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ABSTRACT

After World War II, enrollment in the Japanese educational system underwent an unprecedented expansion, largely on account of postwar economic growth. Although such expansion was common throughout the world, Japan's experience was unique because of the magnitude of changes in the enrollment rates and the degree to which these changes directly reflect popular demand rather than government intervention. Accordingly, this study is a systematic quantitative analysis relating the increased demand for education in Japan to economic variables. The study addresses three questions: (1) What caused the educational expansion? (2) How did it keep momentum for such a long period? and (3) Why did it finally lose momentum in the mid-1970s? After an introduction establishing the framework and issues of analysis, the first chapter sets forth a theoretical framework by creating a model of individual choice from which the aggregate demand function of education can be derived. Chapter II examines internal rates of return of senior high school and college education from 1954 to 1980, and analyzes changes in the benefit-cost ratio over this period. Then alternative indicators of anticipated educational benefits are constructed, based on hypothetical models of rational expectation. Based on this analysis, chapter III presents the methods and results of a time-series regression analysis that discloses determining factors of the actual changes in enrollment rates. The original sources and methods of estimation of the data used in the text are appended: (1) the estimation of cohort enrollment rates; (2) the wage-profile by education; (3) the direct costs of senior high school and college education; and (4) the time-series economic indicators. The last two appendices examine the difference between the United States and Japan and the gender differentials in economic returns to education. (TE)

ENROLLMENT EXPANSION IN POSTWAR JAPAN

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The views presented here are those of the author, and they should not be interpreted as reflecting those of the Research Institute for Higher Education, Hiroshima University.

Enrollment Expansion in Postwar Japan

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PREFACE

The origin of this monograph is my doctoral dissertation presented in 1984 to the University of Chicago. The dissertation, titled "Educational Expansion in Postwar Japan: A Theoretical and Empirical Study," encompassed the analysis of their distribution across family income classes. Only the parts that dealt with the changes in enrollment rates over time are presented here.

In editing the original manuscripts, I was frequently caught by the idea that I should rather rewrite them completely. It was unmistakable that some of the theoretical arguments demanded mor clarification, the empirical analyses an update and the descriptions conciseness. Moreover, when writing the original dessertation I was not fully aware of the significant analytical developments made in Japan by Professors Joji Kikuchi (1982), Masakazu Yano (1984), Shin'ichi Yamamoto (1979), Ikuo Amano et al (1983) and others. On the other hand, I thought if the study were available even in the present form it might be of some use in rendering a basis for future academic dialogue in the field. Eventually, prudency gave way to my reckless character.

I am grateful to Professors Mary Jean Bowman, Robert T. Michael and John Craig for their generous assistance when I was preparing the original dissertation. Without the encourageent from my colleagues in the Research Institute of Higher Education at Hiroshima University this manuscript would have not been published. I am grateful to the friendship of still other people to whom I owe much.

Motohisa Kaneko
Hiroshima, February 1987

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LIST OF NOTATIONS AND ABBREVIATIONS

1. List of Notations

Notation	Stands for:	Definition in Eq.:
B	Anticipated benefit for education	(1.6)
C	Effective cost of education	(1.11)
D	Net effect of residual factors in demand for education	(1.24d)
E	Cohort enrollment rate	(A.)
$F(\cdot)$	Cumulative density function of unobserved variables	(1.19)
$\dot{L}(P)$	Logit change rate of enrollment rate	(3.1)
P	Demand rate for education	(1.21)
Q	Summary index of the differences in FISER	(1.38)
R	Anticipated money benefit/cost (b/c) ratio	(1.16)
$\hat{R}$	Classical benefit/cost ratio	(2.1)
R^A	Type A index of anticipated benefit of education	(2.10a)
R^B	Type B index of anticipated benefit of education	(2.10b)
R^C	Type C index of anticipated benefit of education	(2.10c)
S	Size of eligible population	(3.1)
Y	Family income	(1.12)
Y^M	Median family income of the eligible population	(1.14)
Y^N	"Bench-mark" family income level	(1.12)
DC	Direct cost of education	(2.2b)
FE	Foregone earnings	(2.2b)
a	standardized index of ability	(1.9)
b	Anticipated money benefit of education	(1.9)
c	Anticipated face-value cost of education	(1.11)
$f(u)$	Probability density function of u	(1.4)
g	Anticipated productivity growth rate	(2.5)
i	Discount rate for future income stream	(2.1)
i^*	Internal rate of return (IRR)	(2.1)

Notation	Stands for:	Definition in Eq.:
k	Adjustment factor for non-monetary benefit of Education	(1.8)
nb	Anticipated non-monetary benefit of education	(1.6)
p	Probability of choosing education	(1.20)
u	Net effect of unobserved variables	(1.2)
v	Net benefit of education	(1.18a)
w	Anticipated future wage	(2.3)
$\hat{w}$	Observed wage in the current labor market	(2.1)
x	Net benefit derived from individual attributes	(1.18b)
z	Net benefit derived from environmental variables(1.18c)	
$\mathbf{w}$	Vector of anticipated future wage structure	(2.6)
$\mathbf{x}$	Vector of personal attributes	(1.2)
$\mathbf{z}$	Vector of environmental variables	(1.2)
Δ	Distributed-lag operator	(2.10a)
α	Elasticity of the anticipated benefit of education with respect to ability	(1.9)
β	Elasticity of the effective cost of education with respect to family income	(1.12)
δ	Elasticity of supply of educational opportunity with respect to the demand rate	(2.10a)
ϵ	Elasticity of financing cost of education with respect to consumption level	(1.26)
γ	Reciprocal of the variance parameter of the net effect of the unobserved variables	(1.19)

2. List of Abbreviations

Abbr.	Standsfor:	Description in
FIES	Family Income and Esxpenditure Survey	App. A
FSS	Fundamental School Survey	App. A
FWSS	Fundamental Wage Structure Survey	App. B
IRR	Internal rate of return	Chp. II, Sec. 1
MoE	Ministry of Education, Japan	—
MoL	Ministry of Labor, Japan	—
MoW	Ministry of Welfare, Japan	--
MWS	Monthly Wage Survey	App. B
NLSS	National Living Status Survey	App. E
OoPM	Office of the Prime Minister, Japan	—
SPEE	Survey of Parental Expenditures on Education	App. C
SLSS	Students' Living Status Survey	App. E

INTRODUCTION

1. TRENDS OF EDUCATIONAL EXPANSION

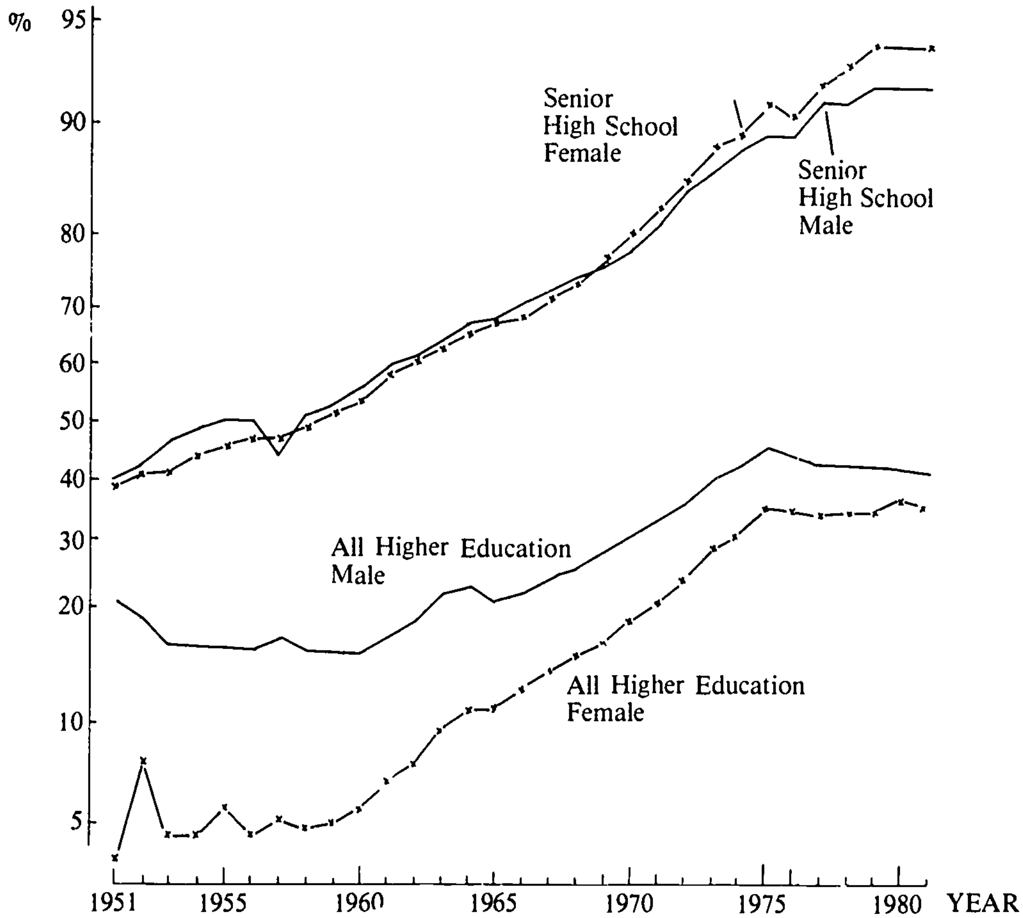
After World War II, the Japanese educational system was transformed into a four-tier system, consisting of 6 years of primary school, 3 years of junior high school, 3 years of senior high school, and 2 years of junior-college or 4 years of college.[1] In this 6-3-3-4(2) system, enrollment in senior high school (at age 15 or over) and in college or junior-college (at age 18 or over) were not compulsory. With the advance of the postwar economic growth, however, the enrollment rates at these levels of education started unprecedented expansion.

Trends of Enrollment Rates in Postwar Japan

Figure 1 presents the changes in the cohort enrollment rates[2] in senior high school and in higher education (including junior-college and college) by sex. The vertical axis is measured in the logit value, so that the "ceiling effect" observed when rates approach the 100-percent mark is presumably removed.[3]

As the figure clearly illustrates, the increaes in enrollment rates were indeed vigorous and consistant. The male enrollment rate (full-time) in senior high school increeased from 40 percent in 1951 to 80 percent by 1971, and eventually almost to the 90-percent level by 1975. The female enrollment rate in senior high school started from a slightly lower level (38 percent) than the male enrollment rate but, since its increase in the postwar periods was even more pronounced, it eventually reached 91 percent in 1975. On the whole, the twenty-five year period from 1950 to 1975 brought about increases of about 50 percentage-points in both the male and the female enrollment rates. The changes in higher education were no less dramatic. male enrollment rate in higher education (including full- and part-time enrollment in junior-colleges and college) was stagnant in the 1950s at around 16 to 21 percent. But with the advances of the 1960s it started a steady increasing trend, to reach the 25-percent mark in 1967 and the 30-percent mark in 1970, and eventually rose to 45 percent by 1975. In the fifteen years from 1960 to 1975, the male enrollment rate in higher education almost tripled.

The female enrollment rate in higher education grew by more than five times.[4]



Note: Vertical axis is logit-transformed.
Source: Appendix A.

FIG. 1: COHORT ENROLLMENT RATES IN POSTWAR JAPAN, 1951-81

But, after the years of steady educational expansion, the momentum of increase started to diminish in the mid-1970s. After almost having reached the 90-percent level in 1975, the male enrollment rate in senior high school showed in 1976 the first decline in twenty-five years. Even though there was a sign of slight recovery in the subsequent years, the past vigor of growth apparently disappeared in the second half of the 1970s. The female enrollment rate also showed a slight decline in 1976, and the pace of increase apparently slackened towards the end of the 1970s.

The inflection of the growth trend at around 1976 was demonstrated even more dramatically by the enrollment rates in higher education. Male enrollment rate in higher education, which reached the 45-percent mark in 1975, fell in 1976 for the first time in fifteen years and eventually dwindled down to 41 percent by 1981. The female enrollment rate in higher education also showed a decrease in 1976 remained in the range of 34-35 percent even since.

Thus, with the turning point at around 1976, the unprecedented epoch of postwar educational expansion had apparently come to an end in Japan.

Cyclical Changes in Enrollment as a Universal Phenomenon

The rise, and the subsequent fall, of educational expansion in the postwar period was by no means a peculiar phenomenon to Japan.

Table 1 persents the changes in proportion of 18-19 year-olds and 20-24 year-olds who are enrolled in schools (enrollment ratios) in the United States. The male enrollment ratio increased from 1960to 1968, halted at the end of the 1960s, declined by more than ten percentage points in the first half of the 1970s and then levelled off. The female enrollment ratios also started increasing in the 1950s; their momentum grew somewhat later than that for males, and remained well into the 1970s. But after 1976, even the increase of female enrollment rate appears to have come to an end.

TABLE 1

ENROLLMENT RATIOS IN THE UNITED STATES FOR AGE 18-19 AND 20-24 (%)

Year	Male		Female	
	Age 18-19	Age 20-24	Age 18-19	Age 20-24
1950	35.7	14 3	24.3	4.6
1960	47.9	19.9	30.0	7.4
1964	50.9	23.8	33.7	10.8
1968	60.4	30.5	41.2	14.3
1970	54.4	29.3	41.6	15.1
1972	51.1	27.8	41.8	16.1
1974	45.8	25.8	40.7	17.3
1976	48.2	26.0	44.4	20.8
1978	47.8	24.3	42.9	19.4
1980	47.1	23.2	45.8	20.8

Source: U.S. President 1981, table B-9.

Table 2 presents the changes in enrollment ratios in higher education, defined as the proportion of those enrolled in high education in the population of age 20-24, in selected West European countries. In the sixteen-year period between 1960 to 1976, the male enrollment ratio for the 20-24 year olds increase from 11 to 25 percent in France, from 13 to 30 percent in the West Germany, from 10 to 31 percent in Italy, from 11 to 35 percent in Sweden, and from 13 to 25 percent in the United Kingdom. The female enrollment ratios were slower in starting the growth, but showed substantial increases in the later 1960s and the early 1970s. Although in some countries the expansion is thought to have started already in the late 1950s (Edwards and Robert 1980, p.15), it is indisputable that in most of the selected countries by far the greatest part of the postwar educational expansion took place in the 1960s and the first half of the 1970s. The momentum of increase, however, apparently lessened substantially in the midst of the 1970s, and since then the change in the enrollment ratios has been negligible esxcept in Sweden.

TABLE 2

ENROLLMENT RATIOS IN SELECTED EUROPEAN COUNTRIES FOR AGE 20-24 (%)

Year	France		W. Germany		Italy		Sweden		U.K.	
	M	F	M	F	M	F	M	F	M	F
1960	11.4	8.2	12.9	3.8	9.5	3.6	11.4	6.6	12.8	4.1
1965	21.8	14.4	13.1	4.3	14.1	7.3	15.1	11.0	16.4	7.0
1970	22.8	16.0	19.2	7.4	20.4	12.9	24.0	18.5	18.6	9.5
1972	—[a]	—[a]	—[a]	—[a]	24.7	15.9	24.5	18.3	19.0	11.0
1974	24.1	22.4	25.1	12.9	28.3	18.9	23.5	20.7	20.9	12.1
1976	24.5	24.8	29.6	19.0	31.2	21.1	35.3	26.5	24.2[b]	14.1[b]
1978	24.6	23.8	30.0	21.1	31.5	23.1	38.7	34.4	25.1	14.4
1979	26.7	23.6	30.5	22.1	30.6	23.4	—[a]	—[a]	24.6	14.6

Sources: Unesco 1970, table 2.5; idem 1975, 1978 and 1982, table 3.2.

[a] Data not available.

[b] Average of the 1975 and 1977 figures.

The review o the enrollment rates thus makes it evident that the rise of what can be called the "great educational expansion" in the process of postwar economic growth and its subsequent fall at some time in the 1970s is an experience shared by many industrialized countries.[5]

Japan as a Challenging Case

From analytical points of view, however, Japan's experience was unique for the following two reasons.

First, the magnitudes of the changes in enrollment rates, and the economic growth that the society underwent at the same time, were greater in Japan than in most other industrialized countries. Over the period 1950-75, the increase in cohort enrollment rates in higher education was almost 30 percentage-points both for males and for females in Japan, compared to the increases in the enrollment ratios for age 18-19 of 12 percentage-points for male and 20 percentage-points in the United States. In the selected West Europeana countries the increases in enrollment ratios for age 20-24 over 1960-1979 fell in the range between 10 and 20 percentage-points esxcept for Sweden, where radical educational reform took place. Meanwhile, the Japanese economy grew tremendously over this period, averagedly at the rate of 8.0 percent per annum in real terms for 1961-80. The corresponding growth rates were 3.6 percent for the United States, and 4.1 percent for the European Countries (United Nations 1981, vol.II, table 6a, pp.338, 289 and 347). Therefore, the dynamic interaction between educational expansion and economic growth must have been demonstrated more drastically in Japan than in the other nations.

Second, the government intervention in education had less effect on the changes in enrollment rate in Japan than in other countries. In the European nations the major segments of the secondary and tertiary education are under the direct control of the various levels of governments, and therefore the sizes of enrollment are determined to a large extent by the governmental policies.[6] This creates serious problems in identifying the demand for education, and in the economic analysis of enrollment rates (Blaug 1976, p.831). In contrast, the Japanese educational system comprises a large private sector, which constitutes about one-third of total enrollment capacity at senior high school level and three-fourths at higher education level.[7] Consequently, of the total increases in the number of students in four year colleges over the period 1950-80. 79 percent are attributed to the increase in the private institutions. In the United States only 25 percent are attributed to private institutions (Kaneko 1984). Therefore, the observed changes in enrollment in Japan must have closely reflected the changes in the popular demands for education,[8] thus enabling systemamtic quantitative analyses about the demand for education in relation with economic variables.

Hence, Japan's experence would provide a promising case for empirical inquiries into the nature of educational expansion in the postwar period.

2. THE FRAMEWORK AND ISSUES OF ANALYSIS

What caused the educational expansion? How did the expansion keep momentum for such a long period? Why did it finally loose the momentum in the mid-1970s? It is these questions about the causes the unprecedented educational expansion that the present study addresses through theoretical and empirical analyses. Before embarking upon such analyses, however, it may be helpful to place the scope of the present study in a wider perspective on educational expansion in the course of economic development.

General Frame-of-Reference

Our general frame-of-reference about the relation between education and economic development can be called the "Human Capital Market" model, the outline of which is presented in Figure 2. The Human Capital Market comprises two subsystems. One is the "Education Market," where the demands for education that originate from educational choices of individual households meet the supplies of educational opportunities from educational institutions.[9] The other is the "Labor Market," where the supplies of labor-force with various levels of educational qualifications meet the corresponding demands from business institutions.

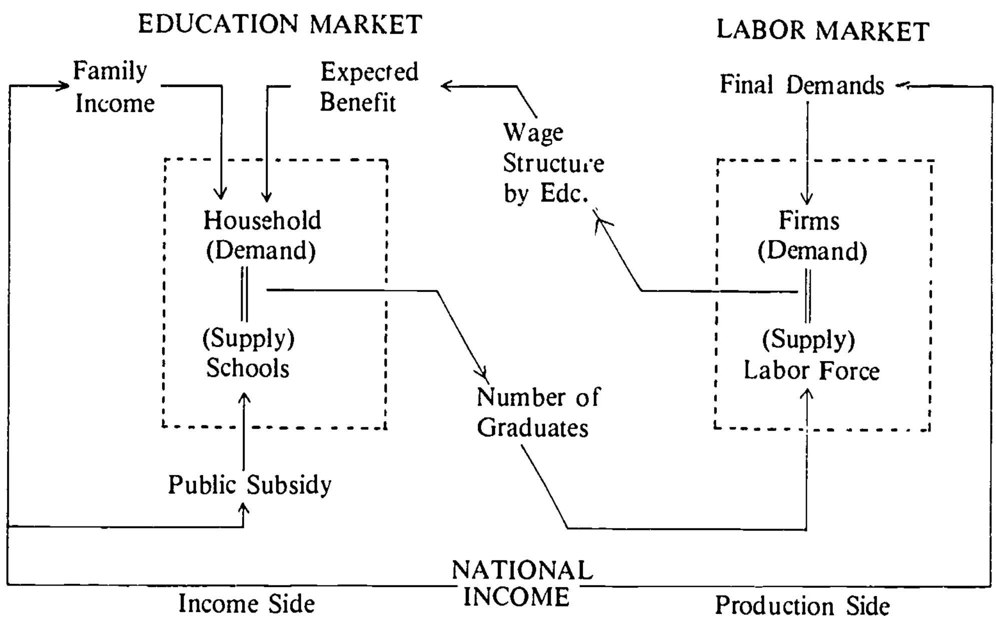


FIG. 2: THE HUMAN CAPITAL MARKET MODEL

The level of economic development affects the two markets in two ways. On the income/expenditure side, the level of the national economy affects the demand for education through the level of household income, and the supply of educational opportunities through public subsidies to education. On the production side, the level of economic development determines the level and distribution of final demands, and consequently the demands for educated labor.

The two susystems are also directly related to each other: equilibrium in the Education Market determines the enrollments in schools and in the long-run the supply of labor by education; equilibrium in the Labor market, in turn, affects the anticipated benefits of education and hence the demands for education from households.

The Human Capital Market model thus illuminates that a comprehensive study of changes in enrollment rates in the course of economic development will be complete only when it encompasses both the Education Market and the Labor Market in its perspective.[10] Numerous theoretical and empirical problems should be examined, however, before attempting a systematic analysis to reveal the nature of the general equilibrium of the human capital market. By focusing only upon the Education Market, and designating the family income and the wage differentials by education as the exogeneous variables, the present study purports to be a partial equilibrium analysis of the Human Capital Market. The analysis, nevertheless, should render a basis for more comprehensive analyses in future.

Hypotheses and Analytical Issues

The basic proposition of the present study is that the changes in the demand in the Education Market can be explained consistently by accounting for the following two factors: (1) the increase in the levels of family-income, which, by reducing the effective cost of education, tends to increase the demand for ducation; (2) a positive or negative change in the anticipated (expected) benefit[11] of education, which reflets the Labor Market demand for education. The demand-supply interaction in the Education Market determines the actual enrollment. Here an important factor is the change in the size of the eligible population, which, due to short-run inelasticity of supply of educational opportunities, creates a gap between the latent demand for education and the realized enrollment in schools.

The economic analyses of the aggregate demand for education in the 1960s (Cambell and Siegel 1967, Galper and Dunn 1969) postulated the aggregate demand as a function of family income levels and the direct cost of education, thus neglecting the benefit of education. With the advent of human capital theory the focus of analyses swung to the net benefit (measured in terms of the internal rate of return or other indices) of education as a determinant of educational demand. The scope of the empirical analyses, however, laid mainly on individual choice about education; the number of analyses seeking to relate the aggregate demand for education to the benefit of education is limited to a few (Handa and Skolnik 1975; Freeman 1975) to date.[12] The analytical framework in this study encompasses both family income and the anticipated benefit of education as explanatory variables of the demand for education.[13]

Before examining the validity of such a proposition on empirical grounds, two theoretical issues will have to be addressed.

The first issue concerns functional form of the aggregate demand function of education. Early studies of the demand for education assumed a linear or log-linear relation between enrollment rate and the designated determining variables and subjected it to time-series regression analysis. It has been pointed out that, since the dependent variable in this scheme has definite value boundaries by definition, the estimation results are likely to be biased (Hanushek and Jackson 1977, pp. 179-187).

An increasingly popular method of bypassing this problem is to apply the logit or probit transformation to enrollment rate, and to assume a linear relation between the transformed value and the determining variables (Meyer et al. 1979). The ultimate issue, however, does not lie in the estimation technique, but rather in the functional form of the aggregate demand function and its theoretical grounds. Further theoretical development thus calls for construction of a theoretical aggregate demand function for education. Such a function may be obtained by postulating a model of individual choice about education, and by aggregating it systematically for the population (Daganzo, 1979). The recent development of the models of individual choice about education (Bowman 1982; Radner and Miller 1975, Willis and Rosen 1979) would provide the necessary basis.

The second issue concerns the changes in the anticipated benefit of education over time. Times-series analyses of the demand of education would require annual data about the benefit of education for a period of substantial length. Fortunately, Japan is one of the very few countries where the necessary data are available.[14] It should be recognized, however, that the conventional indices of the benefit of education are directly derived from the wage profiles observed in the current labor market. When they are used as indicators of the anticipated benefit of education, it is implicitly assumed that a typical individual has perfect knowledge about the current wage structure, and that he would expect the wage structure to prevail over his working life. Since these assumptions are unrealistic, it is conceivable that the benefit of education measured in terms of the conventional indices (which we will call the "classical indices" hereafter) contributes little to explain the changes in the observed demand for education. It is therefore necessary to develop alternative indices of the anticipated benefit of education that integrate both subjective factors and observed wage structures. Operational formulation of such indices would raise difficult problems, for little is known about the subjective structure whereby a typical individual would form expectations about the benefit of education. Nonetheless, the recent contribution of rational expectation theory to macro economics indicates that such an approach may prove to be fruitful in bringing fresh insights into the analysis.

3. PLAN OF THE STUDY

The rest of this study consists of three chapters, conclusions and six appendices.

Chapter I caters to the first methodological question mentioned above by setting forth the theoretical framework about the changes in the demand for education. We start the analysis by building a model of individual choice about education, and therefrom derive the aggregate demand function of education.

Chapter II which deals with the second methodological problem, presents the estimation results of the classical indices of the benefit of education and examine the alternative indices. We first estimate the internal rates of return of senior high school and college education for men and women for the time period 1954-1980, and analyse the changes in the benefit/cost ratio over the observed period. Then, alternative indices of anticipated benefit of education are constructed, based on hypothetical models of rational expectation.

Based on these analytical ground, Chapter III persents the methods and results of regression analysis. The scheme of the regression in Chapter I, and the results of the time-series regression analysis thus constructed are subsequently summarized and examined. Based on selected results of the regression analysis, the actual changes in enrollment rates are attributed to the contribution of each of the three determining factors.

The original sources and the methods of estimation of the data used in the text are described in the appendices. Appendix A notes the estimation of cohort enrollment rates; Appendix B, the wage-profile by education; Appendix C, the direct costs of senior high school and college education; Appendix D, the time-series economic indicators. Appendices E and F will complement Chapter II by examing the difference between the U.S and Japan and the gender differentials in economic returns to education.

Notes

1 An exception to this four-tier system is the "Koto Kogyo Senmon Gakko" [Engineering Polytechnique] instituted in 1963 It is essentially a combination of senior high school and junior-college in terms of the requirements for entrance and graduation, but its curriculum is characterized by a heavy concentration on engineering Its significance in terms of enrollment has been limited, accounting for about 1 percent of the junior high scool graduates advancing to further education. See (Bowman 1983, pp 17-18)

2 The cohort enrollment rate for year t is defined as the proportion of those who enrolled in year t or after in a particular level of education out of the total size of the school-age cohort that reached the eligible age in year t See Appendix A for a detailed definition of the cohort enrollment rate and the method of its estimation.

3 The logit value is derived simply from the formula $ln\ P/(1-P)$, where P stands for the cohort enrollment rate. The theoretical basic of the use of the logit transformation will be descussed in Chapter I

4 Female enrollment in higher education is heavily concentrated in two-year junior-colleges, and a substantial part of the increase in the enrollment rate was due to the increase in enrollment in junior colleges Nonetheless, enrollment in four-year colleges also increased steadily over this period

5 It should be noted, however, that there were slight differences in the trends of enrollment rates by region or by sex The expansion of enrollment ratios in the United States progressed primarily in the 1950s and 1960s, while in est Europe and in Japan it gained momentum in the 1960s and continued into the first half of the 1970s In most countries the female enrollment ratios were late to start the expansion relative to male enrollment ratios, but in the subsequent years they gained momentum that continued for some time after the male enrollment ratios started stagnating.

6 Since the educational policies are affected by the popular demands through political processes, the change in enrollment rates would reflect the changes in the demand for education in the long run But the correspondence is likely to be more remote

7 The prefectural or municipal governments establish and manage the public senior high schools and a small number of public universities and colleges, and the national government finances the national universities. Private institutions at secondary level should be chartered by the prefectual governments, and those at higher level are required to be chartered by the national government In 1971, 31 percent of the students in senior high schools and 75 percent of the students in the four-year colleges were enrolled in private institutions.

8 The rough correspondence between the observed changes in enrollment rates and the changes in potential demands for educational opportunities in Japan can be evidenced also by a longitudinal comparison of opinion surveys Asked about the desired education for their son, 56 percent of the parents surveyed in 1969 responded a college education, the proportion increased to 70 percent by 1973, but remaianed at almost the same level by 1976 (Japan, Office of the Prime Minister, Center for the Youth Problems 1981, pp.120-122).

9 The concept of "Education Market" in combination with Labor Market was first used by Blaug (1966, p 166) and then by Freeman (1971, p.28)

10 The models of the changes in aggregate demand for education by Freeman (1976) and by Dresch (1975) were addressed to some particular aspects of the interaction between the two markets

11 Hereafter the word "anticipated benefit" is used in place for "expected benefit" to avoid confusion with "expectation" in the statistical sense

12 Blaug, criticizing human capital theory, remarked "... it is surprising how little attention has actually been devoted to an explanation of the private demand for schooling . " (1976, p 831), and further, "When we consider that the private demand for ormal schooling is, as it were, at the center of the human-capital research program, the results to date begin to raise doubts as to whether the program is indeed 'progressing'" (ibid., p 836).

