	.02	.02	.02	.01
High	.9	.04	.02	.02	.01	.01	-----

Persistence Rates

The number of years a student was likely to be enrolled in the system was calculated by using Project Talent data and adjusting marginal totals to U.S. Bureau of the Census observed enrollment rates.

- Given enrollment by year, the maximum possible achievement for the 1960 cohort was estimated.
- The actual achievement was then calculated by using Project Talent four-year follow-up interviews. (Table 15)
- The ratio between possible and actual achievement was then used to calculate the survival rates. This is shown in Table 16.
- Beyond five years, the survival rates were projected on the basis of a straight-line fit, to a maximum of ten years or until the value reached zero.

The calculated values were then used to simulate an enrollment cohort for the year 1965. Adjustments were made in the calculated cohort survival rates to have the cohort tally estimates made by the U.S. Bureau of the Census for 1964-1966.

The new survival rates were then used to estimate cohort enrollment rates by sex, income, and aptitude for the period 1960 through 1976. These are reproduced in Table 16.

Mathematical Representation of the Model

The mathematics of calculating the cohorts is as follows:

If the symbol $a_{i,m}$ represents the number of first-time enrolled in college in the i-th income quartile, m-years after high school graduation, then from the values given in Table 14 the maximum possible proportion of the total years of attainment in K years for any given cohort of high school graduate is given by:

$$4.\quad R'_{i,k} = \frac{\sum_{M=K}^{n} A_{i,m}}{\sum_{m=1}^{n} A_{i,m}} \quad \text{for } K = 1,2 \ldots\ldots n$$

TABLE 15

RATES OF ACTUAL ATTAINMENT IN COLLEGE
GIVEN EVER ENROLLMENT
IN FIVE YEARS

Income Quartile	Aptitude Quartile	MALE Fresh-man	Sopho-more	Junior	Senior or BA	Grad. or Prof. Work	FEMALE Fresh-man	Sopho-more	Junior	Senior or BA	Grad. or Prof. Work
1	1	.198	.484	.099	.203	.017	.417	.143	.163	.267	.011
	2	.314	.229	.091	.340	.027	.244	.174	.093	.469	.020
	3	.264	.091	.066	.335	.244	.154	.211	.050	.496	.090
	4	.044	.188	.103	.403	.263	.073	.127	.079	.586	.135
2	1	.272	.253	.148	.310	.016	.179	.522	.074	.220	.006
	2	.300	.255	.140	.216	.089	.134	.273	.190	.295	.108
	3	.131	.163	.168	.401	.137	.279	.130	.155	.368	.068
	4	.145	.076	.124	.428	.227	.127	.109	.168	.398	.199
3	1	.489	.146	.198	.141	.026	.422	.039	.130	.322	.087
	2	.223	.244	.132	.336	.065	.187	.349	.098	.320	.046
	3	.194	.172	.086	.322	.226	.199	.151	.137	.425	.089
	4	.050	.136	.117	.396	.300	.063	.154	.119	.428	.236
4	1	.201	.164	.158	.369	.108	.050	.496	.265	.144	.045
	2	.137	.199	.132	.333	.199	.213	.230	.079	.277	.202
	3	.050	.207	.120	.409	.215	.180	.146	.141	.422	.112
	4	.040	.077	.106	.332	.446	.025	.107	.065	.567	.238

Source: Project Talent 5th Year Interview (unpublished).