13 Occasionally it is argued as if human capital theory dectates that changes in the demand for education are solely determined by the changes in the benefit of education But Becker (1976, chapter III) argued that family income and ability, together with the average rate of return to education, determine the individual choice about education While the distribution of ability does not change over time, that of family income would shift with economic development, thus indusing shifts in educational demand independent of rates of return Human capital theory therefore predicts that the change in the family income, as well as the change in rate of return, would cause the change in the demand for education.

14 Bowman, 1970; Danielson and Okachi, 1976; Umetani, 1977, Yano, 1985.

CHAPTER I
THE DEMAND FOR EDUCATION — A THEORETICAL FRAMEWORK

In this chapter a theoretical model of individual choice about education is postulated (Section 1). It is developed into an aggregate demand function of education (Section 2), which will render the basis for empirical analyses of the changes in enrollment rates over time (Section 3).

1. A MODEL OF INDIVIDUAL CHOICE ABOUT EDUCATION

We consider in this section a typical individual, indexed by *i*, who is about to make a decision about whether to attend college or to enter the labor market after graduation from senior high school. We assume that the only alternative to college education is entering the labor market, and that the two alternatives correspond respectively to the following career patterns: (1) to enter the labor market immediately after graduation from senior high school; and (2) to go to college and enter the labor market.

These restrictions may make the model appear too simplistic in describing the actual mechanism of individual choice about education. [1] But, with these simplifications the choice of college education can be postulated as a binomial choice without a sequential structure, which would ease the theoretical construction enormously. It will be argued later in Section 2, moreover, that the theoretical framework developed under these assumptions is applicable also to the analysis of the demand for senior high school education under a few conditions.

The Choice about Education and Choice Probability

Under the assumptions described above, we postulate that the individual *i* would evaluate the benefit and cost of going to college rather than immediately entering the labor market;

if the net benefit, denoted by ϕ_i, is positive, he would choose to go to college.[2] In symbols the choice rule can be written as:

$$\begin{aligned} &\text{go to college if} \quad \phi_i > 0; \text{ or} \\ &\text{enter the labor market if } \phi_i \leq 0. \end{aligned} \tag{1.1}$$

The anticipated net benefit, ϕ_i, is a function of his observed attributes, denoted by vector x_i, observed environmental factors, denoted by vector z, and the vector of unobserved variables, denoted by u_i. In symbols:

$$\phi_i = \phi(x_i, z, u_i; \theta),$$

where θ is the vector of structural parameters of the educational choice. Let u_i denote the net effect of the unobserved variables; since its values of its components, u_i, are unknown by definition, we treat u_i as a random variable.[3] Following Willis and Rosen (1979) we make a crucial assumption that u_i is identically and independently distributed with respect to x_i and z, and that ϕ_i is additively separable in the form,

$$\phi(x_i, z, u_i) = v(x_i, z) + u_i, \tag{1.2}$$

where $v(x_i, z_i)$ is the value of anticipated net benefit derived from the observed variables x_i and z, and the hypothesized structural parameters θ. Hereafter v_i will be called the "derived net benefit" of college education, or simply the "derived benefit," and f_i, the "total net benefit, or the "total benefit."[4]

Now consider the probability, p_i, for the individual i to choose college education. From the choice rule, Eq.(1.1) above, this is the probability that ϕ_i esxceeds zero; i.e.,

$$p_i = \Pr(\phi_i > 0).$$

Upon substitution of Eq.(1.2), the above equation becomes,

$$p_i = \Pr[\, u_i > -v(x_i, z) \,]. \tag{1.3}$$

By the assumption that u_i is independently and identically distributed with respect to x and z, the above probability can be expressed as,

$$\begin{aligned} P_i &= \int_{u=-v}^{\infty} f(u)\, du, \\ &= 1 - F[-v(x_i, z)\,], \end{aligned} \tag{1.4}$$

where $f(u)$ is the probability density function (p.d.f.) and $F(u)$ is the cumulative density function (c.d.f.) of the distribution of u.[5]

Eq.(1.4) above provide the general form of he choice probability function. Its operational form is derived below by giving specific functional forms to $v(\cdot)$ and $F(\cdot)$.

Total and Derived Benefit Function

We define the anticipated benefit of college education, ϕ_i, for individual i as the difference between the logarithm of his anticipated total benefit, $ln\ B_i$, and the logarithm of the effective cost, $ln\ C_i$; i.e.,

$$\phi_i = ln\ B_i - ln\ C_i, \tag{1.5}$$

so when the benefit exceeds the cost, ϕ_i becomes positive. B_i and C_i are defined below.

Anticipated Benefit

The anticipated benefit, B_i, is the total discounted value of the money and non-money benefit streams that individual i expects to receive after completing college education. We postulate:

$$B_i = (b_i + nb_i)\cdot\exp(\mu_i^B), \tag{1.6}$$

where b_i is the money benefit, nb_i is the non-money benefit, and u_i^B measures the individual bias in perceiving the benefit due to individual differences in accessibility to information and/or attitudes in forming future expectations.

Following Michael (1973), the non-monetary benefit, nb_i, is assumed to be realized through improved consumption productivity. Then,

$$\begin{aligned} b_i + nb_i &= (1+k^C)\cdot I_i^C - (1+k^S)\cdot I_i^S \\ &= (1+k)\cdot b_i, \end{aligned} \tag{1.7}$$

where I_i^C is the present value of the anticipated life-time eaning of individual i after graduation of college and I_i^S is that without college education; k^C and k^S are the average consumption productivities of college graduates and senior high-school graduates respectively. k is defined as,

$$k = k^C + (k^C - k^S)\cdot I^S/b_i, \tag{1.8}$$

the first term corresponding to the non-monetary benefit associated with the increased money income due to college education, the second to the non-monetary benefit due to increased consumption productivity realized with the money income without college education.

The monetary benefit, b_i, is postulated as:

$$b_i = b \cdot \exp(\alpha \cdot a_i), \qquad (1.9)$$

where b is the present value of the anticipated wage differentials averaged over ability levels, a_i is the standardized index of ability of the individual i, and α is the elasticity of the wage differentials with respect to the standardized ability index. Since a is a standardized index, it becomes zero and hence b_i becomes identical with b for the individual with the average ability.

By substituting Eqs.(1.7) and (1.9) into Eq.(1.6), and taking the logarithm of both sides, one obtains:

$$ln\ B_i = ln\ b + ln\ (1+k) + \alpha \cdot a_i + \mu_i^B. \qquad (1.10)$$

Hence, the logarithm of the anticipated benefit, $ln\ B_i$, for individual i is defined as the logarithm of average anticipated money benefit ($ln\ b$) adjusted for the non-money benefit ($ln\ [1+k]$) for his own relative ability ($\alpha \cdot a_i$), and for his own perception and taste bias about the benefit (μ_i^B).

Effective Cost

A typical individual would weight the anticipated relative benefit from college education against the effective cost. The effective cost, C_i, consists of the total face-value cost and the cost involved in financing it. A convenient way to postulate C_i is:

$$C_i = c \cdot (\rho_i / \rho), \qquad (1.11)$$

where c is the present value of the total face-value cost of college education including the direct cost and the foregone earnings, and ρ_i/ρ is the adjustment factor to account for the financing cost incurred to individual i. C_i in the above equation may be interpreted as the present value of total repayment incurred by borrowing the amount of c when the repayment period is infinite, with ρ_i as the average borrowing rate to individual i, and ρ as the market interest rate.[6] Since individuals from wealthier families would have less expensive sources of funds, the average interest rate for the amount of c would be lower for them than those for individuals from poorer families. The adjustment factor for financing cost (ρ_i/ρ) would thus primarily be a function of family-income. Some other factors, however, may also affect the financing cost: the number of siblings, relative sibling position, the parents' taste, e.t.c. Hence we postulate:

$$\rho_i / \rho = (Y_i / Y^N)^{-\beta} \cdot \exp\ \mu_i^C, \qquad (1.12)$$

where Y_i is the family income of individual i, Y^N is the partaicular ("bench-mark") value of family income with which ρ_i becomes identical with ρ, which would reflect the averaged propensity of the families of the eligible population to finance education, and $\beta(>0)$ measures the elasticity of the propensity with respect to family-income.[7] μ^C stands for the net effect of the factors affecting the effective cost that are not captured by family-income.

From Eqs.(1.11) and (1.12) we obtain:

$$ln\ C_i = ln\ c - \beta \cdot ln\ Y_i + \beta \cdot ln\ Y^N + \mu_i^C. \qquad (1.13)$$

Hence, the effective cost of college education is formulated as the face-value of the total cost ($ln\ c$) adjusted for the effective financing cost ($-\beta \cdot ln Y_i + \beta \cdot ln Y^N$), and for the net effect of the other personal factors not captured by family-income (μ_i^C).

Correlation between Family Income and Ability

The benefit function, Eq.(1.10) above, involves family income and ability, which are expected to be strongly correlated with each other. Since less information is available about the distribution of ability than about family income, it is practical to express ability as a function of family income, i.e.,

$$a_i = r \cdot ln\ (Y_i/Y^M) + \mu_i^a, \qquad (1.14)$$

where Y^M is the median family inome μ^a is the random term standing for the error in predicting ability from family income, and r is a constant that measures the correlation between ability and family income. By assuming that $ln\ Y_i$ is normally distributed around Y_M, and also that μ^a is also normally distributed with mean zero and independent of Y, a_i can be considered to be normally distributed around mean zero.[8]

The Total and the Derved Benefit

From Eqs.(1.10), (1.13) and (1.14) we obtain the total net benefit function, ϕ_i, as:

$$\begin{aligned} \phi_i = {} & (r \cdot \alpha + \beta) \cdot ln Y_i \\ & + ln\ R + ln(1+k) - \beta \cdot ln Y_N - r \cdot a \cdot ln Y^M \\ & + u_i, \end{aligned} \qquad (1.15)$$

where $ln\ R$ is defined as,

$$ln\ R = ln\ b - ln\ c = ln\ (b/c), \qquad (1.16)$$

and hence may be called the anticipated benefit/cost (b/c) ratio of collge education in monetary terms.[9] u_i is defined as,

$$u_i = \mu_i^B - \mu_i^C + \alpha \cdot \mu_i^a, \qquad (1.17)$$

and thus stands for the net effect of the random erms.

The total benefit function, Eq.(1.15), can be rewritten following Eq.(1.2) above as:

$$\phi_i = v_i + u_i. \quad (1.2)'$$

The net benefit, v_i, is defined as,

$$v_i = ln\ x_i + ln\ z, \quad (1.18a)$$

where $ln\ x_i$ stands for the net benefit derived from the paraticular levels of ability and family income of individual i, i.e.,

$$ln\ x_i = (r\cdot\alpha + \beta)\cdot ln\ Y_i, \quad (1.18b)$$

and $ln\ z$ stands for the total effect of the environmental factors,

$$ln\ z = ln\ R + ln(1+k) - \beta\cdot ln\ Y^N - r\cdot\alpha\cdot ln\ Y^M. \quad (1.18c)$$

The Choice Probability Function

Eq.(1.17) above states that u_i is a linear combination of the three random factors. Assuming that the three random factors are normally and independently distributed with mean zero, u_i can be considered to be normally distributed with mean zero. Then $F(u)$ becomes a cumulative normal distribution function, which we approaximate with a logit function in the form:

$$F(u) \simeq 1 / [1 + \exp(-\gamma\cdot u)], \quad (1.19)$$

where γ is the reciprocal of the variance parameter of the original p.d.f. of u.[11]

Then recalling Eq.(1.4), we obtain the probability, p_i, for individual i to choose college education in the following form:

$$\begin{aligned} p_i &= 1 - 1 /[1 + \exp(\gamma\cdot v_i)] \\ &= 1 / 1 /[1 + \exp(-\gamma\cdot v_i)] \\ &= F(v_i). \end{aligned} \quad (1.20)$$

The last line reflects the symmetry of the distribution of u, which is implicitly assumed by the logit function. It follows that:

$$\begin{aligned} v_i &= F^{-1}(p_i) \\ &= (1/\gamma)\ ln\ [p_i/(1-p_i)\ ]. \end{aligned}$$

Notice that the eaxpression on the right-hand side of the above equation is identical to the familiar logit transformation applied to p_i. The use of the logit transformation is thus justified in our framework as the inverse function of $F(\cdot)$, which approximated the cumulative distribution of the net effect of the unobserved variables.

2. AGGREGATE DEMAND FOR EDUCATION

In this section the model of educational choice is developed into an aggregate demand function, and further into a framework that relates changes in enrollment rate to changes in family income and the anticipated benefit of education.

The Choice Probability and the Aggregate Demand

The aggregate demand for college education can be measured by the demand rate, denoted by P, which is the proportion of those who decide to go to college in the eligible population. Since Eqs. (1.20) and (1.18a) above defined the probability for individual i to decide to go to college as a function of observed personal attributes, x_i, the aggregate demand rate P will be obtained by multiplying p with the joint density of x and taking the integral of the product over the ranges of x. That is:

$$P = \int_{x_1}\int_{x_2} \cdots \int_{x_n} p(x,z)\cdot J(x)\ dx_1\ dx_2 \ldots dx_n, \tag{1.21a}$$

where x_1, x_2 ..., x_n are the elements of x, and $J(x)$ is the joint density of x. Alternatively. the above equation can be expressed in discontinuous form as:

$$P = \Sigma_{j_1}\Sigma_{j_2}\Sigma_{j_3} \ldots \Sigma_{j_n} p(\bar{x}, z)\cdot \bar{J}(\bar{x}), \tag{1.21b}$$

where j_1, j_2, ..., j_n are the indices that identify the classes of x_1, x_2, ..., x_n; $\bar{x}$ is the vector of the median values of x for each cell of x under a multiple-classifications system; and $\bar{J}(\tilde{x})$ is the share of the cell in the total eligible population.

Eq.(1.21a), or alternataively Eq.(1.21b), is the theoretically general form of the aggregate demand function for college education, but it does not constitute a useful framework of analysis, since even with a simple functional form for $p(\cdot)$ the product $p(\cdot)\cdot J(\cdot)$ will be complicated and evaluation of its integral or summation will be intractable. It will be shown below, however, that in the extreme case where the attribiute vector can be represented by only one variable,[12] the aggregate demand function in the discontinuous form, Eq.(1.21b) above, can be transformed into a simple form.

Derivation of the Aggregate Demand Function

We designate the family income, Y_i, as the representative variable of the observable personal attribute vector x_i. Let the population of those eligible for college education be divided into N groups of equal size (one-N'th of the total size), each indexed by $j = 1$ *to* N in the ascending order of family income. Y_j denotes the median family-income of the j'th family-income class. Provided with the law of large numbers, we observe that the demand rate of college education, P_j, of the j'th family income-class is asymptotically equal to the conditional probability of choosing college education; i.e.,

$$P_j \simeq p[v(Y_j,z)],$$

and hence the aggregate demand rate, P, for the entire eligible population becomes:

$$\begin{aligned} P &\simeq \Sigma_j\, p[v(Y_j,z)]\cdot(1/N) \\ &= (1/N)\, \Sigma_j p[v(Y_j, z)], \end{aligned}$$

By recalling Eq.(1.4), the above expression transforms into:

$$\begin{aligned} P &\cong (1/N)\, \Sigma_j\, (1 - F[-v(Y_j, z)]) \\ &= 1 - (1/N)\, \Sigma_j\, (F[-v(Y_j, z)]). \end{aligned} \tag{1.22}$$

This is our aggregate demand function of college education. Its actual functional form, however, is still highly complicated because of the summation. It will be revealed in section 3 below, however, that the derivative of the above equation in terms of time presents a relatively simple form under some conditions, and thus provides a link to empirical applications.

Applicability of the Model to Senior High School Education

At the outset of construction of the model of educational choice, we limited the scope to the choice of college education. The choice of college education was characterized as a binomial choice, which provided a crucial analytical tool. Now we examine the applicability of the model to the choice of, and the aggregate demand for, senior high school education.

Bowman's (1981, pp.107-117) model of educational choice demonstrated that the choice about senior high school education has a structural difference from the choice of college education in that the former contains the latter as a further alternative. The alternatives of choice include: (1) enter the labor market right after graduation of junior high school; (2a) go to senior high school and trhen enter the labor market; and (2b) go to senior high school, then go to college, and then enter the labor market. The choice is thus made among three alternatives.

An approach to formulate this decision in the framework of binomial choice is to consider it as binomial choices at two stages in sequence, i.e. first between (1) and (2), and second between (2a) and (2b). The choice at the first stage may be postulated to be made based on the weighted average of the benefit and cost of alternatives (2a) and (2b), the weight being the likelihood of choosing (2a) or (2b). It should be noted, however, that the perceived likelihood of choosing (2a) or (2b) would be different among individuals, and it is also a function of ability and family income. For the individuals with particularly high ability and family income, the alternative (2a), entering the labor market right after graduation of senior high school, would represent a low likelihood.[13] On the other hand, those individuals who are on the margin of the decision about senior high school education are with relatively low family income and ability, and therefore the likelihood of choosing (2b), going to college after graduation of senior high school, would look very remote; subsequently their decision is virtually made between (1) and (2a). Hence, the choice probability at the first stage is dependent on the choice probability at the second stage, which makes it difficult to model the choice at the first stage within a framework of simple binomial choice.

Nonetheless, insofar as the ultimate concern of the study lies in the changes in the aggregate demand for education, this problem remain, less relevant. Provided with their ability and family income the choices of the first type of individuals about senior high school education are unlikely to be affected by marginal changes in family income or the anticipated benefit of education — their choices are intra-marginal in the aggregate demand for education. It is rather the choices of the second group of individuals that would critically determine the changes in the aggregate demand for education, for they are most likely to change their decision by the marginal changes in the determining variables. Thus, whereas the theoretical framework developed above may be inadequate when applied to individual choice about senior high school education, it will provide a reasonable approximation of the changes in aggregate demand for senior high school education when the choice is considered to be made between alternatives (1) and (2a).

A related analytical problem is the potential bias created by postulating that all the decision subject expects to enter the labor market, either after graduation of one level of education or another, and stay in the labor market. Since a large proportion of women leave the labor market upon marriage or child-birth and spend substantial time in household works, direct application of the model may appear to cause some bias in analyzing the demand for education among women. A cursory treatment of this problem is precented in Appendix F.

3. THE CHANGE IN DEMAND OVER TIME

The Change in Aggregate Demand Over Time

Now we consider the change in aggregate demand for education over time. If the structural parameters of $F(\cdot)$ and $v(\cdot)$ do not change over time, so that Eq.(1.22) above holds at any time, the change in P over time can be obtained by differentiating Eq.(1.22) by time t, which yields:

$$\frac{dP}{dt} = \frac{1}{N}\sum_j \frac{dF_j}{dv_j}\left[\frac{\partial v_j}{\partial Y_j}\cdot\frac{dY_j}{dt} + \frac{\partial v_j}{\partial z}\cdot\frac{dZ}{dt}\right]. \tag{1.23}$$

The first term, dF_j/dv_j, translates the change in v_j into the change in P_j, and provided with the definition of $F(\cdot)$ in Eq.(1.20) it becomes:

$$\begin{aligned}\frac{dF_j}{dv_j} &= \frac{d}{dv_j}\left[\frac{1}{1 + \exp(-\gamma\cdot v_j)}\right] \\ &= \gamma\cdot P_j\cdot(1-P_j).\end{aligned} \tag{1.24a}$$

The second term is obtained from Eq. (1.18b) as

$$\frac{\partial v_j}{\partial Y_j}\cdot\frac{dY_j}{dt} = (r\cdot\alpha + \beta)\ \dot{Y}_j, \tag{1.24b}$$

where $\dot{Y}_j$ stands for the change rate of Y_j.

The third term measures the effect of the changes in the environmental factors, and is derived from Eq.(1.18c) as,

$$\frac{\partial v_j}{\partial z}\cdot\frac{dz}{dt} = \dot{R} - \beta\cdot\dot{Y}^N - r\cdot\alpha\cdot\dot{Y}^M + D, \tag{1.24c}$$

where the dots above signify the change rates, and D measures the net effect of residual factors defined as,

$$D = \frac{1}{1+k} \cdot \frac{dk}{dt} \tag{1.24d}$$

By substituting Eqs.(1.24a), (1.24B) and (1.24c) into Eq.(1.23), we obtain:

$$\frac{dP}{dt} = \frac{1}{N}\sum_{j} \gamma \cdot P_j \cdot (1-P_j) \cdot [\dot{R} + \beta(\dot{Y}_j - \dot{Y}^N) + r \cdot \alpha \cdot (\dot{Y}_j - \dot{Y}^M) + D]. \tag{1.25}$$

$\dot{R}$ stands for the change in the anticipated monetary benefit of education, which is assumed to be identical across family-income classes: $\beta \cdot (\dot{Y}_j - \dot{Y}^N)$ is the effect of the change in the median family-income of the j'th class adjusted for the change in living standards; $r \cdot \alpha \cdot (\dot{Y}_j - \dot{Y}^M)$ is the correction factor for the bias created by the difference in family-income growth rate by income class; and D stands for the net effect of the changes in residual factors. $P_j \cdot (1-P_j)$ translates the magnitude of the change in v_j to the change in P_j, thus indicating that the change in P_j over time is affected by the value of P_j itself. $P_j \cdot (1-P_j)$ may be therefore called the "scale effect multiplier."

Simplifying Assumptions

The above expression can be simplified further if the rates of change in family-income are identical among family-income classes. For then, the change rate of median family income, $\dot{Y}^M$, and the change rate of family-income, $\dot{Y}_j$, of the j'th family-income class are equal to the change rate $\dot{Y}$ for all j's, i.e.,

$$\dot{Y} = \dot{Y}_j, \text{ for all } j\text{'s}.$$

We may also assume that the "bench-mark" family income level, Y^N, would increase over time with a constant elasticity with respect to the family-income levels reflecting the shift in living standards, i.e.,

$$\dot{Y}^N = (1 - \epsilon)\,\dot{Y}, \tag{1.26}$$

where ϵ $(0 \leq \epsilon \leq 1)$ measures the marginal relative propensity of household to invest on education rather than other investiment and consumption acativities, with respect to the change in median family income level over time. Imposing these conditions on Eq.(1.25) we obtain:

$$\frac{dP}{dt} = (\dot{R} + \epsilon \cdot \beta \cdot \dot{Y} + S) \cdot \gamma \cdot \frac{1}{N} \cdot \Sigma\, P_j \cdot (1 - P_j). \tag{1.27}$$

The last term may be expressed in terms of the average demand rate, P, of college education, i.e.,

$$\frac{1}{N} \Sigma\, P_j \cdot (1 - P_j) = P \cdot (1 - P) \cdot \left[1 - \frac{(1/N)\Sigma_j (P - P_j)^2}{P \cdot (1 - P)} \right] \tag{1.28}$$

Simplified Form

By defining $1 - \sigma$ as

$$1 - \sigma = [\, (1/N)\Sigma(P - P_j)^2 \,] \,/\, [P \cdot (1 - P)\,],$$

so that $1 - \sigma$ becomes a standardized measure of the variance of the demand rates across family-income classes, Eq.(1.25) above becomes:

$$\frac{dP}{dt} = P \cdot (1 - P) \cdot \gamma \cdot \sigma \cdot (\dot{R} + \epsilon \cdot \beta \cdot \dot{Y} + D), \tag{1.29}$$

or slightly rearranging,

$$\frac{dP}{dt} \frac{1}{P \cdot (1 - P)} = \gamma \cdot \sigma \cdot (\dot{R} + \epsilon \cdot \beta \cdot \dot{Y} + D). \tag{1.30}$$

σ can thus be seen as the adjustment factor for aggregation bias.

It should be observed in the above equation that the change in P is normalized by the factor $P \cdot (1 - P)$ to remove the scale effect; the expression $(dP/dt) \cdot [1/(P \cdot (1 - P)]$ may be called the "logit-change rate" of P. It has thus been shown that the logit-change rate of the demand for education is a linear function of the rate of change in the anticipated (b/c) ratio of college education ($\dot{R}$), the rate of change in the median family-income ($\dot{Y}$) and the net effect of the changes in residual factors (D).

The demand function in this simplified form will render the basis for the empirical analysis in chapter III.

Notes

1 Bowman (1981, pp 107-117) set out a general model of educational choice among multiple alternatives set in a sequential structure The model of college-choice by Kohn, Manski and Mundal (1976) allows for multiple alternatives

2 In other words, the comparison is made about the marginal benefit and cost of choosing one alternative over the other, the direct evaluation of the benefit and cost of each of the alternative is not involved in this framework.

3 Consequently, if ϕ is considered as a utility function, the utility function underlying the choice contains a random variable For this reason, this type of individual choice model can be called the "random utility" or "random attractiveness" model (Manski and McFadden 1981)

4 Alternatively v_j may be called the "measured attractiveness (utility)," and ϕ_j, the "perceived attractiveness (utility)" (Daganzo 1979, p 8) "Derived" is used instead of "measured" to emphasize that v_j does not necessarily have to be directly measured, it can be derived from the observed values of x_i and z under the assumed values of θ. "Anticipated" is preferred to "perceived" in order to stress that one makes a decision about education based not only on the perception of current conditions, but also on his anticipation of their change in the future The word "net benefit," rather than "utility" or "attractiveness," is used, for the present model does not involve evaluation of utility or attractiveness.

5 From Eq.(4) it can be observed:

$$v_i = -F^{-1}(1-p_i),$$

where $F^{-1}(\ )$ stands for the inverse function of $F(\ )$. The derived net benefit is thus alternatively expressed as a function of choice probability through the inverse function of $F(\ )$.

6 Becker (1975, p 136) postulated the effective cost in terms of the interest rate of the marginal funds available such as gift from the parents or scholarship The present definition is made in terms of the average interest rate.

7 With $\mu_i^C = 0$, β is found to be

$$\beta = \left[\frac{d\ (\rho_i/\rho)}{d\ (Y_i/Y^N)}\right] / \left[\frac{\rho_i/\rho}{Y_i/Y^N}\right]$$

8 Under these assumptions, r is defined as

$$r = (\sigma_a^2/\sigma_{aY})^{0.5}$$

where σ_a^2 is the variance of μ_a, and σ_{aY} is the covariance of a and $ln(Y/Y^M)$.

9 The operational definition of R and its relation to the classical definition of the benefit/cost ratio will be diskcussed in Chapter III, section 1

10 Under these assumptions the variance of u, denoted by σ_u^2, is given by

$$\sigma_u^2 = \sigma_B^2 + \sigma_C^2 + a^2\,\sigma_a^2.$$

11 The logistic function is known to draw a profile very close to the cumulative distribution of the t distribution with 7 degrees of freedom, which presents a slightly greater kurtosis than the normal distribution With more degrees of freedom the t distribution approaches to the normal distribution Use of the logit function, rather than any theoretical distribution function, greatly eases mathematical manipulation.

12 The variable may be selected on the ground that it it well captured by existing statistics, and it is most representative of x in that it has high covariance with other elements.

13 Bowman (1981, p 43) addressed this issue by applying the concept of "potential surprise" by Shackle Radner and Miller (1976, p 34) pointed out that the multinomial discrete choice model has the property called the "independence of irrelevant alternatives," which raises a question on its applicability.

14 Since

$$\Sigma(P-P_j)^2 = \Sigma P_j^2 - N P^2, \qquad \text{or} \qquad \Sigma P_j^2 = \Sigma(P-P_j)^2 + N P^2,$$

we obtain:

$$\Sigma P_j\cdot(1-P_j) = NP - P_j^2$$
$$= N\cdot P\,(1-P) - \Sigma(P-P_j)^2.$$

CHAPTER II
ECONOMIC RETURN TO EDUCATION IN POSTWAR JAPAN

In this chapter, we turn our attention to the changes in anticipated benefit of education in postwar Japan. We will first estimate the conventional internal rates of return (Section 1). The classical benefit/cost (b/c) ratio, another indicator of economic return, will be next estimated, and the causes of its changes are analyzed (Section 2). Finally, alternative indicators of anticipated benefit will be postulated (Section 3).

1. INTERNAL RATES OF RETURN TO EDUCATION IN POSTWAR JAPAN

Classical Indices of Economic Returns to Education

Economic returns to education may be evaluated in the form of several indices, including the internal rate of return, the benefit/cost (*b/c*) ratio and the net present value. It is well known that the indices derived from the benefit of education after income tax and the out-of-pocket cost of education are called the "private" indices, while those derived from the benefit before tax and the direct cost including subsidy are called the "social" indices.

It is less recognized, however, that all of these indices can be evaluated in two different analytical context, and each of them carries distinctively different implication (Cohn 1979, p.103). One is evaluation of the actual benefit of education that a particular individual or a particular age-cohort has actually obtained through its working life. The indices evaluated from this view-point may be called the *ex post* indices of economic return to education. The other is evaluation of the anticipated benefit from education that a typical individual would perceive upon making decision about education. The indices evaluated from this view point may be called the *ex ante* indices of economic returns, and they constitute one of the key variables in analyzing the demand for education. Actual estimation of "ex-ante" indices, however, is difficult.

The conventional approach in the human capital literature is to estimate the indices directly from the wage structure by education in the current labor market. The indices estimated by this method may be called the "cross-sectional" indices, for the form of the used data, or the "classical" indices of economic returns to education. The classical indices are considered as a primary approximation for both the ex-postand and the ex-ante indices.

It should be recognized, however, that when the classical indices are used as ex ante indices, it is implicitly assumed that (1) a typical individual has perfect knowledge of the wage structure in the present labor market, and (2) he is expecting that the present wage structure would prevail for his working life.[1] These two assumptions are apparently unrealistic, and we shall explore more elaborate indicators of anticipated benefit of education later in section 3. Nonetheless, the classical indices are convenient summary indices of the wage structure, and their changes over time provide significant insights into changes in the underlying factors in the anticipated benefit of education. In this section, we shall estimate classical indices in two forms, i.e., the internal rate of return ("*IRR*" hereafter) and the benefit/cost (*b/c*) ratio. The *IRR* has been widely used in the literature, while the (*b/c*) ratio posesses more convenient properties for analysis.

Definitions and Data

The classical benefit/cost (*b/c*) ratio, denoted by $\hat{R}$, for college education[2] is defined as the ratio of the average money benefit, $\hat{b}$, of college education to the money amount, $\hat{c}$, of the total cost, both estimated from the current wage structure. $\hat{b}$ is defined as the present value of the wage differentials between averaged wages of college graduates and senior high-school graduates after graduating age from college; $\hat{c}$ is the total money cost of college education, which consists of the present value of the wages foregone to go to college and the present value of the direct costs of college education. In symbols,

$$\hat{R} = \hat{b}/\hat{c}$$

$$= \frac{\sum_{n=n_g+1}^{n_r} (\hat{w}_n^C - \hat{w}_n^S)\cdot(1+i)^{-n}}{\sum_{n=1}^{n_g} [\hat{w}_n^S\cdot(1+i)^{-n} + DC_n\cdot(1+i)^{-n}]} \tag{2.1}$$

where $\hat{w}_n^C$ is the annual average wage of college graduates in the n'th year after graduation from senior high-school; $\hat{w}_n^S$ is the annual wage of senior high school graduates, both observed in the current labor market; DC_n is the direct cost of college education in the n'th year, and i is the discount rate for future income. The present values are evaluated at the time of graduation from senior high school, under the assumption that a typical individual would graduate from college in the n_g'th year and leave the labor market at the end of the n'th year.

The classical internal rate of return (*IRR*) for college education, which we denote by $\hat{i}^*$, is defined as the particular value of the discount rate, i, with which the valve of $\hat{R}$ above becomes one.

The wage-profile over age by education and by sex was estimated for every year from 1954 to 1980, based on the *Fundamental Wage Survey (FWS)* data compiled by the Ministry of Labor (*MoL*), Japan. The detailed data sources and the methods used in estimating the wage profiles are described in Appendix B. It should be noted that the wage profiles for women with junior-college or four-year college education are estimated for 1954-57, but are less reliable than those for men due to the small size of sample. They are not estimated for 1958-66 due to the lack of data; estimated for 1968-72 by trend intrapolation for each age bracket and should be regarded with caution (Appendix B, Section 3).

A typical individual was assumed to graduate from senior high school at the age of 18.5.[3] and from junior-college at the age 20.5. The expected length of college education was set at 4.5 years to account for the probability of spending an extra year or more in preparing for entrance examination,[4] so the graduating age was assumed at 23.0. The retirement age was set at 55.5-years.

The time-series of estimated direct costs of education and the procedure followed in the estimation are presented in Appendix C. The direct costs in private institutions, including the payment to school and the other expenses for study, but not including living expenses, were used for estimation. *IRR*s were estimated with and without adjustment for income tax and retirement cash payment,[5] and will be reported separately. The actual computation of the *IRR* was made by iteration from below, assuming that Eq.(2.1) has a unique solution.[6]

Estimated Internal Rates of Return

The estimated *IRR*s, unadjusted for income tax and exclusive of retirement cash payment, are presented in time-series in Table 3.

In reviewing the table it may be helpful to set a "bench-mark" level of *IRR* at the range of 7-8 percent, which was roughly the range of the interest rate for long-term deposits in the observed period.[7]

The table illustrates that, for all the educational levels and for both sexes, *IRR*s were on, or above, the 7-8 percent range in the 1950s; but they declined in subsequent years to fall below the bench-mark by the late 1970s except for women's higher education.

The *IRR* for men's senior high school education was around the 7-8 percent range in the 1950s, declined substantially in the 1960s, and has fluctuated between 4 and 6 percent ever since. The *IRR* for women's senior high school education was greater than the men's, but also declined in the 1960s, to fall below the 7-8 percent range by the late 1960s; it has been fluctuating around the 6-percent mark in the 1970s.

The *IRR* for men's four-year college education was around 10 percent in the 1950s, but

TABLE 3

ESTIMATED INTERNAL RATES OF RETURN IN JAPAN, 1954-80 (In Percent)

Year	Men			Women		
	Senior High School	Junior College	College	Senior High School	Junior College	College
1954	7.5	14.4	10.4	8.5	11.9	9.5
1955	7.7	13.9	10.3	8.8	13.6	13.9
1956	8.1	12.6	10.6	8.5	10.3	8.5
1957	8.6	13.4	10.7	9.2	84	5.1
1958	7.9	12.9	10.1	9.0	—	—
1959	8.1	11.8	10.0	9.4	—	—
1960	7.1	11.7	10.4	8.8	—	—
1961	7.0	11.6	10.2	9.2	—	—
1962	6.9	11.1	9.8	8.7	—	—
1963	7.0	10.4	9.6	8.3	—	—
1964	6.4	9.4	8.9	8.1	—	—
1965	6.1	8.2	8.4	7.7	—	—
1966	5.9	7.9	7.7	8.1	—	—
1967	5.8	7.7	7.6	7.6	8.9	9.9
1968	4.9	6.4	7.5	6.9	9.2	9.7
1969	4.3	6.3	7.4	6.4	9.3	9.4
1970	4.3	6.7	7.4	6.1	9 4	9.0
1971	4.2	6.9	7.3	6.3	9.6	8.8
1972	4.9	7.0	6.9	6.3	9.8	8.5
1973	4.6	4.3	6.1	5.7	10.1	8.6
1974	4.6	4.1	5.7	6.1	10.3	8.8
1975	4.9	5.2	6.1	6.8	11.6	9.2
1976	5.6	5.2	6.4	6.3	8.2	8.4
1977	5.5	5.1	6.3	6.6	8.6	8.5
1978	5.4	4.3	6.1	6.7	8.7	8.2
1979	4.5	4.8	6.0	6.4	8.3	8.4
1980	4.8	3.2	5.8	6.3	7.7	8.1

declined in the 1960s, to fall below the 7-8 percent range by the beginning of the 1970s; the gradual decline continued in the 1970s. As for junior college education, the *IRR* for men appear to be exceptionally high in the 1950s, but this is mainly due to a problem in educational classification.[8] The *IRR* for women's college education was around the 9-percent mark at the end of the 1960s and showed a slight decline thereafter; but even then it still remained within the 7-8 percent range. The *IRR* for women's junior-college education increased from 9 percent to almost 12 percent from 1967 to 1975, but then dropped sharply; it has been fluctuating around the 7-8 percent range since then.

Estimated classical *IRR*s may be used to make a rough evaluation of the profitability of the investent on education made in the past. For it will be shown in Section 4 below that the ex-post *IRR* can be roughly estimated as the sum of the classical *IRR* and the productivity growth rate. Since the average growth rate over the observed period was about 5 percent per annum,[9] the ex post *IRR* in the postwar period can be estimated at around 10 percent for senior high school education, and substantially greater than that for junior-college or college education. For those who received post-compulsory education in the early postwar period, the investments in education indeed should have yielded handsome returns.

Another interesting point to be observed is that *IRR* for women are frequently greater than the corresponding *IRR* for men. The reason for this will be discussed in Appendix F.

Adjustment for Tax and Retirement Payment

Next we examine the effects of the adjustment for income tax and the inclusion of retirement cash payment on the estimated values of *IRR*. The procedure and original data to estimate the income-tax rate function and the retirement cash payment are presented in Section 4 of Appendix B. Table 4 presents the estimated values of (1) *IRR* unadjusted for income-tax or for retirement payment, (2) *IRR* adjusted for income-tax but not for retirement payment and (3) *IRR* adjusted for both income-tax and retirement payment, for 1956 and for every five years since 1960.

A cursory inspection would suffice to find that in general the adjustment by income-tax or by retirement payment make small differences in the estimated values of *IRR*. The adjustment for income tax makes relatively large margin in the earlier periods, particularly with men's college education, for there was a relatively small number of college graduates and their income belonged to relatively high income-brackets. The *IRR*s for men's college education in 1956 were 10.6 percent without adjustment for income tax and 9.6 percent with adjustment. The difference, nonetheless, decreased substantially in later periods. The addition of retirement payment results in minor differences primarily because it is an income at the most remote future from the time of evaluation.

Moreover, the longitudinal patterns of change in *IRR* are not significantly affected by the adjustments. Hence the use of the unadjusted indices rather than the adjusted indices in the analysis of the changes in the of education over time would create negligible biases.

TABLE 4

INTERNAL RATES OF RETURN WITH AND WITHOUT ADJUSTMENTS
(In Percent)

Year	Men			Women		
	Not Adstd.	Adjusted for		Not Adstd.	Adjusted for	
		Tax	Tax & Ret.Pay		Tax	Tax & Ret.Pay
	(1)	(2)	(3)	(1)	(2)	(3)
			Senior High School			
1956	8.1	7.6	7.8	8.5	8.3	8.3
1960	7.1	6.9	7.1	8.8	8.7	8.8
1965	6.1	5.9	6.1	7.7	7.6	7.7
1970	4.3	4.0	4.3	6.1	5.9	6.1
1975	4.9	4.8	5.0	6.8	6.7	6.9
1980	4.8	4.6	4.9	6.3	6.2	6.4
			Junior-College			
1956	12.6	11.8	11.9	10.3	10.0	10.0
1960	11.7	11.3	11.4	—	—	—
1965	8.2	7.8	8.0	—	—	—
1970	6.7	6.3	6.6	9.4	9.2	9.3
1975	5.2	5.0	5.4	11.6	11.4	11.5
1980	3.2	3.0	3.6	7.7	7.6	7.7
			College			
1956	10.6	9.6	9.7	8.5	8.1	8.0
1960	10.4	9.9	10.0	—	—	—
1965	8.4	8.0	8.2	—	—	—
1970	7.4	6.9	7.2	9.0	8.7	8.9
1975	6.1	5.9	6.1	9.2	9.0	9.2
1980	5.8	5.6	5.8	8.1	8.0	8.1

Comparison with Past Estimates

It is of interest to compare the *IRR*s estimated in the present study with the past estimates made about Japan.

As for men's senior high school education, Bowman (1971, table 1) estimated the *IRR* at 8 percent for 1954, 7 percent for 1961, and 5 percent for 1966; these are not adjusted for bonuses (the present estimates are) or for income tax, and do not include retirement payment. Danielson and Okachi (1971, table 1) estimated *IRR* at 10 percent for 1966, which is substantially higher than Bowman's estimate. Our estimates roughly concur with Bowman's, and are lower than Danielson and Okachi's.

More estimates have been published with the economic returns to men's college education, which are summarized in Table 5 together with our corresponding estimates. It should be noted that except for column (4b) the estimates are unadjusted for income tax. The estimates by Kaizuka et al. are derived as the regression coefficient on the years of education in the Mincer earnings function,[10] and thus represent the average returns, rather than the marginal returns, to college education. The *IRR*s estimated for the 1950s range from 9 to 13 percent; those for the 1960s, from 8 to 11 percent; those for the 1970s, from 5 to 9 percent. The present estimates are not at much variance from the past estimates; moreover, they do not present any consistent tendency to deviate from the other estimates.

There are four estimates that allow observation of the change in *IRR* over extended time-periods, i.e., the estimates by Umetani, by Kaizuka et al., by the Ministry of Labor (MoL), and those of the present study. The MoL estimates presented in the table are derived from the wages in the manufacturing sector, but the estimates for the other sectors show little differences. The Kaizuka estimates and the MoL estimates are very close to the present estimates, and indicate a gradual decline of *IRR* for the observed period. The Umetani estimates (unadjusted) are close to these estimates for the 1950s and early 1960s, but tend to appear greater for the late 1960s and early 1970s. The discrepancy from the present estimates can be partly attributed to the definition of working life: the Umetani estimates evaluate the wage differential until age 65, as compared to age 55 for the present estimates. Nonetheless, the Umetani estimates agree with the other estimates in indicating a gradual decline of the *IRR*.

Another point of interest is the comparison with the *IRR* estimated for the United States. It will be discussed briefly in Appendix E.

TABLE 5

ESTIMATES OF IRRS FOR MEN'S COLLEGE EDUCATION IN JAPAN
(In Percent)

Year	Kaneko	Boawman	Danielson & Okachi	Umetani		Kaizuka et al.	MoL
	(1)	(2)	(3)	(4a)	(4b)	(5)	(6)
1954	10.4	12	—	13.4	9.0	—	—
1958	10.1	—	—	10.2	9.4	10.6	
1961	10.2	8	—	9.5	8.7	—	—
1964	8.9	—	—	8.7	8.0	—	8.2
1966	7.7	10	10.5	—	—	—	—
1967	7 6	—	—	9.7	9.3	—	—
1970	7.4	—	—	9.0	8.3	6.3	7.5
1973	6.1	—	—	8.1	7.5	5.9	—
1976	6.4	—	—	—	—	—	6.4
1978	6.1	—	—	—	—	—	5.7
1980	5.8	—	—	—	—	—	5.2

Notes: The estimates are gross of income tax except for (4b). (2) assumes one year of "Ronin". (5) is the average rate of return estimated from the Mincer earnings function. (6) is derived from the wages in the manufacturing sector.

Sources: (2) Bowman 1970, table 1; (3) Danielson and Okachi 1971, table 1; (4) Umetani as cited in Toyokeizai 1977, tab e 2; (5) Kaizuka et.al. 1977, tabale 1; (6) MoL 1982, table 2-2.

2. CLASSICAL B/C RATIO AND ITS CHANGE OVER TIME

The benfit/cost (*b/c*) ratio is used less frequently than the internal rate of return as an indicator of the magnitude of economic returns to education, for its value critically depends on the employed discount rate. But in analyzing the changes in the benefit of education over time, the b/c ratio presents some convenient properties. In this section we therefore estimate the classical benefit/cost (*b/c*) ratio, denoted by $\hat{R}$, and analyze its changes.

Changes in Classical b/c Ratios in Postwar Periods

The classical b/c ratio, and the corresponding money benefit, $\hat{b}$, and money cost, $\hat{c}$, were estimated based on Eq. (2.1), from the same data used for the estimation of *IRR*. They are unadjusted for income tax or the c sh payment upon retirement. The discount rate was set at 7.540 percent per annum, which is the interest rate for long-term deposits averaged for 1951-80. The data source and the time-series of interest rates are presented in Appendix D.

The estimated values of classical b/c ratios for the period 1954-80 are presented in Figure 3. They project essentially the same trends as those indicated by the *IRR*.

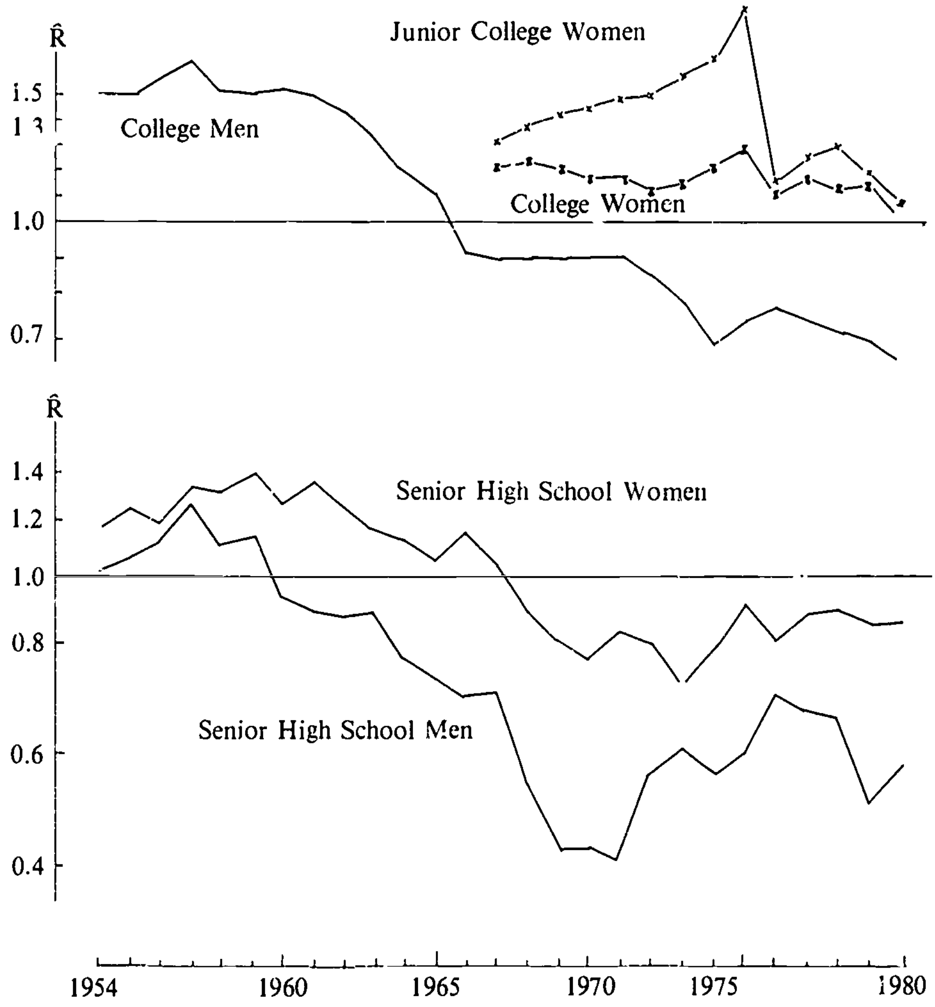


FIG. 3: CHANGES IN CLASSICAL B/C RATIOS — 1954-1980

The patterns of change in the (b/c) ratio presents some distinctive differences between senior high school and college education. In the second half of the 1960s, the b/c ratio for college education remained unchanged whereas that for senior high school education showed a marked decline; in the 1970s, that for college education declined gradually whereas the b/c ratio for senior high school education increased in the second half of the 1970s. Nonetheless, it is indisputable that all the b/c ratios recorded major decline in the 1960s, and that characterizes the basic postwar trend.

It should be recalled at this point that the 1960s and the first half of the 1970s were exactly the periods in which the enrollment rates in senior high school and college recorded unprecedented increases. Since economic theories predict that a decline of the benefit of education would depress the demand for education, the observed correspondence between the substantial increase in the benefit of education and the unprecedented expansion in enrollment in post-compulsory education in the 1960s presents an apparent contradiction. One is therefore lead to suspect that, by neglecting the subjective fact- -e classical b/c ratio does not serve as an appropreate indicator of the anticipated bene... of education. Consequently, alternative indicators of the anticipated benefit of education will be constructed in Section 3.

Factors of the Changes in Retaurns to Education

Before embarking upon the search for alternative indicators, it is of interest to analyze the factors that caused the changes in classical b/c ratio. For it reflects the changes in the supply and demand of school graduates in the labor market. Although the comprehensive analysis encompassing both the education and labor markets is beyond the scope of the present study, a cursory examination would help understand what actually took place in the labor market over this period.

It should be noticed that the change in the classical b/c ratio is divided into the effects of the changes in the benefit, $\hat{b}$, and cost, $\hat{c}$, of education. Therefore, we shall examine in this subsection the changes in $\hat{b}$ and $\hat{c}$ in real prices over time.[11] $\hat{b}$ and $\hat{c}$ were estimated under the same assumptions as those for deriving $\hat{R}$ in the previous section. Using the C.P.I. presented in Appendix D, they were transformed into the values in 1951 price, and further divided by the value of b in 1954, to obtain real-price indices of $\hat{b}$ and $\hat{c}$ with the base of $\hat{b}$ in 1954 as 100. Since $\hat{b}$ and $\hat{c}$ for women's college or junior-college education are available only for 1967 or after, the time-series indices were computed with the base of $\hat{b}$ in 1967. The results of this exercise are presented in Figure 4.

The figure clearly demonstrates that for all the educational levels and both sexes, $\hat{c}$ in real terms increased steadily from 1954 to the mid-1970s. The index of $\hat{c}$ for men's senior high school education increased from 99 in 1954 to 378 in 1975, that for women's senior high school education increased from 84 to 308, and that for men's college education increased from 66 to 202. The increase in the total cost in real terms over the two decades were 3.8-times for men's senior high school education, 3.7-times for women's senior high school education, and 3.4-times for women's college education. The increases in $\hat{c}$ were not only consistent over the two decades but also uniformal in magnitude across educational levels or sex. The patterns of the changes in $\hat{c}$ for women's college or junior-college education can not be observed for the entire period, but at least their change since 1967 do not appear to differ from the others. Hence, the change in $\hat{c}$ contributed to the long-run decline in b/c ratios for all the educational levels and for both sexes.

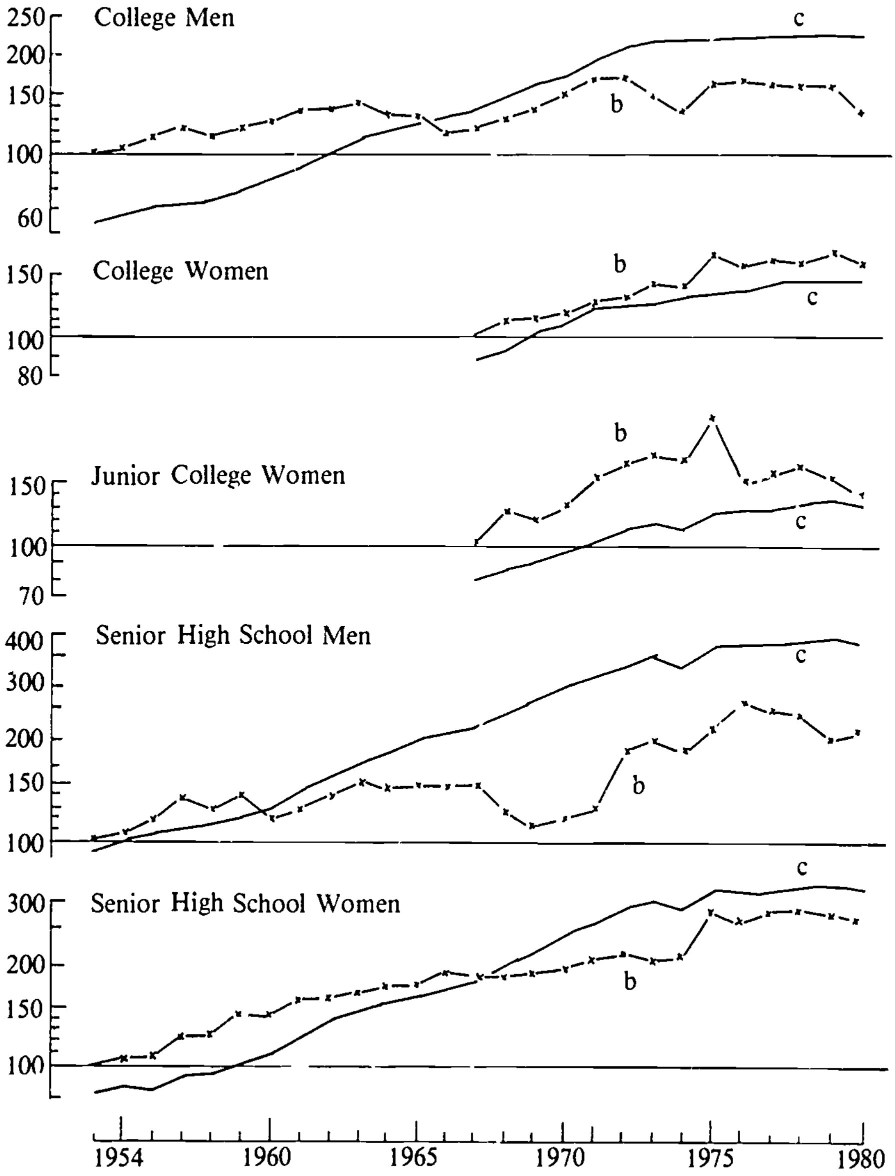


FIG. 4: REAL PRICE INDICES OF THE BENEFIT AND COST OF EDUCATION

Meanwhile, the indices of money benefit of education, $\hat{b}$, fluctuated substantially over time. The index of $\hat{b}$ for men's senior high school education increased in the 1950s to reach the 140-level in 1957, and remained at this level in the 1960s, until it fell to 108 in the latter 1960s. It then increased substantially to 175 in 1972 and further to 250 in 1976, but decreased again to 201 by 1980. $\hat{b}$ for women's senior high school education shows a much steadier trend than men's: itincreased to 160 in 1961, toa 200 in 1971, anda to 270 in 1975, but stabilized after 1975.

As for men's college education, the index of $\hat{b}$ increased in the 1950s almost to reach the 140-mark by 1961, started declining until 1966, then increased again to reach 162 in 1971, and stayed around the 150-level in the 1970s. The index of $\hat{b}$ for women's college education (1967 = 100) increased 1.7-fold from 1967 to 1975, and then remained stable around the 150-level in the second half of the 1970s. That of women's junior-college education grew more rapidly, to increase 1.5-fold from 1967 to 1971, but in the second half of the 1970s it remained at about the same level as that for college education. The benefit of higher education for women thus increased substantially in the late 1960s and in the first half of the 1970s, when the benefit of men's college education remained virtually unchanged.

Hence, the benefit of education, $\hat{b}$, fluctuated substantially over the observed period, and the fluctuation rendered the basis of the cyclical changes in b/c ratio. Moreover, the patterns of changes in the benefit were different, the pattern of changes in b/c ratio varied across educational levels and sexes.

Decomposition into Factor Contributions

In order to relate numerically the changes in the contributing factors to the changes in $\hat{R}$, we consider the following decomposition scheme:

$$\dot{\hat{R}} \cong \dot{\hat{c}} - \dot{\hat{b}}, \quad (1) \; (2) \; (3) \qquad (2.2a)$$

and

$$\dot{\hat{c}} \cong q_1 \cdot \dot{FE} + q_2 \cdot \dot{DC}, \quad (3) \; (3a) \; (3b) \qquad (2.2b)$$

where dots above signify change rates, q_1 stands for the share of the foregone earnings (FE) in the total cost ($\hat{c}$), and q_2 for that of the direct cost (DC). The observed period, 1954-80, was divided into subperiods according to the observation about the changes in $\hat{b}$, and the decomposition scheme was applied to these subperiods. The resulting change rates were translated into average annual change rates, which are presented in Table 6. The numbers of the columns in the table correspond to the number in Eqs.(2.2a) and (2.2b) above. It should be noted that the figures do not exactly satisfy the stated relation due to the nature of approximation.

The decomposition analysis on the whole substantiates the observations made in the previous subsection. The growth rates of $\hat{c}$ were constant for the subperiods before 1975 across the educational levels and both sexes, ranging between 4 and 7 percent per annum except for 1967-71 for senior high school education. Moreover, all the average growth rates of $\hat{c}$ for the entire period fall in the range of between 4 and 5 percent per annum. Indeed, the changes in the cost side of education were constant and universal.

The decomposition analysis reveals further that the principal cause of this steady increase in the cost of education was the rise of *FE*, or foregone earnings. The increase in direct cost rendered substantial contributions in the 1950s and in the first half of 1960s. Over the subperiod 1954-59, the increase in *DC* accounted for about 40 percent of the increase in $\hat{c}$ of men's senior high school education, and about half of that of women's. As for men's college education, the increase of *DC* over 1954-66 constituted about one-third of the total increase in $\hat{c}$. Nonetheless the increase of foregone earnings was steady at 3 to 4 percent per annum for most of the subperiods before 1976, and it accounted for about four-fifth of the increase in the total cost for the whole observed period.

The steady rise in the foregone earnings is considered to have been caused by the continued rise of the wages for less educated labor at younger age brackets. It was one of the consequences of the increease in the wages of unskilled labor in general, which gradually developed in the 1950s and 1960s with the depletion of surplus labor that had long characterized the Japanese economy.[2] The increase in the wages for young unskilled labor was particularly accentuated by the decrease in the supply of young labor that entered the labor market directly after graduation from junior high school or senior high school, which was in turn induced by the increase in the enrollment rates in the upper tiers of school system. The increase in enrollment rate has thus depressed the classical *b/c* ratio through the decreased supply of uneducated labor.

The benefit of education, on the other hand, showed positive growth when averaged for the wole observed period, but its change rates fluctuated substantially. Moreover, its pattern of change varied substantially among educational levels and between sexes. The benefit of women's senior high school education grew at 3.7 percent per annum for 1954-80, as compared to 2.7 percent for men's senior high school education and 1.2 percent for men's college education. The annual growth rate for $\hat{c}$ of women's college and junior-college education for 1967-80 were 2.9 and 2.5 percent respectively.