Table 16

PERSISTENCE RATES IN COLLEGE IN FIRST FIVE YEARS AFTER
HIGH SCHOOL GRADUATION BY SEX, INCOME, AND APTITUDE

Income Quartile	Aptitude Quartile	MALE 1	2	3	4	5	FEMALE 1	2	3	4	5
1	1	1.0	.530	.360	.290	.030	1.0	.598	.498	.371	.021
	2	1.0	.720	.520	.360	.050	1.0	.798	.658	.655	.038
	3	1.0	.770	.750	.580	.120	1.0	.894	.719	.784	.171
	4	1.0	.850	.800	.700	.210	1.0	.978	.904	.965	.257
2	1	1.0	.700	.520	.380	.020	1.0	.848	.323	.264	.008
	2	1.0	.730	.480	.360	.120	1.0	.894	.639	.471	.150
	3	1.0	.900	.770	.630	.190	1.0	.744	.637	.509	.094
	4	1.0	.890	.850	.770	.310	1.0	.902	.824	.697	.267
3	1	1.0	.520	.380	.180	.030	1.0	.590	.562	.451	.105
	2	1.0	.790	.550	.440	.080	1.0	.830	.484	.404	.056
	3	1.0	.820	.660	.600	.270	1.0	.819	.679	.567	.108
	4	1.0	.970	.800	.760	.360	1.0	.957	.816	.732	.286
4	1	1.0	.800	.660	.530	.120	1.0	.951	.468	.199	.050
	2	1.0	.860	.680	.560	.220	1.0	.788	.574	.505	.222
	3	1.0	.950	.770	.660	.240	1.0	.822	.696	.563	.123
	4	1.0	.960	.910	.820	.500	1.0	.976	.896	.847	.261

TABLE 17

ADJUSTMENT FACTORS ON ENROLLMENT RATES

	Years After High School Graduation 1	2	3	4	5	6	7	8*	9*	10*
Males	1.0	1.0	1.1	1.12	1.25	1.25	1.5	8.25	8.25	8.25
Females	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0425	1.0425	1.0425

*These years in the Census data represent five-year age intervals, hence, the larger factor.

Similarly, using the values in Table 15 the actual attainment in K years of enrollment of the cohort of high school graduates may be calculated by sex, income, and aptitude quartiles.

$$5.\quad R''_{s,i,j,k} = \frac{\sum_{m=k}^{n} b_{s,i,j,m}}{\sum_{m=1}^{n} b_{s,i,j,m}} \qquad \text{for } K = 1,2\ldots m \text{ for } S = 2,2$$

The survival rates in Table 16 for each of the 16 income and aptitude quartiles will then be given by the ratio:

$$6.\quad R_{s,i,j,k} = \frac{R''_{s,i,j,k}}{R'_{i,k}}$$

The 16 rates of enrollment in college over K years, given the probability of enrollment at any time after graduation was calculated from the above by "entering" students for the first time m years after high school graduation and applying the survival ratio $R_{s,i,j,k}$ to those enrolled and then summing for each of the K years. The equations giving the 16 enrollment curves are derived as follows:

Let the matrix

$$7.\quad C_{s,i,j,m,k} = A_{i,m}\, R_{s,i,j,(K-m+1)}$$

where $a_{i,m}$ are the entries in Table 14 and the R_s are the survival curves calculated by equation 6

Summing the resulting C matrix for each of the K years over m yields the enrollment rates for each of the 32 sex, income-aptitude cells.

$$8.\quad S_{s,i,j,k} = \sum_{m=1}^{n} C_{s,i,j,m,k} \qquad \text{for } K=1,2\ldots n$$

Since, however, the Talent distribution of first-time enrollment by income and aptitude appeared to be more reliable than the "ever-enrolled" data obtained from the five-year survey, the curve was adjusted to apply to first-time enrollment by transformation:

$$9.\quad P_{s,i,j,k} = \frac{S_{s,i,j,k}}{S_{s,i,j,1}}$$

The Talent data accounted for only the first five years of enrollment after high school graduation, the enrollment curve was therefore adjusted for years beyond five to simulate the total population included in the U.S. Bureau of the Census estimates. The adjustment factors for males and females are given in Table 17.

The enrollment rates, based on first-time enrollment in the first year following high school graduation, for males and females, is presented in Table 18.

Full-time equivalent enrollment students were estimated from total enrollment by weighting the estimated number full-time students by the ratio of years attained to years attended, obtained from Project Talent data. The ratios are given in Table 19.

Estimates of Full-Time Students

Full-time enrollment by ability and income quartile was calculated from total enrolled by applying differential rates of full-time attendance for each of the 16 groups. It was assumed that part-time students carried a one-third load. Given the above ratios of years attained per years attended, it was possible to calculate the full-time students with the equation:

$$10.\quad y_{s,i,j} = a_{s,i,j} + \frac{1}{3}(1.0 - a_{s,i,j})$$

where:

y = Years attained per years enrolled.
a = Ratio of full-time enrolled to total enrolled.