It deserves attention that the benefit of senior high school or college education in real term made net increases over the whole observed period, despite the rapid increase in the supply of educated labor. This is primarily because, reflecting the high productivity growth, the average wage levels grew at such rates that the absolute wage differnetials by education increased, even though the wage ratios by education actually deteriorated reflecting the increased supply of educatedlabor.[13] The differences in the patterns of change in $\hat{b}$, on the other hand, indicate that the supply-demand relation of educated labor shifted in relatively short periods, and the shifts were not uniform across levels of ducation or sexes. Thus the

TABLE 6

DECOMPOSITION OF THE CHANGES IN B/C RATIO (% ANNUM)

		Period	$\dot{\hat{R}}$	$\dot{\hat{b}}$	$\dot{\hat{c}}$		
					total	of which due to	
						FE	*DC*
			(1)	(2)	(3)	(3a)	(3b)
Senior High School							
	Men	1954-59	2.4	7.1	4.6	2.8	1.8
		1959-67	−6.4	0.1	6.9	5.4	1.5
		1967-71	−12.1	−3.3	10.0	9.1	0.8
		1971-75	8.1	13.7	5.1	4.0	1.1
		1975-80	−0.6	−0.6	0.0	−0.7	0.6
		1954-80 ave.	−2.5	2.7	5.3	4.1	1.2
	Women	1954-59	3.2	7.1	3.8	1.9	1.8
		1959-67	−3.7	3.0	7 1	5.5	1.5
		1967-71	−5.8	2.8	9.2	8.3	0.8
		1971-75	2.5	8.0	5.4	4.2	1.1
		1975-80	−1.4	−1.4	0.0	−0.7	0.6
		1954-80 ave.	−1.4	3.7	5.1	3.8	1.2
Junior-College							
	Women	1967-71	3.3	10.7	7.2	7.1	−0.4
		1971-75	7.7	13.6	5.5	4.6	0.8
		1975-80	−12.1	−11.1	1.1	−0.5	1.4
		1967-80 ave.	−1.7	2.5	4.3	3.2	1.0
College							
	Men	1954-60	0.2	4.4	4.2	2.9	1.3
		1960-66	−8.6	−2.0	7.3	4.7	2.5
		1966-71	−0.1	7.1	7.2	7.1	−0.3
		1971-75	−5.4	−1.8	3.8	3.6	0.1
		1975-80	−3.0	−1.9	1.1	−0.4	1.3
		19544-80 ave.	−3.4	1.2	4.8	3.7	1.1
	Women	196-71	−1.2	5.5	6.9	7.1	−0.7
		1971-75	2.9	8.3	5.2	5.0	0.2
		1975-80	−4.5	−3.2	1.4	−0.3	1.5
		1967-80 ave.	−1.3	2.9	4.2	3.4	0.8

effect of educational xpansion on the anticipated *b/c* ratio through the change in the benefit of education appears to have been more complex than the effect through opportunity cost. Further discussion of this point, however, should be left for a future systematic analysis about the supply and demand for educated labor in the labor market.

The final remark to be made abaout the decomposition exercise is that there was a structural change in the determining structure of the *b/c* ratio in the mid-1970s. Although the change rates of the cross-sectional *b/c* ratio for 1975-80 do not appear to be particularly deviant relative to those for previous subperiods, the structure of contributing factors was different. For all the educational levels and both sexes, the increase in foregone earnings became minimal, while the benefit of education showed a decline. In consequence, the increase in the direct cost of education started to constitute a large part of the increase in the total cost and, subsequently, in the decline of the classical *b/c* ratios. Moreover, the magnitude of the decline of the benefit of education was greater with higher education than with secondary education, and much greater for women than for men. The structural change in the mid-1970s created net effects in the second half of the 1970s that were particularly adversary to the benefit from higher education of women.

3. ALTERNATIVE INDICES OF ANTICIPATED RETURN

The classical indices of economic return to education, calculated either in terms of the rate of return or the *b/c* ratio, may not be a good indicator of anticipated eonomic return to education. The above analysis revealed that its theoretical construction is based on very rigid assumptions about subjective expectation. Moreover, the estimated classical *IRR* or *b/c* ratio presented trends that clearly contradict to the trends in enrollment. In this section we therefore develop a new theoretical models of expectation, and derive from them alternative indices of economic returns of education. Those indices will later be used in systematically acounting for the changes in enrollment rate.

Operational Definition of Anticipated b/c Ratio

We first develop models of expectation and construct corresponding indicators of anticipated *b/c* ratio. There is no ultimate test to judge which of the alternative indicators should be the "best". But, their relative relevance shall be evaluated in the following chapter by their ability to explain the actual changes in enrollment rate.

The anticipated *b/c* ratio (R), rather than the classical *b/c* ratio ($\hat{R}$), is defined by substituting anticipated benefit (b) and cost (c) of education for observed benefit ($\hat{b}$) and cost ($\hat{c}$) in Eq.(2.1), i.e.,

$$R = b/c$$

$$= \frac{\sum_{n=n_g+1}^{n_r} (w_n{}^C - w_n{}^S)\cdot(1+i)^{-n}}{\sum_{n=1}^{n_g} [w_n{}^S\cdot(1+i)^{-n} + DC_n\cdot(1+i)^{-n}]} \quad (2.3)$$

where $w_n{}^C$ is the anticipated annual wage for college graduates, and $w_n{}^S$ is the anticipated annual wage for senior high school graduates, both for the n'th year after graduation of senior high school; DC_n is the anticipated direct cost of college education in the n'th year; and i is the discount rate for future income.

The critical point is how to formulate the anticpated wages in operational forms. We postulate that a typical individual has a perception of the current wage levels, which may be different from the actual wage levels due to time-lags; moreover, he may have an expectation that productivity would grow in future and anticipates that the wage levels would increase accordingly. Then the anticipated wages for the n'th year after graduation of senior high school can be approximated by:

$$w_n{}^C = \tilde{w}_n{}^C\cdot(1 + g)^n$$

for college graduates and

$$w_n{}^S = \tilde{w}_n{}^S\cdot(1 + g)^n \quad (2.4)$$

for senior high school graduates, where the tilde (˜) signifies the perceived value and g stands for the expected annual productivity growth rate. By substituting the above two equations into Eq. (2.6) above and further assuming that the anticipated direct cost is constant at the current direct cost, DC, we obtain:

$$R = \frac{\sum_{n=n_g+1}^{n_r} (\tilde{w}_n{}^C - \tilde{w}_n{}^S)\cdot(1+i)^{-n}\cdot(1+g)^n}{\sum_{n=1}^{n_g} [\tilde{w}_n{}^S\cdot(1+i)^{-n}\cdot(1+g)^n + DC_n\cdot(1+i)^{-n}]} \quad (2.5)$$

For expository purposes, let the above equation be expressed as:

$$R = R(\tilde{w}, g), \quad (2.6)$$

where the vector $\tilde{w}$ stands for the perceived wage structure.

The particular value of i with which the value of R becomes the unit is called the antiacipated internal rate of return, and denoted by i^*. Suppose that *DC* constitutes only a small proportion of the total cost, and that the perceived wages are identical with the corresponding actual wages. Then, by comparing Eq. (3.3) with Eq.(3.1) above and remembering that for small values of g and i the following approximation,

$$(1+i)^{-n}\cdot(1+g)^n \cong [1 + (i-g)]^{-n}, \tag{2.7}$$

holds, we find:

$$\hat{i}^* \cong i^* - g, \text{ or } i^* \cong \hat{i}^* + g. \tag{2.8}$$

That is, the classical *IRR* ($\hat{i}^*$) is less than the anticipated *IRR* (i^*) by approximately the percentage points of the expected productivity growth rate.

A similar argument can be made with the relation between the *ex post IRR* and the classical *IRR*. Supposing that the real wage growth rate has been constant at $\hat{g}$ per annum over the past years, the *ex post IRR*, denoted by $\hat{i}^*$, can be approximated by

$$\hat{i}^* \cong i^* - g, \text{ or } i^* = \hat{i}^* + g. \tag{2.9}$$

The *ex post IRR* is therefore greater than the classical *IRR* by approximately the percentage points of the past productivity growth rate.[14]

Hence, when an economy has beengrowing at a steady rate and it is likely that it would grow at that rate in future, both the *ex ante* and the *ex post IRR* would be greater than the classical *IRR*. In other words, under these circumstances the classical *IRR* under-estimates both the *ex ante* and *ex post IRR*s, and the bias is greater with greater past or anticipated productivity growth rates.

Models of Expectation

In order to obtain alternative indices of anticipated *b/c* ratio, we set three sets of hypothesis about the formation of anticipation of future wage structure and postulate corresponding models: i.e., the *conception-lag* model, the *growth-expectation* model and the *integrated* model.

(1) Conception-Lag Model

In the first model, a typical individual is assumed to preceive the current wage structure with some time-lags; he, however, expects that the perceived structure would be unchanged in future. If, as occasionally so argued, the time-lag in perception of the changes in the benefit of education is solely responsible for the incongruity between the changes in the classical *IRR* and the changes in the demand for education, the indices derived under this model should appear to be significant in the resulting regression analysis.

We translate this model into an operational form by postulating as if the value of the b/c ratio is evaluated each year based on perfect information about the wage structure, but a typical individual perceives the evaluated b/c ratio with time-lags. An index derived under this model, denoted by R^A, becomes a function of the classical b/c ratio with time lags, i.e.,

$$R^A{}_t = \Lambda_t \, [\, R(\tilde{w} = \hat{w},\ g = o)\,],$$
$$= \Lambda_t \, [\hat{R}\,],$$

where R and $\hat{R}$ denote the matrix of R and $\hat{R}$ respectively in time-series, and Λ_t stands for a time-lag operator for year t. A theoretically straight-forward and operationally easy way to express time-lags is the distributed-lag scheme, whereby Λ is a linear function of the values of $\hat{R}$ in the current and past years. That is,

$$R^A{}_t = \Sigma_m \, \lambda \cdot \hat{R}_{t-m}, \tag{2.10a}$$

where λ_m is the lag-weight attached to the m'th year from the current year, with $\Sigma_m \lambda_m = 1$. Various patterns of λ should be considered, which will be discussed later.

In actual estimation, the discount rate was assumed to be constant at 7.32 percent per annum, which is the interest rate for long-term deposits averaged for the period 1951-1981.[15] The rate of change in R^A, denoted by $\dot{R}^A$, is defined as:

$$\dot{R}^A{}_t = (R^A{}_t - R^A{}_{t-1}) \,/\, R^A{}_{t-1}.$$

It should be noted that with a particular pattern of time-lags R^A becomes identical with the classical b/c ratio, $\hat{R}$.

(2) Growth-Expectation Model

In the growt-expectation model, a typical individual is assumed to have the perfect knowledge about the current wage structure, but expects the wage structure would change in the future and subsequently evaluate the benefit and cost of education from the anticipated wage structure. The expected rate of the change in productivity reflects the current and the past productivity growth rate. This model corresponds to the hypothesis that the actual demand for education is affected by expectation of future productivity growth through anticipated benefit of education. We denote the indices derived under this model by R^B, and define them by the following formula:

$$R^B{}_t = R[\ \tilde{w} = \hat{w},\ g = \Lambda_t(\hat{g})\ ], \tag{2.10b}$$

where $\hat{g}$ is he vector of observed productivity growth rates in time-series. The time lag operator, Λ, is specified by the following distributed-lag scheme:

$$\Lambda_t(\hat{g}) = \Sigma_m \lambda_m \cdot g_{t-m},$$

where λ_m is the lag-weight as that defined with model A.

(3) The Integrated Model

The third model assumes that a typical individual has perception lags and evaluate the benefit of education with expectation of future productivity growth rate. Formulation of this hypothesis in a general form, however, can be highly complicated. We consider a special case where the indices of anticipated benefit of education, denoted by R^C, can be defined as follows:

$$R^C{}_t = \Lambda_t\, R(\tilde{w}=\hat{w},\ g=\hat{g})\ ]$$
$$= \Sigma_m \lambda_m \cdot R(\tilde{w}=\hat{w}_{t-m},\ g=g_{t-m}). \qquad (2.10c)$$

It is thus postulated as if the b/c ratio is evaluated every year based on the current wage structure and the current productivity growth rate, and a typical individual would perceive it with distributed lags.

Derivation of Alternative Indices

All the three models of expectation involve distributed-lag weights (λ_m). We assume a priori that the span of time-lag is at most six years, and that the profiles of the lag-weights over years draw "inverted-V" shapes, following some studies about the investment behaviors of business firms.[16] The critical parameter of lag-distribution is the relative position of its peak. Within a reasonable range of the peak, ten alternative patterns were postulated, which are presented in Table 7.

Note that the lag-weights used in actual computations are normalized. The alternative patterns are laid out in such a way that the lag-pattern with a greater number have more weights on distant past. Lag-pattern 3 or below do not load the value for the current year, which is not so unreasonable as it may appear because the decision of enrollment is likely to be made before the current calendar year.[17]

The combination of the three basic models of expectation with the ten patterns of lag-distribution produces thirty time-series indices of anticipated benefit of education, which will be denoted by *A-1* through *A-10*, *B-1* through *B-10*, and *C-10*. The indices may be also called the *A indices* the *B indices* and the *C indices*.

TABLE 7

ASSUMED PATTERNS OF LAG-DISTRIBUTION

Lag Pattern	Lag-Weight on Year						
	t	t-1	t-2	t-3	t-4	t-5	t-6
1	1	0	0	0	0	0	0
2	1	2	1	0	0	0	0
3	0	1	2	1	0	0	0
4	0	1	2	2	1	0	0
5	0	1	2	3	2	1	0
6	0	1	2	3	3	2	1
7	0	1	2	3	4	3	2
8	0	1	2	3	4	5	4
9	0	1	2	3	4	5	6
10	0	0	1	2	3	4	5

Notes

1 In other words he assumes that after graduation from college he would receive at age forty, for example, the same amount of wage as a typical college graduate is earning in the current labor market at age forty

2 The following discussion will be made with the particular case of college education for expository purposes it, however, applies to the case of senior high school education without major modifications

3 In the following discussion, age is expressed in terms of continuous scale. Ages greater than or equal to 18.0 and less than 19 0 in the continuous scale correspond to age 18 in conventional age-counting.

4 See appendix A for the method used in estimating of the proportion of "Ronin "

5 The retirement cash payment was imputed as an income at the age 55.5

6 Since in most cases the wage differentials are monotonously increasing by age, the possibility of a plural solution to the above equation is small.

7 The averaged interest rate was 7.54 percent for the period 1951-80. See Appendix D.

8 Most of the educational qualification of men earned in the prewar period and classified as "junior-college" in the original data are more comparable to college education in the postwar system The change in *IRR* reflects this qualitative change.

9 The average growth rate of productivity is estimated at 5.21 percent for the period 1951-80 See Appendix D.

10 The regression equation was in the form

$$ln(Y/H) = a_0 \cdot S + a_1 \cdot t,$$

where Y is the "regular cash earnings" in the *FWS* data (see Appendix A), H is the hours worked, S is the year of schooling, and t is the years in labor force (age minus the graduation year from the last school).

11 Note that the value of classical b c ratio is unaffected whether it is derived as the ratio between the nominal values of $\hat{b}$ and $\hat{c}$ or the ratio between the real values.

12 According to Minami (1970, p 158), the Japanese economy had what W L Lewis called the "turning-point" in the late 1950s

13 This point is emphasized by Becker (1975, p 76) in explaining the chan enrollment rates in the United States

14 Becker's (1975, p 151) estimation focused on what we call the *ex post I* He first estimated the wage profiles in the past by adopting wage profiles at a particular census year and projecting then with assumed productivity growth rate, and then derived the *IRR*s His estimation results show that the above relation provides reasonable approximation

15 See appendix D for a time-series index of market interest rate, and its data source

16 A typical approach using the lag-weights with inverted-V profiles is that by De Leeuw (1962) An alternative approach is the Almon-lag scheme whereby the profile of lag-distribution is approximated with a polynomial function of which parameters are estimated from regression analysis (Almon 1965) The Almon-lag scheme is more general than the former in that it imposes no particular form to the lag-distribution The Almon-scheme, however, yielded lag-distribution with various kinks, which are unjustifiable in light of the concept of perception lags Moreover, the indices derived from this scheme yielded little improvement in the final time-series regression analysis over the indices derived by imposing the inverted-V shape Hence, the results obtained from using the Almon-lag scheme are not reported here

17 An academic year in Japan begins on April 1, and the application for entrance begines in the end of the previous calendar year

CHAPTER III

FACTORS OF THE CHANGES IN ENROLLMENT RATES

The factors that caused the changes in enrollment rates in postwar Japan are examined in this chapter through time-series regression analysis. The scheme of the regression analysis is derived from the theoretical framework developed in Chapter I (Section 1). The results of the regression analysis are summarized and evaluated subsequently (Section 2). Finally, using selected results of the regression analysis, the actual changes in enrollment rates are divided among the fractions attributable to each of the independent variables (Section 3).

1. FRAMEWORK OF EMPIRICAL ANALYSIS

The Regression Model

Eq.(1.30) provides the basic framework for analyzing the change of enrollment rate with respect to the changes in the anticipated b/c ratio $(\dot{R})$, in the median family income $(\dot{Y})$, and the net effect of the residual factors D, i.e.,

$$\dot{L}(P) = \gamma \cdot \sigma \cdot (\dot{R} + \beta \cdot \epsilon \cdot \dot{Y} + D),$$

where $\dot{L}(P)$ is the logit-change of enrollment rate defined as $\dot{L}(P) = \Delta P/[P \cdot (1-P)]$. γ, σ, ϵ and β are structural parameters of individual choice about education and we shall assume that they were constant over the observed period.[1] σ is the adjustment factor for aggregation bias, and its value should change over time. A numerical evaluation of its values based on Eq.(1.34) above revealed however, that σ is likely to be very close to the unit within a reasonable range of the parameters, and its change over time is small relative to its value .[2] Hence, σ is treated as a constant.

Since little is known about the change in the net effect of the residuals, D, we treat it as a random variable independently distributed with respect to $\dot{R}$ or $\dot{Y}$.[3]

Estimation of $\dot{L}(P)$

Under a mixed educational system comprising both private and public institutions, such as that in Japan or in the United States, the aggregate demand for a level of education would be met by its supply in the long run, for the private institutions would adjust their capacity of enrollment to the level of demand,[4] even if the enrollment capacity of the public institutions does not change accordingly. Hence, in the long run, the enollment rate, E,[5] is almost identical with the demand rate, P. Nonetheless, temporary supply-demand disequilibria in the market of educational opportunity due to abrupt changes in the size of the eligible population may cause the erollment rate to be at variance from the demand rate. Since time-series regression analysis critically depends on the annual changes of P, the direct substitution of E for P may cause a bias.

In order to rectify this problem, we postulate the following relation:

$$\dot{L}l(E)_t = \dot{L}(P_t) + \delta \cdot \dot{S}_t. \tag{3.1}$$

$\dot{S}$ is the change rate of the size of the eligible population, and defined as

$$\dot{S}_t = (S_t - S_{t-1})/S_{t-1},$$

where S_t is the size of the age cohort that reached the eligible age for the level of education in year t.[6] δ measures the effect of short-run inelasticity of the aggregate supply of enrollment capacity with respect to the demand rate, and is expected to be a negative constant.

Estimation of $\dot{Y}$

Since the decision of a typical individual about enrollment in the upper level of education is gradually made until the time of official application and admission, not only the level of family income at the year of admission but also those in the preceding years should affect the choice about enrollment.[7] Hence, we derive the value of $\dot{Y}$ as the weighted average of the actual family-income growth rates in the past three years, with four alternative weight distributions, which are presented in Table 8. The value of $\dot{Y}_t$ for year t is then derived by

$$\dot{Y}_t = \Sigma_m \lambda_m{}^Y \cdot \dot{Y}_{t-m}{}^*,$$

where λ_m^Y with m = 0, 1, 2 stands for the lag-weight presented in the table above,[8] and $\dot{Y}_{t-m}$* stands for the growth rate of median-family income in the $t-$m'th year obtained from the actual data.[9] The values of $\dot{Y}$ derived through the lag-patterns will be denoted by $\dot{Y}^a, \dot{Y}^b, \dot{Y}^c$ and $\dot{Y}^d$ according to the employed lag-patterns. Notice that $\dot{Y}^a$ is identical with the growth rate of the median family income in the current year. Among $\dot{Y}^b$, $\dot{Y}^c$ and $\dot{Y}^d$, [illegible] loads the value of $\dot{Y}$ in the current year most heavily, while $\dot{Y}^d$ attaches the greatest weight to two years before actual enrollment.

TABLE 8

ALTERNATIVE WEIGHT DISTRIBUTION FOR DERIVING $\dot{Y}$

Weight Pattern	Weight Attached to the Year		
	t	t-1	t-2
a	1	0	0
b	3	2	1
c	2	2	2
d	1	2	3

The Regression Model

Through the specifications of the variables described above, the final form of the regression equation becomes:

$$\dot{L}(P_t) = b_0 + b_1\cdot\dot{R}_t + b_2\cdot\dot{Y}_t + b_3\cdot\dot{S}_t + e. \qquad (3.2)$$

where b_0, b_1, b_2 and b_3 are the regression coefficients, and e is the error term. Since b_1 is the estimate $\gamma\cdot\sigma$, it is expected to be positive; b_2 is the estimate of $\gamma\cdot\sigma\cdot\epsilon\cdot\beta$ and expected to be also positive. On the other hand, b_3 is the estimate of δ and thus should be negative. The constant term, b_0, measures the secular trend of the growth of enrollment rate that is not accounted for by the independent variables. We may set a hypothesis that b_0 is not significantly different from zero, which would imply that the effect of secular trend was negligible over the observed period.

Zero-Order Correlations

Before embarking upon the regression analysis, it wll be useful to check how the different indices of $\dot{R}$ and the different lag-patterns of $\dot{Y}$ affect the relations between $\dot{L}(P)$ and $\dot{R}$ or $\dot{Y}$.

Figure 5 presents the values of zero-order correlation coefficients between $\dot{L}(P)$ and the different indices of $\dot{R}$. The correlation coefficients were computed for the period 1958-81 with the *A* indices and with the *C* indices, and for 1955-81 for the *B* indices.[10] From the figure we observe the following three points.

First, except for a few cases, the correlation coefficients between $\dot{L}(P)$ and the *A* indices show the negative sign, which is contrary to our theoretical expectation. Moreover, the magnitude of the negative values do not appear to lessen with the lag-patterns of greater numbers. It is therefore unlikely that the signs of the correlation coefficients turn positive even if the span of time-lag was extended beyond six years.

Second, the *B*- and *C-indices* yield reasonably substantial and positive correlation coefficients with $\dot{L}(P)$. Comparing the two indices, the *C* indices fare better than the *B-indices* with male enrollment in senior high school and college, while the difference is not clear with female enrollment in senior high school.

Third, the profiles of the correlation coefficients of the *B*- and *C-indices* have their peaks somewhere between lag-patterns 3 and 9. The weak correlations for lag-patterns 1 or 2 implies that the inclusion of the current year does not improve the correlation, while that of lag pattern 10 signifies the exclusion of the preceding year *(t-1)* would impair the correlation. On the whole, anticipated *b/c* ratio appears to be captured reasonably well with the distributed lags encompassing six years.

The zero-order correlation coefficients between $\dot{L}(P)$ and the alternative estimates of $\dot{Y}$ are presented in Table 9. $\dot{Y}^a$ performs poorly, indicating that the current meddian family income alone would not provide much explanatory power. Also, $\dot{Y}^b$, which puts the heaviest weight to the current year, presents lower correlation coefficients than $\dot{Y}^c$ or $\dot{Y}^d$. It is not clear, however, which of $\dot{Y}^c$ and $\dot{Y}^d$ have better explanatory power. Hence both $\dot{Y}^c$ and $\dot{Y}^d$ should be tested in the full regression analyses.

TABLE 9

CORRELATION COEFFICIENTS BETWEEN $\dot{L}(P)$ AND $\dot{Y}$

		Specification of $\dot{Y}$			
		$\dot{Y}^a$	$\dot{Y}^b$	$\dot{Y}^c$	$\dot{Y}^d$
Senior High.	Men	0.376	0.403	0.482	0.467
Senior High.	Women	0.275	0.281	0.413	0.461
College	Men	0.288	0.342	0.401	0.382

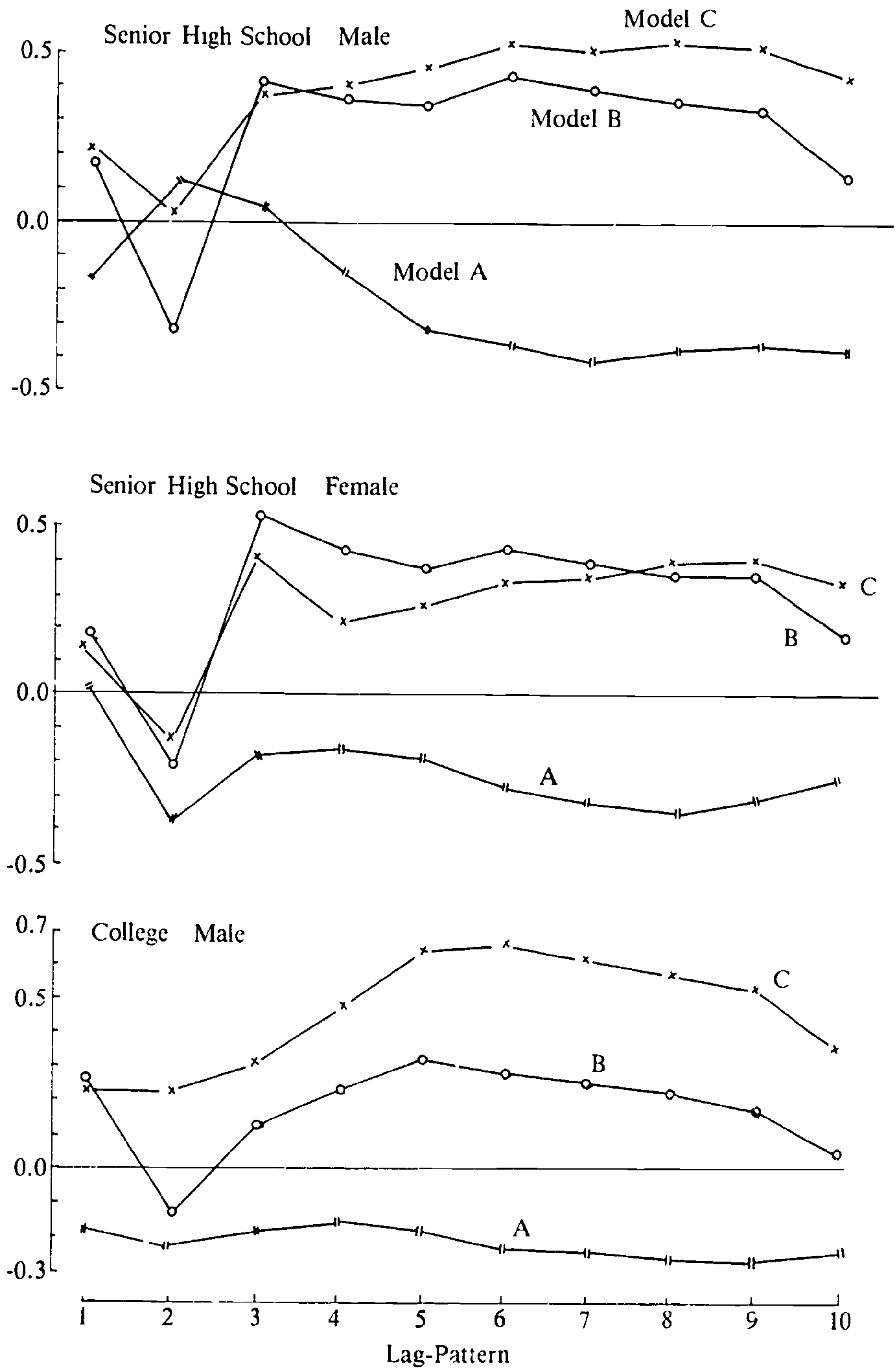


FIG. 5: CORRELATION COEFFICIENTS BETWEEN $\dot{L}$ AND $\dot{R}$

2. RESULTS OF TIME-SERIES REGRESSION ANALYSIS

Based on the regression model, extensive regression analyses were undertaken using each of the thirty indices (*A-1* through *A-10*, *B-1* through *B-10* and *C-1*) of $\dot{R}$, in combination with two indices of $\dot{Y}$($\dot{Y}^c$ and $\dot{Y}^d$). Consequently sixty full-regression models were estimated, which will be referred by combination of the indices of $\dot{R}$ and $\dot{Y}$; model *A-1-C*, for example, employs index *A-1* for $\dot{R}$ and $\dot{Y}^c$ for $\dot{Y}$. The full models with an *A* index will be called the A-models, and so on.

Male and Female Enrollment in Senior High School

The full models that produced the highest F values were selected from each combination of $\dot{R}$ and $\dot{Y}$, and the regression results are presented together with selected partial regression models in Table 10 for male, and in Table 11 for female enrollment in senior high school.

The regression results show that on the whole the full regression models perform better than the partial models, with highly significant F values. The multiple correlation coefficients may appear to be low for a time-series regression analysis, but it should be remembered that the present model is built on the first differences, which tends to depress adjusted R-squares. The adjusted R-squares range from 0.36 to 0.54, indicating that the selected full models explain about one-third to onehalf of the variance of the logit change-rate of enrollment.

In further details, we observe the following three points.

(1) The sign conditions are consistently met by the *B-* and *C-models*, but not by the *A-models*.

With index *A-2* the full-models for male enrollment yield regression coefficients with the expected signs and high over-all F values, but the estimates are probably substantially biased by positive auto-correlations as indicated by the low values of Durbin-Watson statistic.[11] The full-models for male enrollment with index *A-3*, which is not reported in the table, also presented substantial auto-correlation problems, while those with indices *A-4* through *A-10* yielded negative coefficients on $\dot{R}$, which is contrary to our theoretical expectation. As for the regression results for women, all of the *A-models* produced negative coefficients for R.