These estimates were applies to the 1964 cohort, the year for which NCES did their last full-time/part-time census and were scaled to reproduce the NCES estimates. The scaling factor used was .92 on the years attained to years attended ratio.

The estimates used in the model appear in Table 20.

Graduate and First-Professional Degree Students

Estimates of graduate and first professional students are derived in the model in two steps. For the years 1960-1967, NCES estimates of total graduate students by sex were adopted. For the period 1968 through 1976, they are projected as a function of total enrollment based on the fitting of the following function to the period 1960 through 1967:

$$11.\quad y_{s,t} = a s_{s,t}^{b}$$

Where $s_{s,t}$=total enrollment and $y_{s,t}$=NCES estimate of graduate students, the calculated coefficients and exponents were:

a=.054 for males, .027 for females.

b=1.15 for males, 1.18 for females.

The estimated number of graduate students was increased 25 percent, to account for first professional students, in line with observed differences between students enrolled in programs in the fifth year of college as estimated by the U.S. Bureau of the Census and the total graduate enrollment reported by NCES for the period 1964-1966.

The number of full-time graduate students by income quartile and by year was estimated by weighting the relative distribution of all full-time, total enrolled graduate students by an appropriate ratio in each income quartile.

In 1965, the ratio of full-time to total graduate students was 44 percent. The ratio of all full-time to total enrolled students was 63 percent. Hence, a weight of .44=.7 was applied to the ratio of full-time to part-time students in each income cell by sex. For instance, in 1965, the estimate of all full-time students to total male students in the high income cell was .95. It was, hence, estimated that the proportion of full-time graduate students was .95 x .7 = .665 of total enrolled graduate students.

The estimated number of full-time graduate students was subtracted from the estimated number of total full-time students to derive the number of full-time undergraduate students enrolled.

TABLE 18

ENROLLMENT RATES IN COLLEGE BASED ON FIRST-TIME ENROLLMENT

Income Quartile	Aptitude Quartile	1	2	3	4	5	6	7	8	9	10
						MALE					
1	1	1.00	.95	.84	.70	.41	.26	.16	.08	.04	.01
	2	1.00	1.14	1.08	.89	.52	.33	.21	.11	.05	.02
	3	1.00	1.19	1.33	1.21	.75	.51	.30	.18	.10	.04
	4	1.00	1.27	1.42	1.38	.91	.72	.43	.25	.14	.07
2	1	1.00	.89	.75	.60	.23	.13	.08	.04	.02	.01
	2	1.00	.92	.72	.58	.32	.15	.09	.05	.02	.01
	3	1.00	1.09	1.04	.92	.48	.34	.15	.09	.04	.02
	4	1.00	1.08	1.12	1.07	.63	.56	.37	.16	.08	.04
3	1	1.00	.62	.49	.28	.22	.12	.11	.02	.03	.01
	2	1.00	.89	.69	.57	.41	.30	.18	.11	.06	.02
	3	1.00	.92	.80	.74	.42	.31	.29	.18	.10	.05
	4	1.00	1.07	.96	.93	.54	.51	.47	.22	.12	.06
4	1	1.00	.84	.72	.57	.37	.15	.09	.05	.02	.00
	2	1.00	.90	.74	.63	.58	.34	.10	.06	.03	.01
	3	1.00	.99	.83	.74	.64	.49	.27	.08	.04	.01
	4	1.00	1.00	.97	.90	.59	.53	.45	.33	.21	.07
						FEMALE					
1	1	1.00	1.02	1.01	.86	.48	.30	.19	.10	.05	.02
	2	1.00	1.22	1.25	1.26	.68	.43	.26	.15	.08	.03
	3	1.00	1 31	1.35	1.44	.89	.53	.32	.19	.11	.05
	4	1.00	1.40	1.57	1.72	1.11	.65	.39	.24	.14	.06
2	1	1.00	1.03	.58	.47	.18	.11	.07	.03	.01	.00
	2	1.00	1.08	.91	.74	.40	.18	.11	.06	.03	.01
	3	1.00	.93	.88	.76	.34	.17	.10	.06	.03	.01
	4	1.00	1.09	1.09	1.00	.58	.24	.14	.08	.04	.02
3	1	1.00	.69	.68	.57	.23	.09	.06	.04	.02	.01
	2	1.00	.93	.63	.53	.17	.09	.06	.03	.02	.01
	3	1.00	.92	.82	.71	.25	.11	.07	.04	.03	.01
	4	1.00	1.06	.97	.90	.46	.14	.09	.06	.04	.02
4	1	1.00	1.00	.53	.26	.10	.04	.02	.01	.00	.00
	2	1.00	.83	.63	.57	.29	.05	.03	.02	.01	.00
	3	1.00	.87	.75	.63	.19	.05	.03	.02	.01	.00
	4	1.00	1.02	.96	.93	.35	.07	.05	.03	.01	.00