In contrast, the full regression models using the *B-* or *C-indices* lead to results congruent with our theoretical expectation. The *B-models* produce reasonably high over-all performances with the coefficients with expected signs. Moreover, by the *B-models* the regression coefficients of both $\dot{R}$ and $\dot{Y}$ appear to be significantly positive. This is the case with both male and female enrollment. The *C-models* tend to yield better explanatory powers than the B models. The sign conditions are met, but the significance of the coefficient on $\dot{R}$ fails to be significant at the 10-percent level except for model *C-9-d* for male enrollment. The weak significances of the coefficients of $\dot{R}$ may be attributed partly to the multi-collinearity caused by the strong correlation between $\dot{Y}$ and the *C*-indices of $\dot{R}$[12].

TABLE 10

REGRESSION ANALYSIS OF MALE ENROLLMENT IN HIGH SCHOOL

Index of Ṙ	Regression Coefficients					R	R̄²	F	D.W.
	Con.	Ṙ	Ẏc	Ẏd	Ṡ				
	0.046*		0.900**			0.364	0.101	4.274	1.671
	(0.025)		(0.436)					**	
	0.035		1.202**		-0.080	0.478	0.109	3.854	1.679
	(0.026)		(0.460)		(0.102)			**	
	0.067***			0.472		0.229	0.018	1.543	1.680
(0.023)			(0.380)						
	0.062**			0.644	-0.098	0.347	0.053	1.778	1.809
	(0.024)			(0.426)	(0.378)				
	0.092***				-0.118	0.202	0.006	1.185	1.632
	(0.012)				(0.092)				
A-2	-0.008	0.271**	2.582***		-0.047	0.743	0.485	8.205	1.132
	(0.024)	(0.113)	(0.540)		(0.077)			***	
A-2	-0.010	0.237**		2.586***	-0.073	0.793	0.572	11.265	1.125
	(0.021)	(0.101)		(0.459)	(0.070)			***	
B-6	0.095**	0.078**				0.400	0.126	4.758	2.021
	(0.012)	(0.036)						**	
B-7	0.096**	0.072*			-0.090	0.430	0.117	2.720	1.922
	(0.012)	(0.037)			(0.105)			*	
B-7	0.011	0.079***	1.903***			0.655	0.382	9.041	1.747
	(0.027)	(0.027)	(0.558)					***	
B-7	0.012	0.074**	1.875***		-0.059	0.664	0.367	6.030	1.682
	(0.027)	(0.029)	(0.566)		(0.090)			***	
B-7	0.022	0.078***		1.606***		0.641	0.362	8.381	1.769
	(0.025)	(0.028)		(0.495)				***	
B-6	0.024	0.079**		1.587***	-0.095	0.661	0.364	5.956	1.733
	(0.025)	(0.031)		(0.494)	(0.089)			***	
C-8	0.104***	0.163**				0.512	0.229	7.825	2.371
	(0.011)	(0.058)						**	
C-8	0.104***	0.163**			-0.001	0.512	0.102	3.735	2.371
	(0.011)	(0.062)			(0.099)			**	
C-9	0.020	0.099*	1.848***			0.718	0.470	11.199	2.179
	(0.026)	(0.048)	(0.547)					***	
C-9	0.020	0.100**	1.848**		0.005	0.718	0.444	7.113	2.188
	(0.027)	(0.051)	(0.560)		(0.082)			***	
C-9	0.011	0.082*		2.005***		0.759	0.535	14.251	2.085
	(0.024)	(0.046)		(0.501)				***	
C-9	0.011	0.077		2.020***	-0.025	0.760	0.515	9.129	2.017
	(0.025)	(0.049)		(0.515)	(0.077)			***	

Note: Standard error in parenthesis. *** indicates significantly different from 0 at 1 percent level; ** at 5 percent; * at 10 percent. The numbers of observations are 30 (1952-81) for partial models; 24 (1958-81) for the A- and C-models; 27 (1955-81) for theB-model.

TABLE 11

REGRESSION ANALYSIS OF FEMALE ENROLLMENT IN HIGH SCHOOL

Index of $\dot{R}$	Regression Coefficients					R	$\bar{R}^2$	F	D.W.
	Con.	$\dot{R}$	$\dot{Y}^c$	$\dot{Y}^d$	$\dot{S}$				
	0.074**		0.614			0.228	0.018	1.534	1.898
	(0.029)		(0.500)						
	0.073**		0.657		-0.127	0.317	0.031	1.447	1.919
	(0.031)		(0.568)		(0.122)				
	0.069***			0.695*		0.309	0.063	2.947	1.791
	(0.025)			(0.405)					
	0.067**			0.782*	-0.121	0.386	0.083	2.277	1.806
	(0.017)			(0.459)	(0.119)				
	0.106***				-0.150	0.232	0.020	1.597	2.155
	(0.013)				(1.119)				
A-9	0.023	-0.390	2.004**		-0.033	0.559	0.210	3.035 *	2.30[illegible]
	(0.037)	(0.451)	(0.809)		(0.122)				
A-8	0.010	-0.213		2.532***	-0.067	0.678	0.379	5.673 ***	1.994
	(0.032)	(0 414)		(0.698)	(0.108)				
B-3	0.105***	0.101***				0.543	0.267	10.453 ***	2.168
	(0.012)	(0.031)							
B-3	0.105***	0.096***			-0.088	0.559	0.255	5.455 **	2.161
	(0.013)	(0.032)			(0.112)				
B-4	0.038	0.094***	1.489**			0.649	0.373	8.743 ***	1.851
	(0.031)	(0.029)	(0.650)						
B-3	0.040	0.090***	1.472**		-0.080	0.660	0.363	5.929 ***	1.852
	(0.031)	(0.030)	(0.656)		(0.104)				
B-4	0.046	0.085***		1.277**		0.641	0.362	8.376 ***	1.954
	(0.029)	(0.030)		(0.587)					
B-3	0.045	0.079**		1.319**	-0.105	0.660	0.363	5.923 ***	1.931
	(0.029)	(0.031)		(0.588)	(0.104)				
C-3	0.115***	0.119**				0.421	0.140	4.741 **	2.403
	(0.014)	(0.055)							
C-3	0.115***	0.115*			-0.040	0.426	0.103	2.323	2.384
	(0.014)	(0.060)			(0.128)				
C-9	0.037	0.094	1.860**			0.572	0 263	5.094 **	2.308
	(0.038)	(0.077)	(0.807)						
C-9	0.037	0.090	1.853**		-0.036	0.574	0.229	3.281 **	2.296
	(0.039)	(0.080)	(0.825)		(0.119)				
C-9	0.010	0.058		2.416***		0.673	0.401	8.695 ***	2.062
	(0.034)	(0.071)		(0.716)					
C-9	0.009	0.048		2.446***	-0.067	0.680	0.363	5.764 ***	1.997
	(0.025)	(0.031)		(0.494)	(0.089)				

Note: Standard error in parenthesis. ***indicates significantly different from 0 at 1 percent level; ** at 5 percent; * at 10 percent. The numbers of observations are 30 (1952-81) for the partial models; 24 (1958-81) for the A- and C-models; 27 (1955-81) for the B-model.

The estimated values of the coefficients of $\dot{R}$ in the full *B*-models fall in the range between 0.07 and 0.09 for both sexes, the lack of noticeable difference by sex deserve attention. The estimated values for the selected *C-indices* vary in a wider range between 0.05 to 0.10.

(2) The most consistent and robust explanatory variable for male and female enrollment in senior high school is $\dot{Y}$, the rate of change in family income.

Although the explanatory power of $\dot{Y}^c$ or $\dot{Y}^d$ do not appear to be significant as the single predictor of the dependent variable,[13] they prove to be highly significant when combined with the other independent variables in the full regression models. The estimated regression coefficients are significant at the 1-percent level for all the full models, except for those with index *B-3* for women, which is still significant at 5 percent.

The estimated values of the coefficient of $\dot{Y}^c$ in the selected full regression-models vary from 1.8 to 1.9 for men and from 1.5 to 1.9 for women; those on $\dot{Y}^d$ range from 1.6 to 2.0 for men and from 1.3 to 2.4 for women. The particularly high estimated values for women yielded by the full-model using index *C-9*, however, may be a reflection of multi-colliniarity.[14] Hence, the difference in the coefficient between men and women can not be determined definitely.

(3) It should be observed that the estimated values of the coefficients on $\dot{S}$ are mostly negative, which meet our theoretical expectation. They are not significantly so in the full-models, however, suggesting that the depressing effect of the demographic changes through supply inelasticity in schooling capacity was not a significant factor in the change of enrollment in senior high school. It should be also observed that, although some of the estimated constant terms are significantly positive in the partial regression models, they invariably become insignificant in the full models.

Male Enrollment Rate in College

The selected results of the regression analysis about the change in the male enrollment rate in college are presented in Table 12.

The regression results show that in general the full regression models have reasonably high explanatory powers with high over-all significance. The adjusted R-squares of the full regression models are about 0.4 to 0.5, signifying that they account for about one-half of the variance of logit change rates of male enrollment in college.

In further details, the findings of the regression analysis may be summarized in the following three points.

(1) Once again the *A-models* do not satisfy the sign condition on $\dot{R}$, while the *B-* and *C-models* satisfy the condition consistently.

The selected *A-models* present significantly negative coefficients on $\dot{R}$, which is against our expectation. Moreover, all the other *A-models* that are not reported in the table yielded negative coefficients on $\dot{R}$.

The *B-* and *C-models*, on the other hand, meet the sign conditions. Model *B-6-d* yield the coefficient of significantly positive at 10 percent. The significance becomes weaker, however, with the other *B-models*, which is partly due to the negative correlation between the *B-indices* and $\dot{S}$.[15] The *C-models*, on the other hand, Yield higly significant coefficients on $\dot{R}$ with positive signs.

(2) The rate of increase in median family income, $\dot{Y}$, assumes positive coefficients, but its significance varies depending on the combination with the indices of $\dot{R}$. In the selected *B-models* coefficients on $\dot{Y}^c$ and $\dot{Y}^d$ are both significant at the 5 percent level. But in the *C-models* the coefficients lose significance. This is due to the multi-collinearity created by the strong correlation between the *C-indices* and $\dot{Y}$.[16]

The estimated coefficients of $\dot{R}$ in the selected *B-models* fall in the range between 0.06 and 0.07, and the corresponding coefficients of $\dot{Y}$ range from 1.53 to 1.66. It should be noticed that these values are very close to those obtained with senior high school enrollment, especially those for males. The selected *C-models*, however, present different value ranges. The coefficient on $\dot{Y}^c$ and $\dot{Y}^d$ are 0.07 and 0.10 respectively, and the coefficients on $\dot{R}$ ranges from 0.19 to 0.21. Compared to the regression results for the male enrollment rate in senior high school, the size of the coefficients on $\dot{R}$ are more than twice as large, while the coefficients on $\dot{Y}$ are about half as large. Hence, based on the *C-indices* one may argue that the anticipated benefit affected more the college enrollment rate than senior high school enrollment.

(3) The change rate in the size of the eligible population, $\dot{S}$, becomes a powerful explanatory variable with college enrollment rate.

As the single independent variable it yields very large explanatory power with the adjusted R-square at 0.35. The estimated values of its coefficient are significantly negative, which meets our theoretical expectation. Moreover, in combination with the other independent variables in the full regression-models its regression coefficinets remain highly significant with the negative sign. The estimated values of the coefficients are around -0.32 in the *B-models*, and in the range bvetween -0.24 and -0.26 in the *C-models*.

Also it should be observed that, although the constant term appears to be positive in most of the partial regression-models and frequently is significantly so, it becomes insignificant in the full models. Once again, the hypothesis of no significant secular trend in the change of enrollment is supported.

TABLE 12

REGRESSION ANALYSIS OF MALE ENROLLMENT IN COLLEGE

Index of $\dot{R}$	Regression Coefficients					R	$\bar{R}^2$	F	D.W.
	Con.	$\dot{R}$	$\dot{Y}^c$	$\dot{Y}^d$	$\dot{S}$				
	0.054		-0.347			0.102	-0.025	0.029	1.230
	(0.037)		(0.643)						
	0.034		0.261		-0.444***	0.584	0.291	6.734	1.430
	(0.032)		(0.594)		(0.121)			***	
	0.029			0.150		0.053	-0.033	0.077	1.123
	(0.033)			(0.539)					
	0.015			0.643	-0.445***	0.616	0.332	7.952	1.223
	(0.593)			(0.478)	(0.117)			***	
	0.046***				-0.440***	0.611	0.351	6.713	1.489
	(0.014)				(0.108)			***	
A-3	-0.051	-0.521*	2.073***		-0.343***	0.724	0.453	7.344	1.915
	(0.035)	(0.273)	(0.703)		(0.101)			***	
A-3	-0.061*	-0.572**		2.250***	-0.368***	0.761	0.517	9.196	2.133
	(0.033)	(0.258)		(0.637)	(0.095)			***	
B-5	0.059***	0.086				0.314	0.063	2.734	1.605
	(0.015)	(0.052)							
B-6	0.060***	0.064			-0.325***	0.578	0.278	6.007	1.650
	(0.013)	(0.043)			(0.109)			***	
B-6	-0.016	0.074	1.713**			0.496	0.183	3.919	1.801
	(0.037)	(0.045)	(0.761)					**	
B-7	-0.015	0.055	1.661**		-0.317***	0.684	0.399	6.761	1.923
	(0.032)	(0.035)	(0.655)		(0.100)			***	
B-5	-0.009	0.091*		1.491**		0.506	0.194	4.127	1.738
	(0.033)	(0.049)		(0.662)				**	
B-6	-0.009	0.073*		1.525**	-0.324***	0.705	0.432	7.583	1.915
	(0.028)	(0.038)		(0.557)	(0.094)			***	
C-6	0.066***	0.300**				0.662	0.413	17.178	2.152
	(0.013)	(0.072)						***	
C-6	0.066***	0.254***			-0.226**	0.741	0.505	12.752	2.240
	(0.012)	(0.069)			(0.100)			***	
C-6	0.046	0.275***	0.436			0.667	0.392	8.411	2.091
	(0.043)	(0.090)	(0.892)					***	
C-6	0.032	0.209**	0.737		-0.240**	0.752	0.501	8.695	2.168
	(0.039)	(0.086)	(0.818)		(0.101)			***	
C-6	0.040	0.268***		0.553		0.671	0.397	8.591	2.095
	(0.041)	(0.087)		(0.832)				***	
C-6	0.019	0.190**		1.007	-0.257**	0.765	0.522	9.386	2.174
	(0.037)	(0.083)		(0.762)	(0.100)			***	

Note: Standard error in parenthesis. *** indicates significantly different from 0 at 1 percent level; ** at 5 percent; * at 10 percent. The numbers of observations are 30 (1952-81) for the partial models; 24 (1958-81) for the A- and C-models ; 27 (1955-81) for the B-models.

Evaluation and Summary of the Regression Analysis

Figure 6 is a graphical presentation of the actual values of $\dot{L}(P)$ and the corresponding predicted values derived through selected full-regression models.

The figure shows that the predicted values capture what appear to be the trends of $\dot{L}(P)$ fairly well; the differences from the actual values appear to be random in general, although there are some periods over which the predicted values continue to over- or under-estimate the actual values. The nature of the residuals will be discussed later.

Let the time-series regression analysis be concluded by remarking the following points.

The regression analysis on the whole supports our proposition that the change in the enrollment rate can be explained by the changes in family income, in the anticipated benefit of education and in the cohort-size of the eligible population. With the male and the female enrollment rate in senior high school, there was at least one full regression model where both income and anticipated benefit appear significant at the 10-percent level. With male enrollment rate in college, there was one regression model where all three variable appear to be significant at the 10-percent level. On the other hand, none of the constant term in the full regression models are found to be signicicantly positive or negative. It implies that once the three explanatory variables are accounted for, no secular trend of change in enrollment rate can be detected for the observed period.

It should be noted, however, that when the *A-indices* are used, the sign condition for anticipated benefit was frequently unsatisfied. The *A-index* with no time-lag structure, which is identical with the classical *b/c* ratio, Produced negative coefficients as the single independent variable or in combination with the other independent variables. This was the case across sexes and levels of education. But even the *A-indices* involving time-lags, which account for the time-lag in perceiving the changes in the wage structure, performed poorly in explaining the change in enrollment rates, and in most cases their coefficients turn out to be negative. On the other hand, the *B-* or the *C-indices*, which allow for changes in the expectation of future productivity growth, presented significances in explaining the changes in enrollment rate. The *C-indices* on the whole perform better than the *B-indices* with higher explanatory power for the full regression equation, but they suffer from the multi-collinearity with the change rate of family income.

It has thus been shown that the anticipated benefit of education directly based on the wage structure in the present labor market would not help explain the observed change in enrollment, and even models allowing for perception-lags would not contribute much. Young men and women in postwar Japan appear to have evaluated the benefit of education counting for the changes in wage levels in the future.

The change in family income provided consistent explanatory power across sexes or levels of education. The sizes of its coefficient and their significance, however, were particularly large with male and female enrollment rates in senior high school. With male enrollment in college its significance in combination with the *C-index* of the anticipated benefit of education appeared to be weak, but this was partly due to the strong multi-collinearity between the two variables.

Cohort-size proved to be a significant variable in explaining the changes in college enrollment rates, but not high school enrollment rates. The difference in supply elasticities between the two levels of post-compulsory education is unsurprising. Expansion of facilities and faculties is more difficult for higher education, and the private institutions would have small incentives to accommodate temporary changes in the demand for college education. With senior high school education, on the other hand, the government took measures to expand the enrollment capacity, for a frustrated demand at the secondary level would have created serious social concerns.

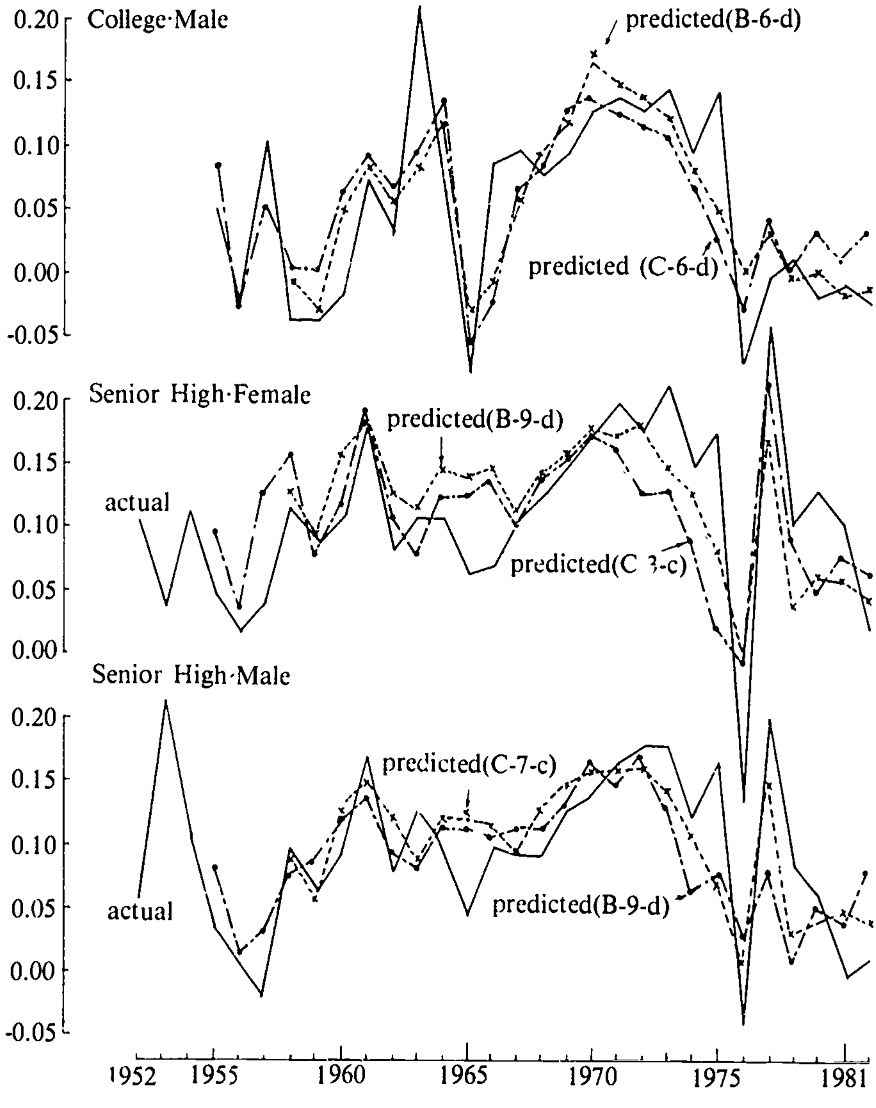


FIG. 6: ACTUAL AND PREDICTED VALUES OF L̇(P)

3. DECOMPOSITION OF THE CHANGES IN ENROLLMENT RATES

The Scheme of Decomposition

The full regression-equations estimated in Section 1 were in the form:

$$\dot{L}(P) = b_0 + b_1 \cdot \dot{R} + b_2 \cdot \dot{Y} + b_3 \cdot \dot{S} + e,$$

where b_0 through b_3 are the estimated regression coefficients, and e is the error term. Since these equations express the logit change, $\dot{L}(P)$, of enrollment rate as the sum of the accountable factors on the righthand side, they would directly serve as the frameworks of decomposition exercises, where the value of observed logit change in year t over the previous year is decomposed to: (1) the benefit effect $(b_1 \cdot \dot{R})$ which is due to the change in the anticipated b/c ratio; (2) the income effect $(b_2 \cdot \dot{Y})$ which is due to the change in the median family-income; (3) the cohort-size effect $(b_3 \cdot \dot{S})$ which is due to the change in the size of eligible population; and (4) the residual $(b_0 + u)$. The values of (1) through (4) may be positive or negative, indicating positive or negative contribution to the change in enrollment rate.

By applying this scheme to the actual data, one may obtain rough accountings of the sources of the growth of enrollment rates in postwar Japan. The decomposition exercise is critically dependent upon the estimated values of the regression coefficients, which have some margins of potential error. Consequently the results of the decomposition exercises should be considered as a hypothetical interpretation of the changes in enrollment rates.

The full regression models that yielded the greatest F-values were selected among the C models as the basis of the decomposition exercise.[17] The estimated coefficients were then applied to the annual data of $\dot{L}(P)$, $\dot{Y}$, $\dot{S}$ and the indices of $\dot{R}$ for the period 1958-81. It should be noted that hereafter the growth rate for a year refers to the growth rate from the previous year to the designated year; accordingly the period denoted by 1954-58, for example, shall refer to the change in five years from 1953 to 1958.

Male Enrollment in Senior High School

The annual changes of the male enrollment rate in senior highschool for the period 1954-1980 were translated into the logit change rates, $\dot{L}(P)$, which was divided into the contributions of $\dot{Y}$, $\dot{R}$ and the residuals. The results are presented in Figure 7. Since the derived contribution of $\dot{S}$ were small relative to the other factors, they are included in the values of the contribution of residuals in this figure.

A cursory examination of the profile of $\dot{L}(P)$ would indicate that the period covered by the analysis may be divided roughly into three periods. *Period (i)* encompasses the decade after 1955, which started with an initial stagnation in enrollment growth over 1955-57 *(sub-*

period (i)a), then saw the first sustained expansion of enrollment rate over 1958-64 *(subperiod (i)b)*, and ended with a temporary pause in the growth trend in 1965 *(subperiod (i)c)*. *Period (ii)* is the decade of educational expansion which comprises a period of sustained growth over 1966-70 *(subperiod (ii)a)* and a period of trend acceleration over 1971-75 *(subperiod (ii)b)*. *Period (iii)* started with a temporary but dramatic decline of the growth trend that induced the first negative growth of enrollment rate for two decades in 1976 *(subperiod (iii)a)*, followed by a temporary recovery and gradual decline of the growth trend toward the begining of the 1980s *(subperiod (iii)b)*.

The results of the decomposition computed from the annual change rates were averaged for these periods and subperiods, and presented in Table 13.

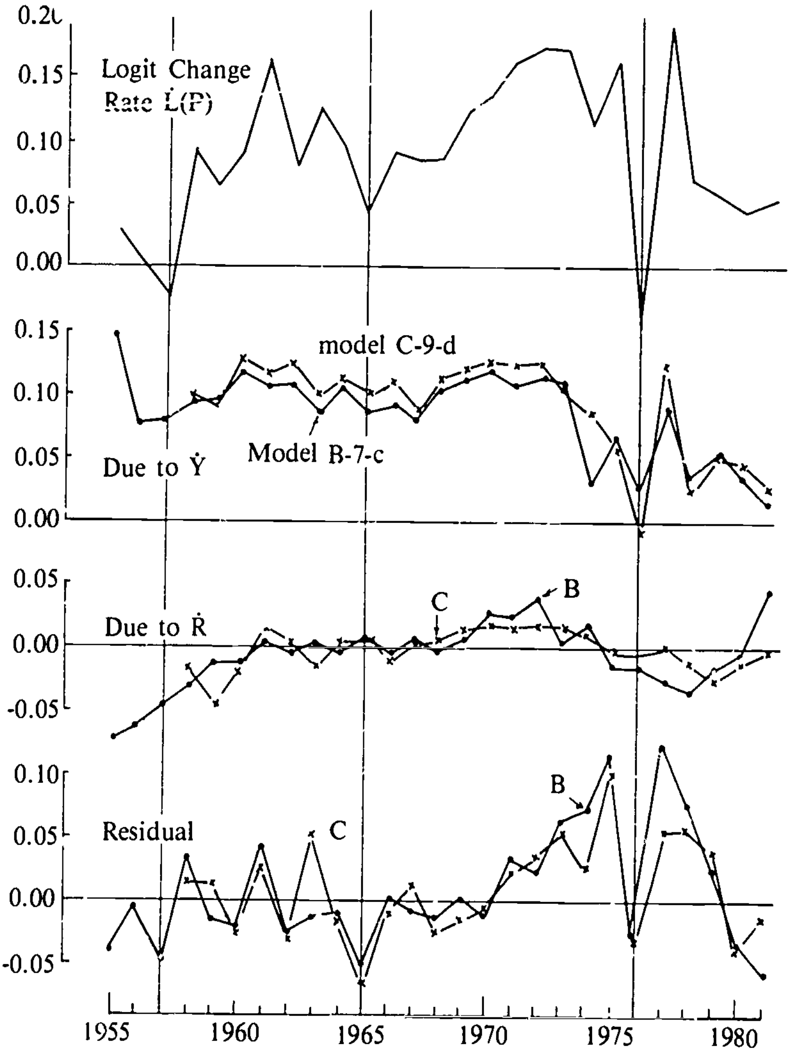


FIG. 7: LOGIT CHANGE RATES AND FACTOR CONTRIBUTIONS:
— Male Enrollment in Senior High School —

TABLE 13

DECOMPOSITION ANALYSIS: MALE ENROLLMENT IN HIGH SCHOOL

Period	Change in Enrollment Rate (%)		Logit Change Rate			
			Total	of which due to		
	Base[a]	Annual Change	$\dot{L}(P)$	$\dot{Y}$	$\dot{R}$	Resid.
(i) a 1955-57	49.2	0.08	—	—	—	—
b 1958-64	49.4	2.49	0.103	0.108	-0.011	0.006
c 1965	66.8	1.01	0.046	0.099	0.007	-0.060
(ii) a 1965-70	67.8	2.09	0.079	0.104	0.006	-0.031
b 1970-75	78.3	2.20	0.158	0.098	0.011	0.049
(iii) a 1976	89.3	-0.47	-0.049	-0.007	-0.007	-0.035
b 1976-81	88.8	0.59	0.064	0.057	-0.012	0.019
Average (i) and (ii) 1985-75	49.4	2.19	0.108	0.103	0.001	0.004
Average (iii) 1976-81	89.3	0.36	0.048	0.048	-0.011	0.011

[a]Enrollment rate in the base year of the designated period, i.e., 1954 for 1955-57, e.t.c.

The findings from the decomposition exercise may be summarized in the following three points.

(1) For the two periods *(i)* and *(ii)*, when the male enrollment rate in senior high school rose by as much as 40 percent points from 49 percent (1954) to 89 percent (1975), the predominant impetus of the increase in erollment came from the growth in family-income.

The annual average increase of the enrollment rate over 1958-75 was 2.19 percent-point, which corresponds to 0.108 points in $\dot{L}(P)$. Of the 0.108 point, about 95 percent (0.103 ÷ 0.108) can be attributed to the increase in family income. Moreover, the contribution of $\dot{Y}$ was fairly constant over this period, despite the temporary fluctuations of the logit change rate itself.

The contributions of the other factors were not negligible over this period, but they mostly affected the temporary fluctuations of $\dot{L}(P)$. On the other hand, the temporary pause in the growth trend in 1965 was brought about by the large negative effect of the residuals.[18]

It should be emphasized, however, that the negligible contribution of $\dot{R}$ over this period does not signify that the anticipated *b/c* ratio was insignificant in determining the change in enrollment rate. For if the anticipated *b/c* ratio declined, $\dot{R}$ could have created a negative effect and depressed the potential increase in demand. Despite the decline in the classical *b/c* ratio (see Section 2 of Chapter II), the anticipated *b/c* ratio can be considered to have remained unchanged because of increasing confidence in the productivity growth fermented in the process of rapid economic growth.

(2) The expansion of enrollment rate accelerated in the first half of the 1970's. From 1970 to 1975, the male enrollment rate in senior high school rose dramatically from 78 percent to 89 percent, or by an average annual rate of 2.2 percent-point. The average annual gain of enrollment in terms of percentage-points was not necessarily greater than the preceding sub-periods; but this was because the level of enrollment rate was approaching the 90 percent-mark, and the ceiling effect was already depressing the growth. But, in fact, the magnitude of growth in underlying demand became greater, as indicated by the logit change-rate over this period (0.16 point), which was about 1.5 times greater than that for *sub-period (i)b*, or twice as great as that for *(ii)a*.

What deserves attention is that the composition of the contributing factors shifted dramatically during this period. Form 1970 to 1972, the value of $\dot{L}(P)$ stayed at a high level mainly because the $\dot{Y}$ created contributions of about 1.2 points, and the positive effect of $\dot{R}$ made marginal contributions. But after 1972, the growth of the whole economy started decelerating,[19] and the growth rate of family income started to decline. Consequently the magnitude of the contribution of $\dot{Y}$ lost its momentum. A puzzling phenomenon was that, despite the decline of the contribution of $\dot{Y}$, the level of logit change-rate stayed at a high level until 1975. In the framework of our decomposition analysis, it appears as the exceptionally large values of the residuals in this period.

What the large contributions of the residuals were reflecting will be discussed later. We note at this point that, behind the culmination of the growth trend, a structural shift in the demand for senior high school education was already starting in the first half of the 1970s.

(3) The long-term trend of enrollment growth that spanned two decades finally came to an end in 1976, with an abrupt decrease in enrollment rate over the previous year. The growth rate showed a temporary recovery in 1977, but ever since, it appears to be converging to a substantially lower level than in the previous two decades.

At least a part of what appeared to be a sharp drop of $\dot{L}(P)$ in 1976 can be attributed to the decline of $\dot{Y}$ that started a few years before. The logit change rate for 1976 was -0.05 point as contrasted to an average of 0.16 point over the preceding 1970-75 period, hence the difference was 0.21 point. Since the corresponding difference in $\dot{Y}$ was 0.11 point, about one-half (0.11 ÷ 0.21) was attributable to the decline of $\dot{Y}$. What made the change abrupt, however, was a drastic decrease in the value of the residual from 0.10 point for 1974 to -0.03 point in 1976. In 1977, $\dot{L}(P)$ showed a sharp recovery by gaining 0.24 points over the 1976 level. Again, about one-half of the change can be attributed to the recovery of $\dot{Y}$ and the remaining one-half to the residual.

The deviations in these two years eventually cancelled out, and the logit change rate in later years have been diminishing. The average logit change-rate over 1976-81 amounted to only 0.05 point, which was about one-half of that for the preceding two decades. The small increase in the enrollment rate over this period thus can not be attributed to the ceiling effect; the driving forces of enrollment expansion actually shifted downward in this period. The major factor of this decline was the slowed growth of family income levels. The average value of $\dot{L}(P)$ for 1976-81 was by 0.06 point less than that for 1958-75, while the corresponding difference in the contribution of $\dot{Y}$ was about 0.05 point, which accounts for roughly 90 percent of the former. It should also be noted that the contribution of $\dot{R}$, which was almost zero over the preceding two decades, became -0.11 in this period; that is, the anticipated benefit of senior high school education started declining, and it depressed the growth of the enrollment rate.

TABLE 14

DECOMPOSITION ANALYSIS: FEMALE ENROLLMENT IN HIGH SCHOOL

Period	Change in Enrollment Rate (%)		Logit Change Rate			
			Total	of which due to		
	Base[a]	Annual Change	$\dot{L}(P)$	$\dot{Y}$	$\dot{R}$	Resid.
(i) a 1955-57	44.1	0.83	—	—	—	—
b 1958-64	46.6	2.71	0.111	0.130	-0.005	-0.146
c 1965	65.6	1.35	0.060	0.120	0.005	0.065
(ii) a 1965-70	67.0	2.42	0.120	0.105	0.004	0.011
b 1970-75	79.1	2.33	0.178	0.119	0.006	0.053
(iii) a 1976	90.7	-1.09	-0.129	-0.008	-0.004	-0.117
b 1976-81	89.6	0.92	0.119	0.069	-0.007	0.057
Average (i) and (ii)						
1958-75	46.6	2.45	0.129	0.119	0.001	0.009
Agerage (iii)						
1976-81	89.6	0.50	0.084	0.058	-0.007	0.032

The enrollment rate in the base year of the designated period, e.g.,1974 for 1975-78, e.t.c.

Female Enrollment in Senior High School

$\dot{R}$ and the corresponding contributing factors for women's enrollment rate in senior high school are presented in Figure 8. Since the profile of $\dot{R}$ over time is very similar to that for male enrollment rate, the same sub-periods as those for male were used to summarize the results of fecomposition the exercise, which are presented in Table 14.

The results of the decomposition exercise indicates that the basic patterns of the composition of factor contributions and their change over time for female are similar to those for male. The principal driving force of the increase in enrollment for the two decade until the mid-1970s was the increase in family income, and the downward-shift of the growth trend after 1976 can be primarily attributed to the slowed growth of family income.

The growth of enrollment rates for the entire two-and-half decade, however, was slightly greater for females than for males. The major part of this difference can be attributed to the greater contribution of $\dot{Y}$ for females than for males. From 1957 to 1975 the enrollment of women grew by an annual average of 2.45 percent point, or by 0.129 point in logit change rate, compared to 2.19 percent point or 0.108 point for men. The corresponding contribution of $\dot{Y}$ were 0.119 point for women and 0.103 point for men. Hence, about 70 percent of the margin is attributable to the difference in the effect of family income growth.

Male Enrollment in College

The changes in $\dot{L}(P)$ of male enrollment in college and the corresponding factor contributions are presented in Figure 9.

The profile of $\dot{L}(P)$ draws a similar pattern to those for senior high school enrollment rates. There are slight differences in details, however, and we analyze its change using the following three time-periods. *Period (i)* includes: *subperiod (i)a*, which covers the initial fluctuation of growth trend over 1955-57; *(i)b*, a temporary negative growth over 1958-59; *(i)c*, the first subperiod of continued growth over 1960-64; and *(i)d*, a temporary negative growth in 1965. *Period (ii)* includes: *subperiod (ii)a*, the second subperiod of sustained growth over 1966-69; and *(ii)b*, a trend-acceleration over 1970-75. *Period (iii)* comprises: *subperiod (iii)a*, the abrupt change to a negative growth in 1976; and *(iii)b*, the subsequent conversion to zero-growth. The summary of the decomposition exercise accoding to these subperiods is presented in Table 15.

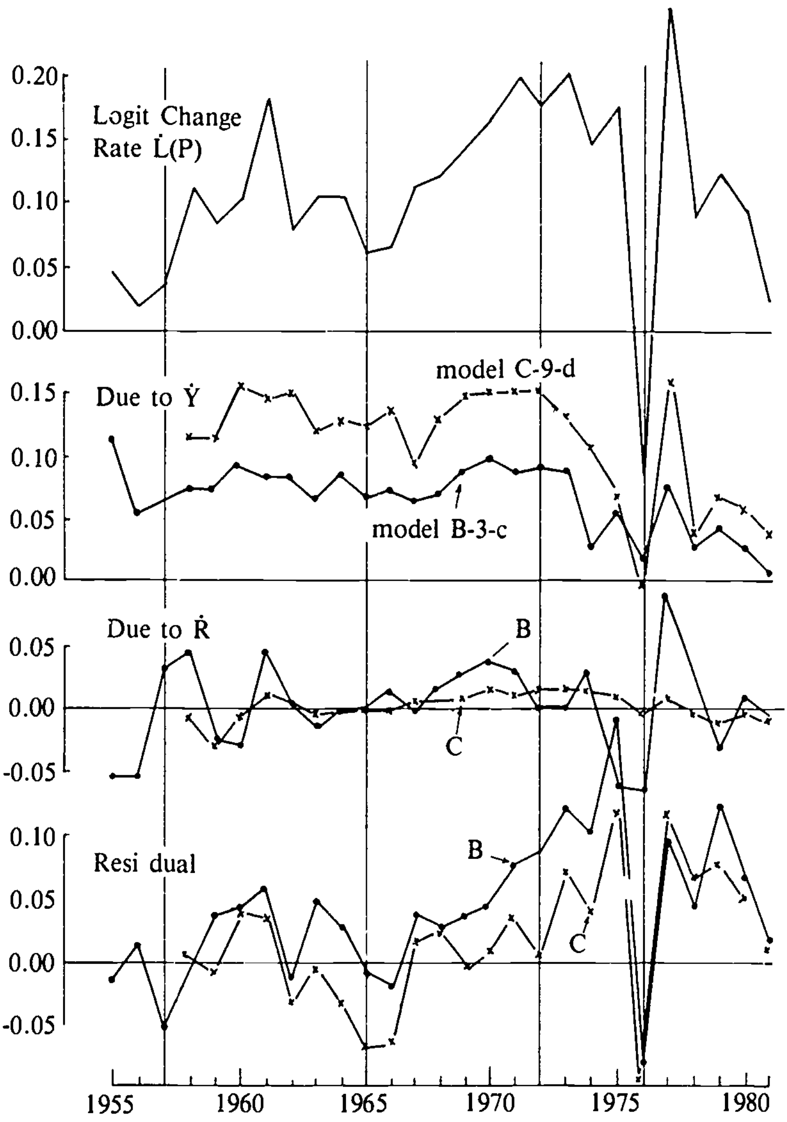


FIG. 8: LOGIT CHANGE RATES AND FACTOR CONTRIBUTIONS:
— Female Enrollment in Senior High School —

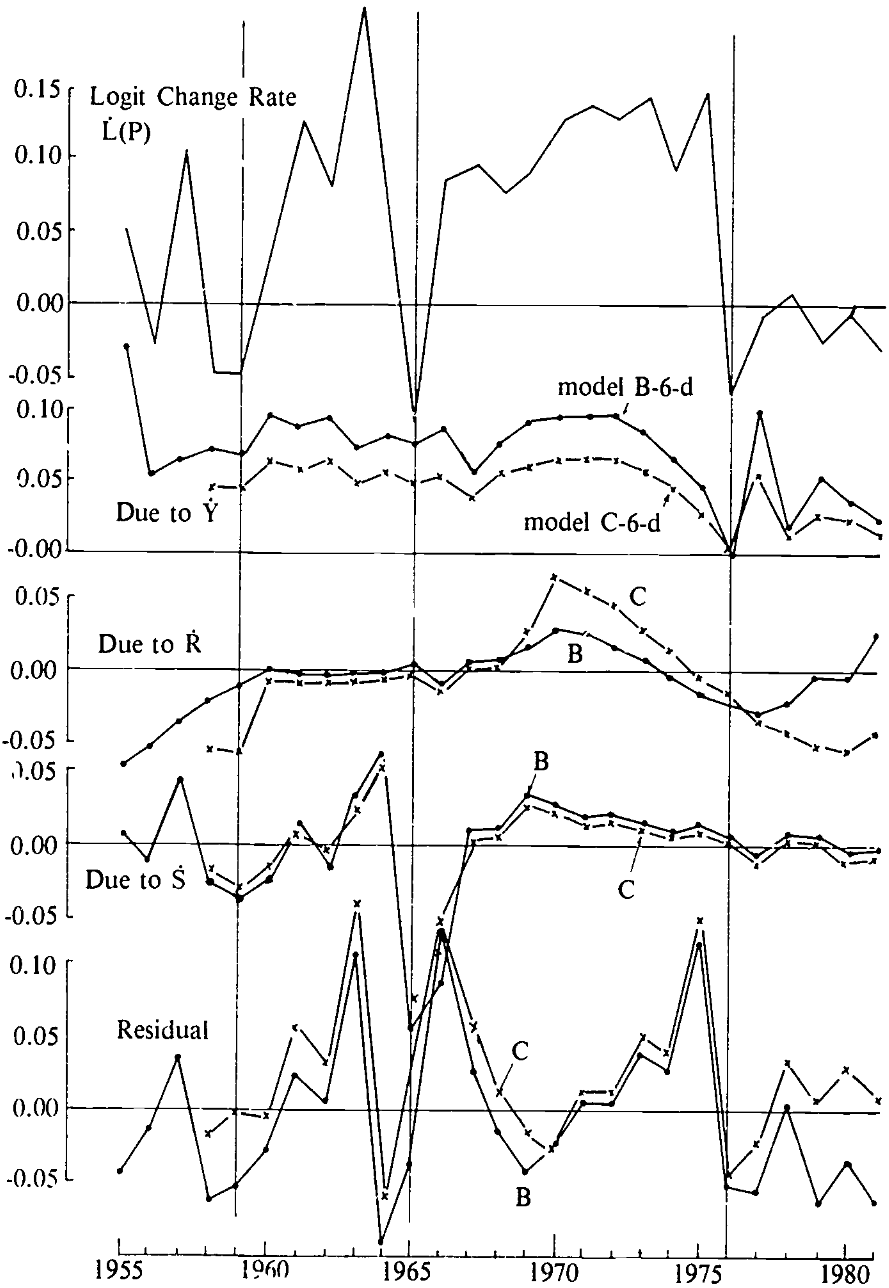


FIG. 9: LOGIT CHANGE RATES AND FACTOR CONTRIBUTIONS:
— Male Enrollment in College —

TABLE 15

DECOMPOSITION ANALYSIS: MALE ENROLLMENT IN COLLEGE

Period	Change in Enrollment Rate (%)		Logit Change Rate				
			Total	of which due to			
	Base[a]	Annual Change	$\dot{L}(P)$	$\dot{Y}$	$\dot{R}$	$\dot{S}$	Resid.
(i) a 1955-57	13.9	0.49	—	—	—	—	
b 1958-59	15.3	-0.55	-0.043	0.046	-0.052	-0.027	-0.010
c 1960-64	14.2	1.36	0.099	0.057	-0.005	0.03	0.034
d 1965	21.0	-1.48	-0.090	0.049	0.001	-0.012	-0.038
(ii) a 1965-69	19.5	1.23	0.087	0.051	0.005	-0.008	0.039
b 1970-75	25.4	2.74	0.127	0.051	0.031	0.012	0.033
(iii) a 1976	41.9	-1.78	-0.073	-0.018	-0.003	0.003	-0.054
b 1977-81	40.1	-0.17	-0.012	0.028	-0.047	0.002	0.009
Average (i) and (ii) 1958-75	13.9	1.47	0.079	0.052	0.004	-0.003	0.026
Average (iii) 1976-81	41.9	-0.47	-0.021	0.021	-0.041	-0.001	0.000

The enrollment rate in the base year of the designated period, e.g., 1974 for 1975-78, e.t.c.

A cursory inspection on the table would reveal the following three points.

(1) For the periods *(i)* and *(ii)* the increases in family income was the major and most consistent source of enrollment increase. In the two decades from 1957 to 1975, men's college enrollment rate grew from 15.3 percent to 41.9 percent, which corresponds to an annual increase of 1.47 percent-point, or an annual logit-change rate of 0.079 point. The contribution of $\dot{Y}$ was fairly stable over this period, and its annual average was about 0.052 point. Hence, the growth of family income consistently accounted for about two-thirds of the enrollment increase throughout this period.

The change in the anticipated *b/c* ratio and the change in the size of the eligible population, on the other hand, caused short-run flucuations in the growth trend. Over the period 1958-59, $\dot{R}$ made a negative contribution of -0.05 point. while the positive contribution of $\dot{Y}$ was only 0.05. In consequence, the enrollment rate decreased from 15.3 percent to 14.2 percent. It was only after the negative effect of the decline in the anticipated benefit disappeared that the first subperiod of enrollment expansion started. In 1965, more dramatic temporary change in the growth of enrollment rate was induced by the change in the size of eligible population. In this year, the first wave of the baby-boom cohort reached college-going age, inducing a dramatic increase in the size of the eligible population. The contribution of $\dot{S}$ turns out to be -0.10 point, which outweighed the effect of $\dot{Y}$[20]

(2) There was a clear acceleration of growth-trend of college enrollment rate over 1969-75, and a considerable part of the acceleration can be attributed to the increased contribution of the anticipatec *b/c* ratio.

The college enrollment rate grew from 25.4 percent to 41.9 percent in the six years between 1969 to 1975, by a remarkable annual increse of 2.74 pcrcent-points, which was mcre than twice as large as the average for 1976-79. The logit change-rate over 1970-75 reached 0.127 point, compared to 0.087 point for 1965-69. The trend acceleration of college enrollment was thus of greater magnitude than that of senior high school enrollment. A clear difference from the case of senior high school enrollment was the substantial contribution of $\dot{R}$, particularly in the first few years of this subperiod. In 1970, for example, the logit change rate reached 0.12 point while the contribution of $\dot{R}$ was 0.06 point; one-half of the growth can be attributed to the increase in the anticipated net benefit. The trend acceleration was thus initiated by the substantial marginal contribution of $\dot{R}$.

But after 1973, the sizes of contribution of $\dot{Y}$ and $\dot{R}$ both diminished. Since the logit change rate did not decline accordingly, the contribution of the residual increased considerably, to reach 0.13 point in 1975. This was exactly the same phenomenon as observed for senior high school enrollment. The nature of the residual in this particular period will be discussed later.

(3) The change of the college enrollment rate suddenly became negative in 1976, and since then it appears to be converging to a zero-growth path.

The male enrollment rate in college fell from 41.9 percent in 1975 to 40.1 percent in 1975, and then eventually to 38.6 percent in 1981. This is equivalent to an annual change of -0.47 percentage point or -0.02 point of logit change-rate. The negative logit change-rate was the consequence of the negative contribution (-0.04 point) of $\dot{R}$ that outweighed the pcsitive effect (0.02 point) created by $\dot{Y}$. Since the growth rate of family income diminished over this period, it was not large enough to offset the decline of expected benefit from college education.

When this period is compared to the previous two decades of continued growth of enrollment rate, the average logit change-rate is lower by 0.10 point; meanwhile, $\dot{Y}$ decreased by 0.03 pc.nt, and $\dot{R}$ by 0.05 point. About one-half of the downward shift of the growth trend can attributed to the falling expected benefit from college education, and one-third can be attributed to the slowed growth of family income.

Interpretation of the Residuals

The decomposition analysis above left a substantial fraction of the logit change-rates unaccounted for, which we called the residuals. Partucularly, the derived residuals for a few years before and after the dramatic decline of growth trend in 1976 draw attention, for they are not only large in magnitude but also appear to reflect some non-random factors. A close examination of these residuals may help widen the perspective of the decomposition analysis, although the discussion cannot avoid being highly speculative.

Three hypothesis can be postulated about the residuals.

The first hypothesis is that the changes in the observed values of the independent variables are not capturing their actual changes in a particular period for some reason. This hypothesis helps explain the residuals for 1973, 1974 and 1975, which was a period of radical structural transformation of the Japanese economy. Following the reorganization of the international monetary order and the subsequent oil crisis, the period saw the first hyperinflation since the end of the world war. The C.P.I. growth rate (see Appendix D) rose from 4.5 percent in 1972 to 11.7 percent in 1973, and to 36.0 percent in 1974, while nominal wage grew by 15.8 percent, 21.8 percent and 26.5 percent respectively. Since the nominal wage (or the family-income) growth rates were less than the inflation rate, the real index of family income declined. It is conceivable, however, that under these circumstances the public perception of their real income and wages was somewhat deviant from what the economic indicator would suggest. Moreover, increases in nominal wage rate of such magnitudes may have caused a "momey illusion" to raise the anticipated future productivity growth, thus creating the positive residuals.

The second hypothsis holds that the deviation of an independent variable from a regular range of variance have triggered a temporary disequilibrium. This may help to explain the extreme fluctuations of the residual in 1976. In 1976, the estimated value of $\dot{Y}$(the weighted average of the last three years) reached almost zero, which had not been experienced for more than two decades. One could argue that it triggered a "potential surprise" that induced a temporary disequilibrium that can not be accounted for by the estimated structure of educational demands.

The third hypothesis holds that some factors not specified in the model exerted a strong effect on the dependent variable in a particular period. This appears to help to explain the residuals in a few years after 1976. It should be noticed that the substantial residuals in this particular period are observed only with the enrollment rates in senior high school. It is conceivable that the residuals are related with the increasing psychological and social pressure to attend senior high school when enrollment was becoming almost universal.

Testing the validity of these hytpothesis is left as a subject of future studies.

Notes

1 Their constancy over time may be checked through cross-sectional regression analyses for different time periods

2 The assumed values of parameters were. γ (r $\alpha+\beta$) = 5 0, γ^{Y} = 0 05, and γ = 3 0 The derived value of σ was 0 990, 0 967 and 0 979 when the enrollment rate was 8, 50 and 92 percent respectively. Hence, its change was at most 3 percent of its greatest value

3 It should be noted that by this assumption it is not implied that the mean value of D should be zero In fact, its mean value for the observed period will be measured by the constant term in the resulting regression equation

4 The aggregate supply of the opportunity in private institutions ould change through the change in the number on institutions as well as through the change in t ie capacity of each institution

5 In this study the enrollment rate, E_t, for year t is defined as the proportion of those who etered a level of education in year t or later out of the age-cohort that reached the eligible age for the level of education in year t The process of its estimation is presented in Appendix A

6 For the data about the size of eligible population see Appendix B

7 Moreover, the inclusion of only the values of Y for the current years in the regression scheme may be invalid for a technical reason the value of Y measures the real family income growth rate for the whole calendar year, while enrollment in schools take place at the beginning of the calendar year.

8 The actual values of λ_m^Y are normalized so that

$$\Sigma_m \lambda_m^Y = 1$$

9 Although the estimation requires a time-series of the median-income of the families of the eligible population, such data are unavailable in a consistent form Hence a time-series of the average family-income of worker's household was used The originl data and the method of estimation of this index are presented in Appendix D

10 The difference is due to the construction of the indices Model B yields the estimate of R for all the years when the wage data are available, for it does not involve the wage differentials in preceding years.

11 The D W statistics are close to the lower boundary of the 5 percent critical range, implying that the null-hypothesis of auto-correlation is not likely to be rejected.

12 The zero-order correlation coefficients are as follows.

Index of R	Y^c	Y^d	Period Covered
B-7 Males	-0 104	-0 098	1955-81
B-3 Females	0 109	0.240	1955-81
C-9 Males	0 473	0.550	1958-81
C-9 Females	0 359	0 417	1958-81

13 The relatively low significance of Y^c in the partial regression models an be partly attributed to the large fluctuation of the income growth rate in the early 1950s, which was caused by large inflation rates The same regression equation estimated for 1955-58 produced some improvements

14 Observe the coefficient on R in the same equation, which is much smaller than the corresponding values in the other full-models

15 The zero-order correlation coefficients among selected independent variables are as follow

	Y^c	Y^d	S	Period
R(B-6)	-0 045	-0 066	-0.275	1958-81
R(B-7)	-0.074	-0 078	-0 315	1958-81
R(C-6)	0 559	0 552	-0 098	1955-81
R(C-7)	0.492	0.472	-0 142	1955-81
S	-0.044	0 030	—	1956-81

16 See the footnote above

17 The selected equations were C-9-d for male enrollment in senior high-school, C-9-d for female enrollment in senior high school, and C-6-d for male enrollment in college With all these equations, the null hypothesis of auto-correlation are rejected at 5 percent level by the D W. test

18 The negative value of the residual in this period may be reflecting two factors One is the recession in 1964 through 1965, which was relatively short-lived and not captured adequately by the data of annual increase rates of family income Another is the accumulated effect of the size of baby-boom generation, by this time, the first two afe-cohorts of exceptionally large size were enrolled in senior high schools and the schools should have exhausted their ability to expand enrolment capacities

19 The "Nixon Shock" in 1971, the follwing disorder in world trade, and finally the oil shock in 1974 drew the Japanese economy in to the first prolonged recession for a decade.

20 It should be noticed, however, that he contribution of the residual became large before and after 1965 Since the pattern of their change shows a clear relation with the change of *S*, those values of the residual may be capturing the lagged effects of supply-and-demand interaction around the period that was not properly represented by *S*

SUMMARY AND CONCLUSION

As the first step in exploring the causes of the cyclical changes in enrollment rates, a model of individual choice was postulated (Chapter I, Section 1), and subsequently an aggregate educational demand function was developed. Based on the aggregate demand function it was found that the logit-change rate in the demand for education over time can be approximated by a linear function of the rates of change in median family income and anticipated benefit/cost *(b/c)* ratio (Chapter I Section 2). This relation provided the basic framework for an empirical analysis about changes in enrollment rates.

The theoretical model assigned a critical significance to the changes in the anticipated benefit of education. As a preliminary approach to the changes in the anticipated *b/c* ratio, the "classical" *b/c* ratios were estimated from the data of observed wage structure in the labor market and direct cost of education for the period 1954-1980. It was shown that the classical *b/c* ratios for men's and women's senior high-school education and men's college education declined gradually over the observed period, although the pattern of the change varied in detail by sex and by the level of education. Particularly from the late 1950s to the first half of the 1960s the classical *b/c* ratio decreased substantially across sexes and the levels of education (Chapter II, Sections 1 and 2). This was, on the other hand, the very period that enrollment rates started their unprecedented increases. Since a decline in anticipated benefit of education is expected to depress the demand for education, the observed educational expansion in the face of the declining benefit of education appears to suggest that benefit of education was an irrelevant variable in explaining the educational expansion in postwar Japan.

The classical *b/c* ratio, however, can be a poor indicator of the anticipated *b/c* ratio: it ignores subjective factors involved in evaluation of the anticipated benefit of education, such as time-lag in perception of a change in the wage structure and expectation of future productivity growth. Accordingly, alternative indices of the anticipated *b/c* ratio were constructed based on the following three hypothetical models of rational expectation: the "perception-lag" model *(model A)*, which accounts only for time-lag in perceiving changes in wage structure; the "growth expectation" model *(model B)*, which accounts only for the effect of expectation in the future productivity growth; and the "integrated model" *(model*

C), which corresponds to a case where both subjective factors enter the evaluation of the *b/c* ratio in a particular way. In combination with ten alternative patterns of time-lag, this scheme created thirty alternative indices of the anticipated *d/c* ratio (chapter III, Section 1).

Subsequently an extensive regression analysis was applied to time-series of male enrollment rate in senior high school, the female enrollment rate in senior high school and the male enrollment rate in college, the results of which may be summarized in the following three points: (1) The regression scheme produced in general good performances in explaining the changes in enrollment rates with expected signs attached to the coefficients, insofar as the indices of anticipated benefit derived from the growth-expectation model or the integrated model are used. The perception-lag model, on the other hand, frequently yielded negative coefficients on the anticipated *b/c* ratio. (2) The size of the eligible population is a significant variable in explaining the changes in male enrollment rate in college, but not the changes in enrollment rates in senior high school. (3) After these variables are accounted for, no significant secular trend in the change of enrollment rates can be identified (Chapter III, Section 2 and 3).

The above findings indicate that the changes in the demand for education over time can be explained consistently by the changes in family income and in the anticipated benefit of education. The poor performance of the perception-lag model indicates that the lag in diffusion of information about education was not the primary reason for educational demands to keep growing in the face of declining benefit of education measured by conventional internal rates of return. Young men and women in postwar Japan expected the wage structure to change in future and evaluated the benefit of education based on this expectation. In this way, expectation for future productivity growth becomes one of the critical factors in explaining the change in enrollment in postwar Japan.

Results of the regression analysis can be used directly as the scheme of a decomposition exercise whereby changes in enrollment rates are divided into factor contributions. The decomposition exercise based on selected *C* indices indicated the following three points: (1) The major impetus to the expansion of enrollment rates in the 1960s and early 1970s was the increase in family income levels. This was the case for both male and female enrollment rates in senior high school and male enrollment rate in college. (2) The anticipated benefit of education did not exert negative effects on the demand for education in this period, despite the decline in the classical *b/c* ratio, primarily because the anticipation of future productivity growth was building up over this period. (3) The downward shift of the growth trend in enrollment rates in the mid-1970s can be attributed primarily to a slow-down in the pace of family income growth. The rapid decline in the anticipated benefit of education, partly induced by an erosion of confidence in the future growth, also depressed the demand for education particularly at the college level (Chapter III, Section 3).

From the theoretical and empirical findings summarized above speculations may be made concerning the changes in enrollment rates in the course of economic development.

which would lead to the prospects for future studies.

It was observed at the outset of the present study that the tremendous expansion of enrollment rates in the 1950s and 1960s, and its subsequent disappearance at some point in the 1970s, was an experience shared by many industrialized countries. The lack of detailed data hinders detailed observation about the developing countries, but it is indisputable that most of them also experienced massive educational expansion in the 1950s and 1960s. In many countries, meanwhile, there was prolonged economic growth in the 1950s and 1960s which came to an end with the world-wide recession in the beginning of the 1970s. The trends in enrollment rates and the cycle of economic growth thus present a rough correspondence.

One may argue from our analysis of the changes in enrollment rates in postwar Japan that the correspondence was in fact not accidental. A sustained economic growth would induce an increase in the demand for education through the following three processes: first, the increase in family income brought about by economic growth augments the demand through an income effect; second, increases in the demand for educated labor and the growth in general productivity prevent the wage differentials due to education from diminishing, despite an increased supply of educated labor; and third, the increased expectation for future productivity fermented by the prolonged economic growth augment the anticipated benefit of education. With the down-turn in the economic cycle, the increase in family income diminishes, the demand for educated labor declines, and the expectation for future productivity growth becomes eroded — all of which would depress the demand for education.