TABLE 19

RATIO OF YEARS ATTAINED PER YEARS ATTENDED

Income Quartile	MALE Aptitude Low	2	3	High	FEMALE Aptitude Low	2	3	High
Low	.691	.711	.774	.886	.726	.778	.739	.849
2	.676	.744	.819	.901	.738	.763	.785	.889
3	.679	.767	.844	.924	.714	.758	.835	.897
High	.661	.831	.894	.946	.763	.816	.867	.950

TABLE 20

RATIOS OF FULL-TIME ENROLLMENT TO TOTAL ENROLLMENT BY SEX, INCOME, AND APTITUDE

MALE

Income Quartile	Aptitude Low	2	3	High
Low	.454	.481	.569	.723
2	.433	.526	.630	.743
3	.437	.559	.665	.775
High	.412	.647	.733	.805

FEMALE

Income Quartile	Aptitude Low	2	3	High
Low	.502	.574	.520	.672
2	.519	.553	.583	.727
3	.486	.546	.652	.738
High	.553	.627	.696	.810

TABLE 21

MEAN STUDENT COSTS BY SEX AND INCOME QUARTILE

	MALE		FEMALE	
Income Quartile	Tuition Expense	Living Cost	Tuition Expense	Living Cost
Low	319	559	290	509
2	411	728	394	762
3	333	557	311	528
High	401	772	397	762
Annual Increment	r_T =.06	r_L =.02	r_T =.06	r_L =.02

FINANCIAL ASSISTANCE REQUIREMENTS

The total need for assistance in the financing of the cost of higher education for full-time undergraduate students, the difference between total student costs and total family contribution was estimated on three alternative bases in the model for Low and High enrollment projections.

Needs based on mean expenditures. Mean costs reported by full-time students for Project Talent by sex were calculated for each of the four income groups, and Mean parental contributions were calculated for each income quartile from the College Scholarship Service expected of parental support for college expenses for families with two children. [3]

The estimated college costs from Talent were in 1960 dollars, and these were incremented at an annual rate of 6 percent for tuition expenses and at 2 percent for living costs. Parental incomes were allowed to grow at 5 percent annually, assuming a 2 percent rate of inflation. Parental contributions, in 1966 dollars, were incremented at a varying annual ratio as shown in Table 22 in such a way that the 1966 proportion of the real income was actually set aside for college expenses. The gap, $g_{t,i}$ was calculated as follows:

Let

$$T_{t,s,i} = \sum_j {}^{T}C_{s,i} \cdot E_{s,t,i,j} \cdot (1+n_t)^t$$

$$L_{t,s,i} = \sum_j {}^{L}C_{s,i} \cdot E_{s,t,i,j} \cdot (1+r_L)^t$$

$$K_{t,s,i} = \sum_j P_i \cdot \sum_s E_{s,t,i,j} \cdot (1+r_k)^t$$

Then

$$12. \quad g_{t,i} = \sum_s T_{t,s,i} + L_{t,s,i} - K_{t,s,i}$$

If T + L - K was < 0, then $g_{t,i}$ was made = 0.

T = Tuition cost by sex and income quartile.
L = Living cost.
K = Parental contribution by year, second income quartile.
E = Estimated enrollment by year, sex, income, and aptitude.
C = Student costs for tuition or living expenses as indicated in the superscript.
P = Parental contribution.

TABLE 22

PARENTAL CONTRIBUTIONS TO COLLEGE EXPENSES BY INCOME QUARTILE

	INCOME QUARTILE			
r_k =	Low .22	2 .07	3 .08	High .014
1966	$ 20	$ 750	$1,360	$3,500
1967	25	795	1,458	3,565
1968	35	843	1,633	3,630
1969	43	898	1,730	3,698
1970	56	977	1,887	3,767
1971	68	1,071	2,023	3,836
1972	82	1,158	2,134	3,908
1973	96	1,297	2,281	3,980
1974	111	1,319	2,464	4,054
1975	120	1,410	2,751	4,129
1976	149	1,532	2,869	4,205

2. Distribution of college-enrolled male and female students by tuition cost and living expenses were calculated from Project Talent data. These distributions are given in Tables 23 and 24. On the assumption that students who pay the lowest tuition also have the lowest living cost, 16 combined tuition-living cost curves were calculated for men and women by quartile.

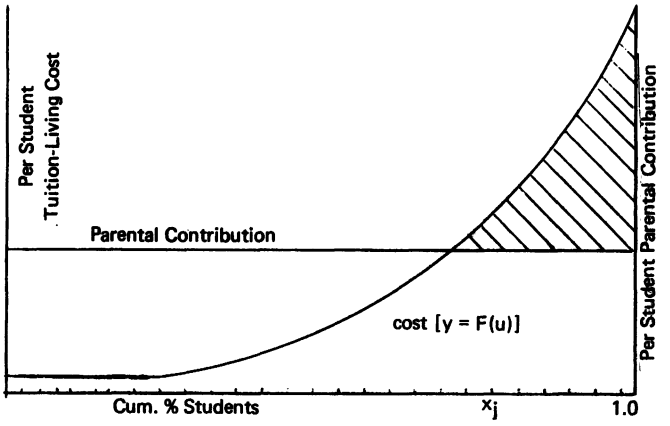
An exponential curve of the form:

$$13. \quad y = ae^{bx}$$

(where x = Percentile scale; y = Combined cost per student) was fitted to each of the 16 cost curves, and the "GAP" was then recalculated on

the following basis:

Given the two cumulative curves on the graph below, representing the combined student costs and the parental contribution, the shaded area represents the total gap between student costs and parental contribution.



The "GAP" in a given income quartile is the sum of the gaps calculated for men and women in that income quartile, by the equation:

$$14.\quad g_{t,i} = E_{t,i} \cdot \sum_{s} \left(\int_{j}^{1.0} f_{s,i}(u)\, du - (1-x_j)P_i \right)$$

TABLE 23

DISTRIBUTION OF COLLEGE-ENROLLED STUDENTS BY SEX, FAMILY INCOME QUARTILE, AND TUITION EXPENSES

MALE

Tuition Expense	Income Quartile 1	2	3	4
50	.029	.024	.022	.018
75	.090	.069	.060	.039
150	.146	.124	.106	.085
250	.195	.162	.130	.117
400	.166	.197	.207	.175
625	.145	.115	.130	.130
875	.129	.142	.128	.125
1250	.082	.134	.157	.190
1500	.017	.034	.060	.123

TABLE 23 (Continued)

DISTRIBUTION OF COLLEGE-ENROLLED STUDENTS BY SEX, FAMILY INCOME QUARTILE, AND TUITION EXPENSES

FEMALE

Tuition Expense	Income Quartile 1	2	3	4
50	.032	.027	.020	.012
75	.076	.054	.060	.041
150	.141	.102	.111	.075
250	.173	.369	.154	.103
400	.216	.156	.201	.166
625	.152	.106	.126	.129
875	.092	.090	.135	.139
1250	.108	.080	.144	.202
1500	.011	.016	.049	.134