The above argument suggests that it is entirely possible within the framework of the rational behavior of individuals to explain why in Japan or in some developing countries educational expansion continued in the face of declining internal rates of return to education. With the family income levels rising and the confidence in productivity growth building, the demand for education can expand even though benefit of education measured by the conventional indices is decreasing. One may speculate, however, that with a slowed growth in family income and diminished expectation for productivity growth, demand for education in the post-growth era would correspond more closely to the benefit of education measured by classical indices.

These speculation may be tested through close comparative studies on the changes in enrollment rates in postwar world.

APPENDIX A
ESTIMATION OF COHORT ENROLLMENT RATES

This appendix describes the procedure for estimating cohort enrollment rates for the period 1951-1981, by level of education (senior high school/junior-college/four-year college/all higher-education). and by sex (male/female/both sexes). Enrollment rates in senior high-school education are estimated for full-time and for total (including both full-and part-time) enrollment, and enrollment rates in higher education are for total enrollment.

1. DEFINITION AND DATA

The cohort enrollment rate ("enrollment rate" hereafter) is defined as the proportion of those who entered a level of education out of a particular school-age cohort.[1] Specifically, the enrollment rate, E_t, of a level of education at year t is defined as:

$$E_t = EN_t / SC_t, \qquad \text{(A.1)}$$

where SC_t is the size of the school-age cohort that reached in year t the eligible age for the level of education under consideration, and EN_t is the total number of individuals from this cohort who entered the level of education in year t or after. Notice that, whle E_t carries the number of year as its suffix, it is essentially an indicator describing the behavior of a particular school-age cohort over time, the suffix indicating the year of graduation from the lower tier of education.

For estimation of EN_t, the following two data sets, both from the *Fundamental School Survey*("*FSS*" hereafter) conducted by the Ministry of Education,[2] are available: (1) the graduates' status data which, based on the reports from the students' school of origin, provide the distribution of graduates from junior and senior high schools by their status as of shortly after (May 1) graduation (March 31); and (2) the admission data which, based on the reports from the schools of destination, show the number of students admitted to various levels of education as of the beginning of an academic year (April 1). The sizes of school-age cohorts, SC_t, by sex can be obtained from the number of total graduates in the graduates data (1) of junior high schools, of which attendance is compulsory.

2. ENROLLMENT RATES IN SENIOR HIGH SCHOOL EDUCATION

Derivation of enrollment rates in senior high schools is straighforward. Since there is no major discrepancy between the graduates' status data and the corresponding admission data in regard to the number of entrants to senior high schools for a given year, I derived the enrollment rates by simply dividing the numbers of entrants to senior high schools by the number of total graduates from junior high schools, both obtained from the graduates status data from junior high schools.[3] The graduates data classify the entrants by type of enrollment,[4] and consequently I constructed two sets of time-series—-one corresponding to full-time enrollment, and the other corresponding to total (including both full-and part-time) enrollment. The time series of the full-time enrollment rates are presented in Table A-1.

3. ENROLLMENT RATES IN HIGHER EDUCATION

The same procedure as above can not be applied in estimating enrollment rates at higher education. This is because a large number of senior high school graduates spend one or more years before entering colleges preparing themselves for college entrance examinations.[5] In consequence, neither the graduates' status data nor the admission data should directly provide an adequate basis for estimating the enrollment rates. The graduates' status data from senior high-schools do not include late entrants in the total number of college entrants. On the other hand, the admission data from colleges and junior-colleges by definition include those late entrants. But the numbers of admitted at a particular year include those belonging to various school-age cohorts.[6] Since the size of school-age cohort changed substantially in some period, an enrollment rate derived by simply dividing the total number of those who were admitted to higher education in a particular year by the size of corresponding school-age cohort would be inaccurate as an estimate of the cohort enrollment rate. In fact an enrollment rate estimated in that manner present erroneous fluctuations.[7]

In order to obtain reasonable estimates of cohort enrollment rates from the existing data, I postulated a simple model of cohort enrollment in higher education under the following two assumptions: (1) any late entrants do not spend more than one year before entering a four-year college; and (2) there are no late entrants to junior-colleges. These two assumptions are not at much variance from what we observe in available data for recent years.[8] The total number of entrants (EN_t) to both types of higher education (colleges and junior-colleges) from the school age cohort that reached the eligible age in year t, is the sum of the numbers of entrants to junior college in the same year (EN_t^J), the direct entrants to college (EN_t^{cd}), and the late entrants to college who enroll in the following year (EN_t^{cl}). By denoting the number of graduates enrolled in higher education from the graduates' status data in year t by GE_t, the number of entrants to junior colleges from the admission data by AD_t^J, and the number of entrants to colleges from the same data by AD_t^C, we observe the following relations:

$$EN_t = EN_t^J + EN_t^{cd} + EN_t^{cl},$$

and

$$\begin{aligned} EN_t^J &= AD_t^J, \\ EN_t^{Cd} &= GE_t - AD_t^J, \\ EN_t^{Cd} &= AD_{t-1}^C - EN_{t-1}^{Cd} \\ &= AD_{t-1}^J + AD_{t-1}^C - GE_{t-1}. \end{aligned} \qquad (A.2)$$

Since all the variables in the right-hand sides of the latter-three equations are available from the original *FSS* data,[9] this scheme provides an estimate of the enrollment rates. Since the distinction by type of enrollment (full-or part-time) is unable to be made in this scheme, enrollment rates in higher education are calculated for total enrollment. The estimated numbers of total, direct and late entrants to colleges, and the share of late entrants in the total entrants (late-entrance rate), are presented in Table A-2. The following two points deserve attention about the table.

First, while the estimated late-entrance rate for men stayed in the range between the upper-30s and the lower-40s in percentage points for the most part of the period, there were two distinctive departures from this range: since 1951 through 1957, it increased steadily to reach the 47-percent mark; and in 1964 it dropped abruptly to 16 percent, to stay in low levels for a few years. The former is probably reflecting the stagnant enrollment capacity of higher education institutions in this period in face of the growing size of eligible age-cohorts, while the latter can be seen as a consequence of the unusually small sizes of school-age cohorts that reached the eligible age in this period.

Second, the estimated numbers of female late-entrants assume a negative sign until the mid 1960's, implying that in these years the number of total female entrants to higher education reported in the graduates data exceeded the reported number of senior high school graduates admitted to higher education. This is presumably due to very small numbers of female late-entrants in this period and large numbers of junior college graduates who entered four-year colleges. The late-entrance rate, however, increased steadily in the 1960s to approach the level for men by the 1970s.

Enrollment rates in higher education estimated through this procedure are presented in Table A-3.

TABLE A-1

COHORT ENROLLMENT RATES IN SENIOR HIGH SCHOOL

Year	Cohort Size (thds.)			Entrants (thds.)			Erlmt.Rate (%)		
	M	F	M+F	M	F	M+F	M	F	M+F
1951	872	840	1713	346	320	666	39.7	38.1	38.9
1952	856	825	1682	351	335	687	41.1	40.6	40.8
1953	887	858	1746	411	355	767	46.4	41.4	43.9
1954	777	753	1531	382	332	715	49.2	44.1	46.7
1955	845	817	1663	422	370	792	50.0	45.3	47.7
1956	950	920	1871	473	421	896	50.0	45.7	47.9
1957	1015	982	1997	501	458	960	49.4	46.6	48.1
1958	962	933	1895	498	461	959	51.8	49.4	50.6
1959	1000	973	1974	533	501	1035	53.3	51.5	52.4
1960	897	873	1770	499	472	971	55.6	54.2	54.9
1961	712	689	1401	425	405	830	59.7	58.8	59.3
1962	995	952	1947	613	578	1191	61.6	60.7	61.2
1963	1271	1219	2491	821	770	1592	64.6	63.2	63.9
1964	1237	1189	2426	827	780	1607	66.8	65.6	66.2
1965	1204	1155	2359	817	773	1591	67.9	67.0	67.4
1966	1088	1045	2133	760	715	1475	69.9	68.4	69.2
1967	994	953	1947	712	673	1386	71.7	70.7	71.2
1968	942	904	1846	692	662	1354	73.5	73.2	73.4
1969	886	850	1737	672	646	1318	75.8	76.0	75.9
1970	851	815	1667	667	644	1311	78.3	79.1	78.7
1971	828	792	1621	672	652	1324	81.1	82.3	81.7
1972	797	764	1561	667	647	1315	83.8	84.8	84.3
1973	787	755	1542	678	660	1338	86.1	87.4	86.8
1974	828	794	1623	725	707	1432	87.5	89.0	88.2
1975	807	773	1580	721	701	1422	89.3	90.7	90.0
1976	798	765	1563	709	685	1395	88.8	89.6	89.2
1977	808	771	1579	733	710	1443	90.7	92.0	91.4
1978	821	785	1607	750	727	1478	91.4	92.7	92.0
1979	873	798	1635	768	746	1515	91.8	93.5	92.7
1980	880	842	1723	808	792	1600	91.8	94.1	92.9
1981	857	820	1677	787	773	1560	91.8	94.2	93.0

Note: Full-time student only.

TABLE A-2

TOTAL, DIRECT AND LATE ENTRANTS TO FOUR-YEAR COLLGES
(In Thousands Persons)

Year	Male				Female			
	Total	Direct	Late	% Late (%)	Total	Direct	Late	% Late (%)
1951	97	65	32	33.4	5	20	-14	—
1952	116	76	40	34.7	29	30	-1	—
1953	113	73	40	35.6	17	19	-2	—
1954	120	75	45	37.8	8	22	-3	—
1955	123	70	53	43.0	25	23	1	—
1956	125	66	58	46.8	17	18	-1	—
1957	119	63	56	47.1	17	20	-3	—
1958	124	70	54	43.8	17	23	-5	—
1959	135	79	56	41.4	20	27	-7	—
1960	148	86	62	42.1	24	31	-6	—
1961	155	88	66	42.9	28	34	-6	—
1962	172	101	71	41.1	34	39	-4	—
1963	182	106	75	41.3	37	38	0	—
1964	149	107	42	28.5	29	36	-6	·
1965	194	162	31	16.2	38	51	-12	—
1966	265	206	59	22.3	62	67	-4	—
1967	277	194	82	29.8	63	63	0	0.6
1968	286	12	104	36.4	65	60	5	8.7
1969	276	164	112	40.5	62	54	7	11.6
1970	276	158	117	42.5	69	54	14	20.5
1971	287	168	118	41.3	73	58	14	19.6
1972	293	178	115	39.3	80	64	15	19.2
1973	308	187	121	39.2	90	70	19	21.8
1974	318	194	23	38.9	93	72	21	22.6
1975	333	202	130	39.2	102	76	26	25.8
1976	315	191	124	39.4	96	71	24	25.3
1977	330	203	126	38.3	99	75	23	23.8
1978	323	202	120	37.4	94	72	21	23.1
1979	315	193	122	38.7	94	71	22	24.0
1980	317	195	122	38.5	111	72	38	34.8
1981	317	195	122	38.5	95	57	38	40.3

TABLE A-3

COHORT ENROLLMENT RATES IN HIGHER EDUCATION

Year	Male				Female			
	Cohort Size (thds.)	Erlmt.Rate (%)			Cohort Size (thds.)	Erlmt.Rate (%)		
		C	JC	C + JC		C	JC	C + JC
1951	532	18.4	2.7	21.1	466	1.2	2.6	3.8
1952	680	17.2	2.2	19.3	603	4.8	2.2	7.0
1953	810	14.0	2.0	16.0	777	2.3	2.2	4.4
1954	872	13.9	2.0	15.8	840	2.2	2.3	4.6
1955	856	14.4	1.9	16.3	825	3.0	2.6	5.6
1956	887	14.1	1.6	15.7	858	2.0	2.6	4.6
1957	777	15.3	1.6	17.0	753	2.3	2.9	5.2
1958	845	14.7	1.4	16.2	817	2.1	2.8	4.9
1959	950	14.2	1.3	15.5	920	2.2	2.8	5.0
1960	1015	14.7	1.2	15.9	982	2.5	3.0	5.6
1961	962	16.2	1.5	17.7	933	3.0	3.5	6.6
1962	1000	17.3	1.6	18.9	973	3.5	4.1	7.6
1963	897	20.3	1.9	22.2	873	4.3	5.1	9.4
1964	712	21.0	2.3	23.3	689	4.3	6.5	10.8
1965	995	19.5	1.7	21.2	952	4.1	6.7	10.8
1966	1271	20.9	1.5	22.4	1219	5.1	7.3	12.4
1967	1237	22.5	1.6	24.1	1189	5.4	8.5	13.8
1968	1204	23.8	1.7	25.5	1155	5.7	9.2	14.9
1969	1088	25.4	1.9	27.4	1045	5.9	10.3	16.2
1970	994	27.8	2.0	29.8	953	7.2	11.2	18.5
1971	942	30.5	2.2	32.6	904	8.1	12.8	20.9
1972	886	33.1	2.2	35.3	850	9.4	14.4	23.8
1973	851	36.3	2.4	38.7	815	11.1	16.4	27.6
1974	828	38.4	2.4	40.8	792	11.8	18.2	29.9
1975	797	41.9	2.6	44.5	764	13.4	20.2	33.6
1976	787	40.1	2.4	42.5	755	12.7	20.6	33.4
1977	828	39.9	2.3	42.2	794	12.5	20.7	33.2
1978	807	40.1	2.3	42.4	773	12.2	21.0	33.2
1979	798	39.5	2.2	41.7	765	12.3	20.9	33.2
1980	808	39.3	2.0	41.3	771	14.4	21.0	35.4
1981	821	38.6	1.9	40.5	785	12.2	22.8	35.0

Notes: C stands for four-year college; JC, for junior-college; and C + JC, for all higher-education. All include part-time.

Notes

1 A school-age cohort is the group of population who entered the compulsory education at the same time. In Japan, it comprises those born from April 1 to March 31, next year

2 Fundamental School Survey is a complete survey on schools and students at various levels of education defined by School Education Law, based on compulsory reporting from individual schools

3 Japan, Office of the Prime Minister, Bureau of Statistics, *Japan Statistical Year Book, 1957* (Tokyo Nihon Tokei Kyokai, 1958), Table 248; idem, *1962*(1963), Table 269, idem, (1968), Table 348, idem, *1972*(1973), Table 366, idem, *1977*(1978), Table 394, idem, *1983*(1984), Table 19-4

4 The form of classification of full-and part-time enrollment of the original data were changed in 1955 and again in 1976, for which I made necessary adjustments to obtain consistent time-series

5 Those late entrants to colleges are called "Ronin", which originally meant a samurai who is awaiting for serving for a feufdom, and constituted about one-third to a half of total college entrants in regular years

6 The classification of the entrants by the year of graduation from senior high school, however, is available for recent years

7 The school-age cohorts that became eligible for higher education in 1963 and in 1964 were particularly small in size, as the consequence of the temporary decline of birth rates in the last years of the war The following cohorts, particularly that reached higher education in 1966. 1967, 1968. were the baby-boom generation In consequence, the enrollment rate (in 4-year colleges for men) computed directly from the admission data was around 15 percent from 1951 to 1962, which increased to 20 percent in 1963 and then to 25 percent in 1964, but decreased to 19 percent in 1966

8 In 1980, 61 3 percent of male entrants to colleges were fresh graduates of senior high school of that year, 28 8 percent had been "Ronin" for one year, and 9 9 percent were "Ronin" for two or more years With female entrants the corresponding shares were 80 1, 17 0, and 2 9 percent respectively For junior-colleges, only 4 7 percent of female entrants experienced 'ronin'. Although 31 6 percent of male entrants to junior-colleges were late entrants, they constituted a very small segment of men's enrollment in higher education See Japan Ministry of Education, Office of the Minister, *Gakko Kihon Chosa Hokokusho, 1980* [Report of the Fundamental School Survey, 1980] (Tokyo Okurasho Insatsukyoku, 1981), Table 17

APPENDIX B
ESTIMATION OF WAGE-PROFILES BY EDUCATION

This appendix describes the procedure followed in estimating wage-profiles over age (hereafter "wage-profiles") by sex and by education. The time-periods covered are 1954-1980 for male of all educational class, 1954-1980 for female workers with junior high school and senior high school education, and 1967-1980 for female workers with junior-college and college education.

1. DATA, DEFINITIONS AND THE PROBLEMS OF DATA

The basic wage data came from the Fundamental Wage Structure Survey (hereafter *"FWSS")*, which has been conducted by the Ministry of Labor annually since 1948. The survey is designed to reveal the wage structure in terms of occupation, industry, size of establishment, age, sex and education, With workers employed in establishments with ten or more workers.[1] The data exclude the workers in the national or municipal governments and a part of part-time workers.[2] Since the data of wage profile by level of education are available for the period from 1954 to 1980, scope of the present estimation is limited to this period.[3] Supplementary information about time-trends in monthly wage and bonus was obtained from the *Monthly Wage Survey (MWS)* which has been conducted by the Ministry of Labor focusing upon the changes in wage and bonus of the workers in establishments with thirty or more employees. Income tax rates were estimated from the *Family Income and Expenditure Survey(FIES)* data prepared by the Office of the Prime Minister.[4]

Following the terminology and definitions of the *FWSS* data, the wage in this estimation is defined as the annual total of (1) "Monthly Contract Cash Payment", which consists of "Monthly Contract Regular Cash Payment" and "Over-Time Payment", and (2) "Bonus". Excluded from this definition of wage are fringe-benefits and the payments upon and after retirement. Adjustment for cash retirement payment will be discussed later.

In further details, however, the definitions and the forms of tabulation of the FWSS data have undergone significant changes over time, creating serious problems to over-time comparisons of wage structure. Particularly, the following four points deserve attention.

First, coverage of industrial sectors and the reporting of the allindustry average wages changed. The services sector was not included in the sample from 1954 to 1960, included only once in three years from 1961 to 1972, and included every year thereafter. The average wages were reported for non-services sectors for 1954 through 1957; not reported in any form for 1958 through 1964; reported for the non-services sectors for 1965 through 1972; reported both for the non-services sectors and for all the sectors since 1973.

Second, the amounts of bonus were not reported until 1960, reported only for the workers in large-scale establishments from 1961 to 1964, and reported with all the workers in the sample after 1965.

Third, the classification of age changed. The data reported the average wages for nine age-brackets from 1954 to 1957; for eight brackets for males and six brackets with females from 1958 to 1960; for nine brackets from 1961 to 1972; and for 12 brackets since 1973.

Fourth, from 1958 to 1972 the wages of female workers with education more than junior high school were classified together to produce a single average, and hence the wage profiles of senior high-school graduates, junior-college graduates and college graduates are not available separately.

Hence, in order to obtain consistent time-series of wage-profiles, a systematic estimation procedure to adjust those problems was called for.

2. THE WAGE-PROFILES OF MALE WORKERS

Wage-profiles of male workers were estimated from the *FWS* data[5] through the following four steps.

(1) Derivation of all-sectors averages

Since the original FWSS data for 1957 through 1964 report wages only by industrial sector, the average wage for all (non-services) industrial sectors had to be computed from the sectoral averages, using the distribution of workers (by age, sex and education) over the sectors as weights. That, combined with the average wages for non-services sectors available from the original data for 1954-56, created time-series of average wages for all non-services sectors for 1954-72. These time-series should have been linked to the time-series of all-sectors average for 1973-80. It was found from the 1974 data, however, that with the wages of male workers the differences between the non-services sectors average and the all-sectors averages were minor, due to a small share of the males employed in the services sector and minor wage differences between the services sector from the other sectors.[6] I assumed that this had been the case for the earlier years, and simply combined the two time-series without any adjustment to produce a single time-series for 1954-1980. With female workers, on the other hand, the differences between the two averages were considerable. The additional procedure of adjustment thus necessitated will be discussed later.

(2) Estimation of Annual Bonus

The amounts of annual bonus were estimated for 1954-64 as follows. First, the ratio of annual bonus to monthly cash earnings in 1965 was computed from the 1965 data by education and by age. Second, the ratio between the annual total of monthly wage and the value of bonus (averaged over sex, education and age) was computed from the MWS data for every year from 1954 to 1965,[7] to derive trend-indices of bonus ratio. Third, the bonus ratios for 1954 through 1965 were obtained by adjusting the bonus ratios in 1965 by the trend index of bonus ratios estimated above, to produce a time-series of bonus ratio by education and age for 1954-80. And finally, the amounts of bonus were obtained by multiplying the monthly wages with the corresponding bonus ratios.

(3) Estimation and Adjustment of the 1962 and 1978 Data

The data for 1962 are not available, and estimated through trend intrapolation through the following formula:

$$W_{62} = W_{61} \cdot \sqrt{\left(\frac{W_{63}}{W_{61}}\right) / \left(\frac{M_{63}}{M_{61}}\right)} \cdot \frac{M_{63}}{M_{62}} ,$$

where W_t is the wage in year t of the workers in the e'the education and the a'th age class, and M_t is the average wage in year t obtained from the *MWS* data. As for 1979, the only available published data provided "Monthly Regular Contract Cash Payment," which do not include over-time payments. Hence the annual wage for 1979 were obtained by multiplying (by age, sex and education) the Monthly Regular Contract Cash Payment in 1979 by the corresponding ratio of the annual total wage to Monthly Regular Contract Cash Payment in 1978.

(4) Estimation of Wage-Profile Over Continuous Age Scale

In order to facilitate the comparison of wage structures over the periods when different age-classification systems were used, the wage profiles estimated through steps (1) through (4) above were transformed into wage profiles over a continuous scale of age. To avoid the imposition of any arbitrary functonal form to the entire profile of wage over age, I chose to fit quadratic functions locally to the obsercvations. For the $m-1$'th, m'th and $m+1$'th age classes, a quadratic function in the form

$$W = b_0 + b_1 \cdot AG + b_2 \cdot AG^2$$

was fit to neighboring three observations of wage, W, and age, AG. AG is a continuous variable, and assigned the values of median ages of the age-brackets in the original data.[8] The values of b_0, b_1 and b_2 were then obtained by solving the equation system. The resulting function provided a local approximation of the wage profile between the median ages of the m'th and the m + 1'th classes. This procedure was iterated for all the values of m, to obtain an approximation for the entire wage -profile for age 15.5 through 55.5. The whole procedure was applied to each of the education classes and years.

3. THE WAGE-PROFILES OF FEMALE WORKERS

Since female workers with senior high-school education and those with junior-college or college education were classified together ("senior high school or more") in the *FWSS* data for 1958 through 1972, the average wages of senior high school, junior-college and college graduates are not available separately for this period. This would have substantially limited the scope of the present analysis.

As it turned out, however, the wage-profiles of senior high-school graduates for 1958 through 1972 can be estimated from the original data by making relatively minor assumptions. The wages of female junior-college and college graduates can be estimated for 1967-1972 although the results may be less accurate. The estimation required the following extra procedures.

First, using the 1973 FWSS data of the wages of female workers in the non-services sectors, the average wage for senior high school graduates and the average wage for the combined clas of senior high school, junior-college and college graduates were computed by age, which revealed that the differences between the two averages were in fact negligible. This is because the number of junior-college and college graduates employed in the non-services sector was small, and also because the wage differentials between the senior high school graduates and the junior-college or college graduates were not large in the non-services sectors.[9] I assumed that this had been the case for the entire period 1957-1972, ana reckoned the wages for "senior high school or more" as a proxy of the wages of senior high school graduates in the non-services sectors. Second, the ratio between the average wage for the non-services sectors and that for all the sectors was calculated by education and by age, also using the 1973 *FWSS* data. I assumed that these ratios did not change for 1954 through 1973, and multiplied the wages of senior high school graduates in the non-services sectors with these ratios, to obtain the all-sectors averages for senior high school graduates for 1954 through 1972. The continuity of the estimated wage profiles for 1958-1973 with those before and after the period was checked by examining the wage ratios among age or education classes. It was found that the wage ratios draw smooth profiles around 1954 and 1972.

The wages of junior-college and college graduates between 1967 and 1973 were estimated through what can be called a mixed trend-intrapolation. First, the wages of junior-college and college graduates (in the non-services sectors) in the 1967 *FWS* data were compiled for both sexes and for men, it was possible to obtain the wages for femle junior-college and college graduates for this year.[10] Second, for estimating the wages in the years between 1967 and 1973, I assumed that the ratio between the annual wage growth rate of college graduates and that of senior high school graduates was constant (for each age class) for this period. The values of these constants were obtained from the 1967 figures and 1973 (non-services sector) averages. The wages of college graduates were then derived from these constants and the wages of senior hign school graduates in this period obtained from the preceding procedure.

The exact formula was:

$$W_{67+t}{}^{C} = W_{67}{}^{C} \cdot C^{t} \cdot (W_{67+t}{}^{SH} \; W_{67}{}^{SH})$$

where W is the wage, and the subscript 67 refers for the year 1967, superscript C for college graduates, and SH for senior high school graduates. The constant C is derived from

$$C = \left(\frac{W_{67}{}^{C}}{W_{73}{}^{C}} \Big/ \frac{W_{67}{}^{SH}}{W_{73}{}^{SH}} \right)^{1/6}$$

The same procedure was applied to the junior-college graduates. Finally, the estimated wages, which are averages for non-services sectors, were converted into the all-sectors averages using the ratios between the two averages obtained from the 1973 data.

After these procedures, the same steps (1) through (4) as for men were followed to obtain the estimated wage-profiles for women.

4. ESIMATION OF INCOME TAX RATES AND RETIREMENT PAYMENT

(1) Tax Rates

In order to obtain wage profiles after deduction of income taxes, tax rates were estimated as a function of annual income for 1956, 1960, 1965, 1970, 1975 and 1980. The estimation was based on the FIES data about incomes and expenditures of employed workers.[11] The tax-ratio was defned as the ratio of total amount of "Income Tax" and "Other Taxes" to the total income, for the amount of most of the "Other Taxes" are also related with the level of income.

The tax-ratios, *TR*, were regressed on the amount of annual icome, *IN*, in three alternative forms of specification:

(i) $1000\ TR = b_0 + b_1 \cdot \ln IN$,
(ii) $1000\ TR = b_0 + b_1 \cdot (\ln IN)^2$, and
(iii) $\ln TR = b_0 + b_1 \cdot \ln IN$.

The regression analysis showed that the performance of specifications (ii) and (iii) are better than (i), and the results from (ii) and (iii) are presented in Table B-1

TABLE B-1

REGRESSION ANALYSIS OF TAX RATES

Year	Model (ii) Dependent var.: *1000 TR*			Model (iii) Dependent var.: *ln TR*		
	Constant	(ln IN)	$\bar{R}^2$	Constant	(ln IN)	$\bar{R}^2$
1956	-149.6	6.4	0.898	-10.6	1.3	0.957
	(19.2)	(0.5)		(0.4)	(0.1)	
1960	-77.4	3.1	0.862	-10.7	1.2	0.915
	(13.2)	(0.3)		(0.6)	(0.1)	
1965	-76.8	2.8	0.972	-9.3	0.9	0.984
	(10 0)	(0.2)		(0.4)	(0.1)	
1970	-70.6	2.3	0.973	-9.3	0.9	0.921
	(9.4)	(0.2)		(0.9)	(0.1)	
1975	-19.6	1.0	0.964	-6.1	0.4	0.960
	(6.1)	(0.1)		(0.3)	(0.0)	
1980	-91.3	2.2	0.973	-8.6	0.6	0.968
	(12.6)	(0.2)		(0.5)	(0.6)	

Note: Standard error of regression coefficients in parenthesis.
All coefficients are significant at 1 percent.

(2) Retirement Payment

The payments upon and after retirement constitute a significant part of life-time earnings. Estimation of their values, however, entails considerable difficulties, for they are varied in forms,[12] and consistent data sources are scarce. I made a tentative estimation of the cash payment upon retirement based on the data from the Survey on Retirement Payment Policies in 1978.[13] The data provided average values of the factors that are used to derive the amount of cash payment from the amount of *Monthly Regular Contract Cash Payment* at the time of retirement. These factors are available by education but only for male workers, and I assumed that the same factors apply also to female workers. The factors are presented in column (1) of Table B-2. In order to obtain the factor of retirement payment in terms of annual total wage at age 55.5, the ratio of monthly regular contract cash payment to the annual total wage at age 55.5 was computed by education and by sex based on the *1978 FWSS* data. The ratios are presented in column (2) of the table. The estimated factors of retirement payment were simply obtained as the product of columns (1) and (2), and presented in column (3). Since there are no reliable data sources that indicate the time-trend of the factors of retirement payment, I assumed that the rate did not change over time and estimated the amount of retirement payment for 1956, 1960, 1965, 1970, 1975 and 1980 by multiplying the annual wage at 55.5 by the corresponding factors of retirement payment.