TABLE 24

DISTRIBUTION OF COLLEGE-ENROLLED STUDENTS BY SEX, FAMILY INCOME QUARTILE, AND LIVING COSTS

MALE

Living Costs	Income Quartile 1	2	3	4
300	.428	.373	.331	.216
400	.209	.162	.163	.142
625	.207	.250	.232	.195
875	.110	.143	.173	.213
1250	.041	.062	.084	.170
1750	.001	.007	.013	.044
2250	.001	.002	.003	.013
2750	.000	.001	.000	.004
3000	.000	.002	.002	.004

FEMALE

Living Costs	Income Quartile 1	2	3	4
300	.439	.383	.288	.201
400	.239	.192	.179	.147
625	.229	.245	.260	.222
875	.066	.127	.181	.221
1250	.023	.043	.074	.152
1750	.001	.007	.013	.037
2250	.003	.001	.004	.013
2750	.000	.001	.001	.002
3000	.000	.001	.001	.006

3. Student costs and the financial gap were calculated on the basis of a third set of alternative assumptions as follows:

   The number of students in the lower and upper two-year levels in all institutions were calculated from ratios obtained from Project Talent data and from projections of full-time undergraduate students.

TABLE 25

FULL-TIME UNDERGRADUATE STUDENT IN ALL INSTITUTIONS IN ACADEMIC LEVEL

Income Quartile	Lower 2-Years	Upper 2-Years
Low	.70	.30
2	.65	.35
3	.60	.40
4	.55	.45

Average student costs were calculated from cost estimate given in Table A-6 of *Students and Buildings* [4] and the entries in Table 25 above by the equation.

$$15. \quad \bar{C}_{i,m} = \Sigma\, d_{i,j} \cdot C_{j,m}$$

where $\bar{c}$ = average cost, d = the entries in Table F-5 and c = the cost factors from *Students and Buildings* (see Tables 26 and 27)

TABLE 26

ASSUMED COST FACTORS

Academic Level	Tuition m = 1	Living Exp. m = 2
Lower 2-yrs.	$103	$1,000
Upper 2-yrs.	278	1,283

TABLE 27

AVERAGE STUDENT COSTS

Income Quartile	Tuition	Living Exp.
Low	$156	$1,084
2	164	1,100
3	173	1,112
4	182	1,175

The projected student costs for each year by income quartile may be calculated from the above by the equation:

$$16. \quad C_{t,i} = \sum_{m} E_t \cdot \bar{C}_{i,m} \cdot (1+rm)^t$$

and as in hypothesis one the gap, $g_{t,i}$, is calculated as the difference between student costs and parental contribution.

NOTE 1

Explanation of Symbols (Equation 1)

E = Total Enrollment.

d = Distribution of High School Graduates by Sex, Income, and Aptitude.

f = First-Time Enrollments in College in Year Following High School Graduation by Sex, Income, and Aptitude.

r = Rate of Growth in the Propensity of High School Graduates to Enroll in College by Income, 1944-1976. Table 11. (p.).

P = Enrollment Rates in College in Years after High School Graduation, Given First-Time Enrollment in First Year Following High School Graduation by Sex, Income, and Aptitude. Tables 9, 10. (p.).

G = Estimated Number of High School Graduates by Sex. Source: U.S. Office of Education Publication Projections of Educational Statistics to 1976-1977.

Subscripts:

t = Current Year.

s = Sex.

i = Income Quartile (1 = low, 4 = high).

j = Aptitude Quartile (1 = low, 4 = high).

n = Years Since High School Graduation.

REFERENCES

[1] It should be noticed that the realtionship between total and full-time equivalent enrollment varies from year to year in the projections, and is different from NCES estimates. Full-time equivalent enrollments have been imputed by the model on the basis of attendance rates by quartile. NCES projects a slightly changing mix between full-time and part-time students. See Technical Appendix C.

[2] National Center for Educational Statistics, *The Academic and Financial Status of Graduate Students,* (Washington, D.C., Government Printing Office), 1965.

[3] Financing a College Education. *A Guide for Counselors.* 1966. College Entrance Examination Board.

[4] *Students and Buildings,* U.S. Department of Health, Education, and Welfare, U.S. Office of Education, Government Printing Office, Washington, D.C., 1968.