TABLE B-2

ESTIMATED FACTOR OF RETIREMENT PAYMENT

Education	Factor in terms Monthly Contract Cash Payment (1)	Ratio of Monthly Cont. Cash Paymt. to Annual Regular Payment at Age 55.5 (2)	Derived Factor in terms of A.R.P. at Age 55.5 (3)
Male			
Junior High	31.50	0.06463	1.85058
Senior High	31.20	0.05919	1.84670
Junior Colg.	30.45	0.05804	1.76742
College	29.70	0.05697	1.69213
Female			
Junior High	31.50	0.06594	2.07702
Senior High	31.20	0.06325	1.97329
Junior Colg.	30.45	0.05955	1.81325
College	9.70	0.05972	1.77366

Notes

1 The coverage, scope and form of tabulation have undergone some changes, and consequently the title has changed slightly a few times The subject of the survey are selected through two-stage sampling, first by industrial sector and second by occupation and sex In the typical survey in 1960, 797 thousands workers in twenty-eight thousands establishments were selected This accounted for 12 6 percent of the total number of establishments employing ten workers or more, and 8 1 percent of the workers therein The expected error of estimation of the average wage of the male white-collar workers in the establishments employing one thousands workers or more, for example, was 1.05 percent

2 The FWSS data limits the sample to the "regularly employed" workers, which is defined as those working more than twenty days a month and more than three hours a day

3 The FWSS in 1949 encompassed wage structure by education and age, but the sample was limited to selected areas.

4 For description of the Family Income and Expenditure Survey, see Appendix F.

5 The data are taken from Japan, Ministry of Labor, Department of Labor Statistics, *Chingin Kihon ChosaHokokusho*, [Report of the Fundamental Wage Survey (FWS)] (Tokyo Rodo-Horei Kyokai, annual) The tables referred are in the 1954 report, vol 19, Table 2, 1955, Vol.1, Table 1, 1956, Table 100, 1957, Vol.1, Table 1, 1958 through 1960, Vol 1, Table 2, 1961, Vol.1, Table 2 and Vol 2, Table 2; 1963 through 1965, Vol 1, Table 2, 1966 through 1972, Vol 1, Table 1, 1973, Vol 1, Table 2, 1974 through 1980, Vol.1, Table 1.

6 In 1974, the share of the services sector in total male employment was 14.6 percent. The difference of its average monthly cash earnings from the all-industry average at age 30-34 was 1 0 percent with junior high school graduates, -2 0 percent with senior high school graduates, and 3 3 percent for college graduates Japan, Ministry of Labor, Department of Labor Statistics, *Chingin Kihon Chosa Hokokusho*, 1974 [Report of the Fundamental Wage Survey (FWS), 1974] (Tokyo Rodo-Horei Kyokai, 1975), Vol 1, Table 1

7 The data are taken from Japan, Ministry of Labor, Office of the Minister, *Rodo Tokei Nenpo* [Annual Report of Labor Statistics] (Tokyo. Nihon Rodo Kyokai, annual).

8 *AG* was assumed to be 16 5 for age-class 15-17, 19 0 for 18-19, 22 5 for 20-24 with senior high school and junior-college graduates, 24.0 for the same age class with college graduates, 27.5 for 25-29, 32 5 for 30-34, and so on

9 The 1973 *FWSS* data show that 57 percent of total sixty-three thousands employed female junior-college graduates, and 75 percent of total twenty-two thousands employed female college graduates, were employed in the services sector. Consequently, of the 345 thousands female workers with senior high school education or more and employed in the non-services sectors, 8 percent were junior-college graduates and only 1 6 percent were college graduates The wage difference between junior-college graduates and senior high school graduates was 7 3 percent, and that between college graduates and senior high school graduates was 21 5 percent for all ages Hence, the computed difference of average wage for senior high school graduates from that for "senior high school or more" was 0 9 percent.

10 The average wages for both sexes are not compiled for the other years between 1957 and 1973.

11 The data were taken from Japan, Office of the Prime Minister, Bureau of Statistics, *Kakei Chosa Nenpo* [Annual Report of the Family Income and Expenditure Survey (FIES)] (Tokyo Nihon Tokei Kyokai, annual) The years and tables referred were. in the 1956 report, Table 1, 1960, Table 2, 1965, Table 16, 1970, Table 8, 1975, Table 8, 1980, Table 4 The 1956 and 1960 data include only the households in urban areas

12 The Payments include the cash payment at the time of retirement, direct payment of pensions, and the contribution to pension funds by the employer. Evaluation of the total values of these payments is difficult.

13 The data were taken from Toyo Keizai, *Chingin Somu Yoran*, 1978 [Manual of Wage Management, 1978] (Tokyo Toyo Keizai, 1978), Table 43 The survey was conducted by Ministry of Labor with the sample of six thousands establishments that employ thirty or more workers, and based on the responses from the employers and not from individual workers

APPENDIX C
ESTIMATION OF THE DIRECT COST OF SCHOOLING

The direct costs of senior high school, junior-college and college attendance were estimated by type of establishment (public/private) for the period 1951-81.

1. DATA AND DEFINITIONS

The principal data source for estimating the direct cost, denoted by *DC*, of senior high school education was the *Survey of Parental Expenditures on Education (SPEE)*, which has been conducted by the Ministry of Education. The data about the costs of higher education came from the *Students' Living Status Survey (SLSS)* by the Ministry of Education[1] Supplementary information about the costs paid to schools were gathered from the school finance statistics compiled by Ministry of Education.

The concepts and definitions regarding to the various kinds of costs of education vary by the data sources, and potentially confusing.[2] I define the total cost of educations as the sum of the "direct cost" and the "indirect cost", or foregone earnings. The direct cost, denoted by *DC*, is the total sum of DC_A, the amount paid to school in the form of tuition and other required fees and, DC_B, the other cash expenditures necessary in receiving education. Living expenditures are excluded from this definition of direct cost, for it should be accounted for by foregone earnings. Some educational outlays that are not required by formal schooling, such as the payment to private tutors, are also excluded from this definition. In the following discussion theaverage amount paid to school in public institutions is denoted by DC_A^u, and that in private institutions by DC_A^r; the average amount of other expenditures in public institutions is denoted by DC_B^u. and that in private institutions by DC_B^r. The average total cost of a level of education in public institutions, DC^u, is obtained as the sum of DC_A^u and DC_B^u and that in private institutions, DC^r, as the sum of DC_A^r, and DC_B^r.

2. THE DIRECT COST OF SENIOR HIGH-SCHOOL EDUCATION

The *SPEE* data[3] provide "the amounts of tuitions and other fees paid to school" and " other expenses spent for schooling by the parents", which roughly coincide with my definition of DC_A and DC_B respectively, for the students in public senior high schools. The data, however, are not available for the years 1951 through 1954, 1957, 1961 or 1963, and they were estimated by adjusting the corresponding figures in the previous years by C.P.I.[4] The complete time-series of DC_A^u and DCB^u for senior high school education were thus obtained, and the direct cost of public senior high school education was derived by simply adding the two.

Next, the average amount of payment to school in private institutions, DC_A^r, was estimated for each year by dividing the total amount of "Tuition and Other Revenues from Students" of private senior high schools[5] by the total number of students in private senior high schools.[6] It was assumed then that "the other expenses" were same between public and private institutions, and accordingly the total direct cost of senior high school education in private institutions was derived as the sum of DC_A^r and DC_B^u.

3. THE DIRECT COST OF HIGHER EDUCATION

The *SLSS* data classifies the expenditures of college students into the "Educational Costs" and the "Living Costs", and the former roughly coincides with my definition of the direct cost. The data are available for students in national, municipal and private institutions, but for only selected years, i.e., 1962, 1965, and every two years since 1970 (Japan, Ministry of Education, Bureau of Higher Education 1981, pp.67 and 72). On the other hand, the total amounts of revenues from students of both public and national institutions are available from the school finance statistics for the whole period. Consequently, the estimation procedure took the following three steps.

First, the average cost paid to school by students in national colleges was estimated for each year by dividing the revenue of national colleges from student payments by the total number of students in national colleges.[7] Both the revenue and the number of students include full-time and part-time students. Since the number of students in municipal colleges are small relative to the national colleges, and their tuitions are not greatly different from those of national colleges, the estimated figures for the national colleges were considered as the average for public institutions, or DC_A^u. The same procedure were also applied to the data of private four-year colleges, to obtain DC_A^r.[8]

Second, "the other costs"of national college students was derived by subtracting the estimated value of DC_A^u from the "educational costs" of public college students reported in the *SLSS* data, for each year with which the *SLSS* data are available. Thn, the amount of "the other costs" in the remaining years were estimated by adjusting the values estimated above by C.P.I, to produce a complete time-series of DC_B^u. The same procedure was applied to "other costs" in prive . colleges to obtain DC_B^r.

Finally, time-series of the total direct cost of college attendance was derived by adding DC_A^u and DC_B^u for public institutions, and by adding DC_A^r and DC_B^r for private institutions.

Time-series of "payment to school" in private junior-colleges was estimated from the same source for private four-year colleges. "Other expenses", DC_B^r, were supposed to be the same as those in private four-year colleges.

The estimated direct costs are presented in Table C-1.

Notes

1 See (Kaneko 1984, Appendix D) for a brief description of Students' Living Status Survey

2 The SPEE data, for example, use the word "direct costs" to refer to the expenses directly spent by the parents, and "indirect costs" to the costs spent indirectly through other agents, mainly the schools Hence, the money spent on textbooks is classified as the direct cost, while tuition is included in the indirect costs This convention is not adopted here

3 Japan, Office of the Prime Minister, Bureau of Statistics, *Japan Statistical Year Book, 1967* (Tokyo. Nihon Tokei Kyokai, 1968), Table 365;, idem, *1972* (1973), Table 387, idem *1977* (1978), Table 418, idem, *1983* (1984), Table 19-28.

4 The time-series of C P.I used here is presented in Appendix D

5 The data were taken from Japan, Ministry of Education, Office of the Minister, *Monbusho Nenpo* [Annual Report of the Ministry of Education] (Tokyo Okurasho Insatsu Kyoku, annual) The tables referred were. in the reports from 1951 to 1974, Table 1(7)a, in the reports from 1975 to 1980, Table 1(4)e

6 The revenue and the number of students include both full-and part-time students.

7 The data about students' payment were taken from. Japan, Ministry of Education, Office of the Minister, *Monbusho Nenpo* [Annual Report of the Ministry of Education] (Tokyo Okurasho Insatsu Kyoku, annual). The tables referred were. in the reports from 1951 to 1974, Table 1(7)a. in the reports from 1975 to 1980, Table 1(4)a The data about the total number of students were taken from Japan, Office of the Prime Minister, Bureau of Statistics, *Japan Statistical Year Book, 1957* (Tokyo Nihon Tokei Kyokai, 1958), Table 252; idem *1962* (1963), Table 271, idem, *1967* (1968), Tables 352 and 356, idem *1972* (1973), Tables 369 and 371 idem, *1977*(1978), Tables 399 and 401, idem, *1983* (1984), Tables 19-4 and 19-13.

8 The data were taken from Japan, Ministry of Education, Office of the Minister, *Monbusho Nenpo* [Annual Report of the Ministry of Education] (Tokyo Okurasho Insatsu Kyoku, annual) The tables referred were in the reports from 1951 to 1974, Table 1(7)a, in the reports from 1975 to 1980, Table 1(4)c

TABLE C-1

ESTIMATED DIRECT COSTS OF SCHOOLING (YEN)

Year	Senior High.		College		Junior-College (Priv.)
	Priv.	Pub.	Priv.	Pub.	
1951	20668	15321	15929	19867	25717
1952	21692	16080	23332	21283	27887
1953	23110	20690	30324	23166	32808
1954	24607	23093	32745	25154	35450
1955	24345	25485	34079	25471	36977
1956	25830	26494	35217	27010	39177
1957	26199	28632	37983	28408	41341
1958	28393	32153	40021	29082	43654
1959	30519	33863	41361	30174	45813
1960	31159	33673	49929	30868	54084
1961	33753	41117	56862	32121	62850
1962	37077	50117	64575	33616	71360
1963	39312	59545	90539	36862	95417
1964	40540	61753	105591	40664	101768
1965	44313	66215	123760	43492	109002
1966	49389	71717	139470	46563	136892
1967	51270	76569	146654	47719	146122
1968	55834	84823	155119	48917	150850
1969	61350	91510	159994	50118	161415
1970	68910	99851	169925	65800	167100
1971	75570	109307	177532	68827	169506
1972	67466	117143	182871	72300	182500
1973	76435	135609	214431	88266	195011
1974	85825	162750	264974	110900	240400
1975	100262	220682	326832	130601	283488
1976	128101	260745	400975	146700	341300
1977	136176	293719	459159	177149	398216
1978	144079	319847	490792	206500	449300
1979	153225	338328	541859	235634	459576
1980	166423	352948	592436	265900	565500

APPENDIX D
TIME-SERIES OF ECONOMIC INDICATORS

This appendix describes the data sources and methods used in constructing the time-series of economic indicators that are utilized in various parts of the text. The indicators are presented in Table D-1.

(1) The time-series of the Consumer Price Index (C.P.I.) was obtained from the C.P.I. estimated by the Office of Prime Minister.[1] which provide several Laspires time-series of C.P.I. with different base-years. In order to obtain a single time-series, the original time-series were linked at 1963, 1966 and 1974.[2]

(2) The average household incomes were taken from the *Family Income and Expenditure Survey (FIES)* data.[3] The original data are for the cash incomes of workers' households abveraged only for urban areas until 1962. Since the average for urban areas and that for all (both urban and rural) areas are available for 1963, the ratio between these two averages was computed and, using this ratio, time-series for urban areas before 1963 was adjusted, to produce a single time-series of average cash income for all areas.

(3) The average wage index was taken from the *Monthly Wage Survey (MWS)* data.[4] The data provide the average annual cash earnings of the workers in establishments that employ thirty or more workers. Until 1971, the wages in the services sector was not included in the sample. Hence the time-series up to 1970 (of non-services sectors average) was linked to the time-series for 1971 and after (of all-sectors average) using the ratio of the two averages obtained from the 1971 *FWS* data.

(4) The interest rate is that of Loan Trust with maturation period of five years.[5] Since the official rate changed frequently within single years, the annual average interest rates were estimate by computing multiplication averages of the official rates.

TABLE D-1

TIME-SERIES ECONOMIC INDICATORS

Year	Indices (1951 = 100)			Growth Rates To Previous Year			Interest Rate
	C.P.I.	Income (Real)	Wage (Real)	C.P.I.	Income (Real)	Wage (Real)	
1951	100.0	100.0	100.0	16.42	-12.88	9.52	8.33
1952	105.0	120.0	112.7	4.96	20.00	13.35	9.00
1953	111.8	140.8	122.7	6.54	17.32	9.45	9.00
1954	119.1	143.7	123.2	6.48	2.07	0.43	9.00
1955	117.8	149.8	129.6	-1.07	4.25	5.13	9.00
1956	118.2	157.5	138.6	0.32	5.17	6.99	7.61
1957	121.9	162.1	143.4	3.12	2.92	3.57	7.23
1958	121.4	172.8	142.9	-0.42	6.57	-0.35	7.50
1959	122.6	181.9	151.1	1.05	5.27	5.79	7.50
1960	127.1	194.7	157.2	3.63	7.03	4.19	7.50
1961	133.8	204.0	163.1	5.30	4.81	3.93	7.18
1962	143.0	215.0	168.9	6.84	5.39	3.80	7.07
1963	153.8	223.3	174.5	7.56	3.82	3.54	7.07
1964	159.7	240.7	183.6	3.88	7.83	5.43	7.07
1965	170.3	246.4	189.5	6.60	2.35	3.42	7.07
1966	178.9	256.8	201.2	5.07	4.24	6.52	7.04
1967	186.0	272.5	214.7	3.98	6.12	6.93	6.98
1968	195.8	288.1	231.9	5.26	5.71	8.47	7.02
1969	206.2	305.0	255.7	5.32	5.86	10.79	7.03
1970	222.0	327.7	274.9	7.64	7.44	8.06	6.14
1971	235.6	340.5	296.2	6.12	3.92	8.23	6.25
1972	246.3	362.4	328.2	4.53	6.43	11.31	7.01
1973	275.1	388.3	357.9	11.71	7.13	10.12	7.32
1974	374.1	354.3	332.9	35.98	-8.75	-9.52	8.81
1975	382.8	397.2	371.9	2.34	12.12	12.01	8.69
1976	418.5	397.3	384.4	9.33	0.02	3.67	8.32
1977	452.1	407.5	390.3	8.01	2.55	1.66	7.46
1978	469.4	417.9	402.9	3.82	2.56	3.35	6.34
1979	486.3	431.8	409.6	3.60	3.32	1.72	6.88
1980	525.0	428.9	403.1	7.97	-0.65	-1.73	7.87
1981	550.8	428.9	407.1	4.90	-0.65	1.06	7.79

Sources: See text.

Notes

1 The data were taken from Japan, Office of the Prime Minister, Bureau of Statistics, *Japan Statistical Year Book, 1957* (Tokyo. Nihon Tokei Kyokai, annual) The tables referred were in 1957 edition, Table 191-A, 1959, Table 195-A, 1965, Table 246-A, 1970, Table 262, 1975, Table 274; 1983, Table 14-7

2 The C P I up till 1963 are based on urban samples Adjustment for the difference from those in later period, however, is not possible

3 The data were taken from Japan, Office of the Prime Minister, Bureau of Statistics, *Japan Statistical Year Book, 1957* (Tokyo. Nihon Tokei Kyokai, annual) The tables referred were in the 1957 edition, Table 222, 1959, Table 229, 1965, Table 287, 1970, Table 281; 1975, Table 298; 1983, Table 15-19

4 The data were taken from Japan, Office of the Prime Minister, Bureau of Statistics, *Japan Statistical Year Book, 1957* (Tokyo. Nihon Tokei Kyokai, annual) The tables referred were in the 1957 edition, Table 199, 1959, Table 201, 1965, Table 254, 1970, Table 270; 1975, Table 285; 1983, Table 3-29.

5 The data were taken from Bank of Japan, Statistics Department, *Economic Statistics Monthly* (Tokyo. Okurasho Insatsu Kyoku, Monthly) The Tables referred were in Vol 286 (January 1971), Table 57(1), in Vol.322 (January 1974), Table 16, in Vol 416 (November 1981), Table 60(1).

APPENDIX E
JAPAN-U.S. COMPARISON IN RETURNS TO EDUCATION

In this appendix, the internal rates of return to schooling estimated in Chapter II are compared to the past. estimates of the internal rate of return in the United States.

1. HIGH SCHOOL

Table E-1 presents private rates of return to men's high school education in Japan and in the United States. Note that the estimates for Japan are unadjusted for income taxes, but as the analysis above showed, the unadjusted figures are not at much variance from the adjusted figures.
that the estimates for Japan are unadjusted for income taxes, but as the analysis above showed, the unadjusted figures are not at much variance from the adjusted figures.

It should be noted that the *IRRs* estimated for the United States vary substantially among the individual estimates. The estimated *IRRs* for circa 1940 and circa 1950 range from 12 to 23 percent, except for the Carnoy-Marenbach estimate for 1939, which amounts to 49 percent. The estimated *IRRs* for the 1950s range from 15 to 25 percent; and those for 1970, from 11 to 19 percent. Moreover, there are discrepancies as to the trend in the *IRR* over time: both the Becker estimates and the Mincer estimates suggest an increase in *IRR* from circa 1940 to circa 1960, whereas the Carnoy-Marenbach estimates suggest the opposite. The Psacharopoulos estimates for the 1970s give an impression that the *IRRs* for the 1970s are substantially lower than those for the earlier periods, but the difference is insignificant if compared with the Mincer estimates foer 1960 and before. Nonetheless, it is evident that the *IRR* for high school education in the United States has been substantially greater than that for senior high school education in Japan. The *IRRs* estimated for the United States never fall below the 11-percent mark, while those for Japan are about 8 percent for the 1950s, and declined further to around 5 percent by the 1970s.

TABLE E-1

IRR FOR MEN'S HIGH SCHOOL EDUCATION IN JAPAN AND THE U.S.

(In Percent)

	Japan	United States				
Year	Kaneko (1)	Hansen (2)	Becker (3)	Mincer (4)	Carnoy & Marenbach (5)	Psacharo-poulos (6)
1939	—	—	16	12.5	49.1	—
1949	—	14.5	20	11.8	22.7	
1956	8.1	—	25	—	--	—
1958	7.9	—	28	15.1	—	—
1960	7.1	—	—	—	14.6	—
1970	4.3	—	—	—	18.9	11.3
1972	4.9	—	—	—	—	11.3
1974	4.6	—	—	—	—	14.8
1976	5.6	—	—	—	—	11.0

Notes: All the estimates for 1939 and 1949 in the U.S. are for urban white male. (1) for Japan is gross of income tax.

Sources: (2) Hansen 1963, table 5; (3) Becker 1975, table 15; (4) Mincer 1974, table 3.2; (5) Carnoy and Marenbach 1975, table 1; (6) Psacharopoulos 1981, table V.

2. COLLEGE

The private *IRR* for men's college education in the two countries are presented in Table E-2.

The private *IRRs* of men's college education estimated for the United States at circa 1940 and circa 1950 vary in the range between 10 and 15 percent, with the exception of the Carnoy-Marenbach estimate for 1939, which is over 20 percent. A comparison of each estimate over time indicates that the *IRRs* remained basically unchanged in the 1940s, and the stability probably carried on until the 1950s. The estimates for the 1960s and 1970s vary in a wide range, and again the Carnoy-Marenbach estimates show a tendency to deviate upward from the other estimates. It seems to be at least clear, however, that the *IRRs* estimated for the late 1960s and the 1970s are considerably lower than those estimated for the previous periods. Moreover, all the three estimates covering the 1960s and 1970s indicate a decline in *IRR* during this period, and the estimates for the 1970s fall bellow the 10-percent mark.

Comparing the estimates across the two countries, it appears that the private *IRR* of men's college education had been traditionally greater in the United States than in Japan, although the difference was much less than in the case of high school education. The *IRR* in both countries, however, declined substantially in the late 1960s and in the 1970s. Since the magnitude of the decline was much greater in the United States, the differnce in *IRR* has become very small. If the Psacharopoulos estimates for the United States are adopted, the *IRR* for men's college education for the two countries can be considered to have been converging toward the 5-6 percent range by the mid-1970s.

It should be also observed that most of the estimates of the *IRR* for the United States agree that the *IRR* for high school education has been greater than that for college education by a substantial margin, presumably indicating the "diminishing returns" to investment in education.[1] In contrast, the reverse appears to be the case in Japan. Bowman's estimates of *IRR* for men indicates that the *IRR* for senior high school education was less than that for college in 1954, 1961 and 1966. The present estimates show that the *IRR* for senior high school education has been less both for men and for women, and consistently so since 1954. The difference between the two countries in this regard suggests that the relative size of the *IRR* between secondary and higher education is affected by the supply and demand of high school graduates and those of college graduates in the labor market, and not necessarily indicative of the diminishing return of investent on education.

Another point of interest is the sex differential in *IRRs*. The private *IRRs* for women in the United States were estimated for 1969 by Carnoy and Marenbach (1975, table 1), and the estimated values were 1 percent-point greater than that for men for high school education, and 1 percent-point less than that for men for college education. In Japan the *IRR* for women is greater than that for men both at the secondary and at higher education level. The methodological problems involved in evalnating economic returns for women will be discussed in Appendix F below.

Notes

1 Becker (1976, p 203) argues, however, that the difference in IRR between the two educational levels would diminish, or even become reverse, if the IRRs are adjusted for ability

TABLE E-2

IRR FOR MEN'S COLLEGE EDUCATION IN JAPAN AND IN THE U.S.
(In Percent)

	Japan	United States					
Year	Kaneko (1)	Hansen (2)	Becker (3)	Mincer (4)	Carnoy & Marenbach (5)	Freeman (6)	Psacharopoulos (7)
1939	—	—	14.1	11.0	21.4	—	—
1949	—	11.4	13+	10.6	13.2	—	—
1956	10.6	—	12.4	—	—	—	—
1958	10.1	—	14.8	11.5	—	—	—
1960	10.4	—	—	—	17.6	—	—
1968	7.5	—	—	—	—	11.0-12.5	—
1970	7.4	—	—	—	15.4	—	8.8
1972	6.9	—	—	—	—	—	7.8
1973	6.1	—	—	—	—	7.5-10.0	5.5
1974	5.7	—	—	--	—	—	4.8
1976	6.4	—	—	—	—	—	5.3

Notes: All the estimates for 1939 and 1949 in the U.S. are for urban white males. (1) for Japan is gross of income tax. The upper boundary of (6) assumes productivity growth rate of 1.5 percent per year.

Sources: (2) Hansen 1963, table 5; (3) Becker 1975, table 15; (4) Minser 1974, table 3.2; (5) Carnoy and Marenbach 1975, table 1; (6) Freeman 1976, table 1; (7) Psacharopoulos 1981, table V.

APPENDIX F
GENDER DIFFERENTIALS IN RETURNS TO EDUCATION

The analysis in Section 1 of Chapter II revealed that the benefit of education measured by the classical indices is greater for women than for men at the senior high school level and higher education level. This is somewhat surprising, for the wages for women are lower than men's in general. In this Appendix we make a brief digression about the factors of the sex differentials in economic returns to education.

1. MEASUREMENT OF RETURNS TO EDUCATION FOR WOMEN

Before entering the analysis, a methodological issue about compar-ability of *b/c* ratios between men and women should be addressed.

The standard method of estimating a classical index is based on the profile of average incomes over age by education, often available from census data. In this method, any individual without cash income is assigned a zero income, so a substantial number of women in working age and staying in household appear as having no income. Consequently, the average income for women are substantially lower than the average wages for employed women. We denote the *b/c* ratio estimated through this method by $\hat{R}_1$. An alternative method is to use wage statistics, where the samples include only wage workers. The present estimation is based on this method. The *b/c* ratio estimated through this method is denoted by $\hat{R}_2$.

$\hat{R}_1$ is a precise indicator of the benefit of education in terms of cash earnings, but its comparison across sex has limited analytical implications. $\hat{R}_2$, on the other hand, stands for the economic returns to education for a typical women who stayed in the labor market for the working life. The comparison of this index between men and women therefore measures the difference in the economic returns to education in the labor market. It should be also noted that, if one assumes that the shadow price of a typical woman's service can be measured by the wage in the labor market of a woman of corresponding age and education, this index can be used as an indicator of a quasi-money return of education, and in this sense comparable with that for men.

The relative size of $\hat{R}_2$ and $\hat{R}_1$, estimated for the same economy, depends on the labor force participation rate for women. Suppose that the labor-force participation rate of senior high-school graduates not enrolled in colleges or junior-colleges is 100 percent for the ages of college attendance. By further assuming that the labor force participation rate after the age of graduating from college is constant at π^c for college graduates and at π^s for senior high-school graduates, we observe:

$$\hat{R}_1 = \frac{\pi^C \cdot I^C - \pi^S \cdot I^S}{c},$$

The relative size of $\hat{R}_2$ and $\hat{R}_1$ depends on the labor force participation rate for women. Assume that the labor-force participation rate of senior high school graduates not enrolled in colleges or junior-colleges is 100 percent for the ages of college attendance. By further assuming that the labor force participation rate after the graduating age of college education is constant at π^c for college graduates and at π^s for senior high school graduates, we observe:

$$\hat{R}_1 = \frac{\pi^C \cdot I^C - \pi^S \cdot I^S}{c}, \tag{F.1}$$

Where I^C is the present value of the future wages of college graduates after the graduating age of college, I^S is that of senior high school graduates, both obseved in the labor market. It follows, then,

$$\hat{R}_1 = \pi^C \cdot \hat{R}_2 + (\pi^C - \pi^S) \cdot (I^S/c). \tag{F.2}$$

Hence in general $\hat{R}_1$ can be less or greater than $\hat{R}_2$ depending on the values of the labor force participation rates and the ratio I^S/C.[1] In the particular case when the labor force participation rates are the same across education levels, i.e. $\pi_c = \pi_s = \pi$, the above equation becomes,

$$\hat{R}_I = \pi \cdot \hat{R}_2. \tag{F.3}$$

That is, $\hat{R}_1$ is equal to the product of the labor force participation rate and $\hat{R}_2$. Since π should be necessarily less than the unit, $\hat{R}_1$ should be less than $\hat{R}_2$. Thus, if there are no substantial differences in labor force participation rate among education classes, $\hat{R}_2$ should necessarily yields greater values than $\hat{R}_1$.

Since the female labor force participation rates in Japan do not vary significantly by education, it is conceivable that the *b/c* ratios for women estimated through the first method appear lower than the corresponding estimate, and hence the sex differentials may diminish or reverse.

In the discussion below we focus on $\hat{R}_2$.

2. THE DIFFERENCE BY SEX IN THE BENEFIT AND IN THE COST

Since the *b/c* ratio is the ratio between $\hat{b}$ and $\hat{c}$, the greater values of $\hat{R}$ may be attributable to a lower opportunity cost of education for women.[2] In order to examine if this was the case, the values of $\hat{b}$ and $\hat{c}$ of senior high school and college education for women and men in 1960, 1970 and 1980 were estimated and then transformed into the 1951 prices using the C.P.I presented in Appendix C. The results are presented in Table F-1.

The table clearly indicates that the greater values of $\hat{R}$ for women than for men on the whole can not be attributed to lower total costs of education for women. It is true that the lower wages for women make the foregone earnings for women somewhat small relative to men. But, since the wage differentials by sex were small in the younger age brackets, the differences in the total costs were not substantial. For senior high school education, the differences in $\hat{c}$ were only 3 to 8 percent for the three time-periods. In contrast, the differences of $\hat{b}$ were about 30 to 70 percent. As for college education, the difference in $\hat{c}$ by sex was greater than inthe case of senior high school education. Nonetheless, the difference in $\hat{b}$ far exceeded that in $\hat{c}$ in 1980.

Hence, the major source of the differences in $\hat{R}$ should not be considered as the difference in $\hat{c}$.

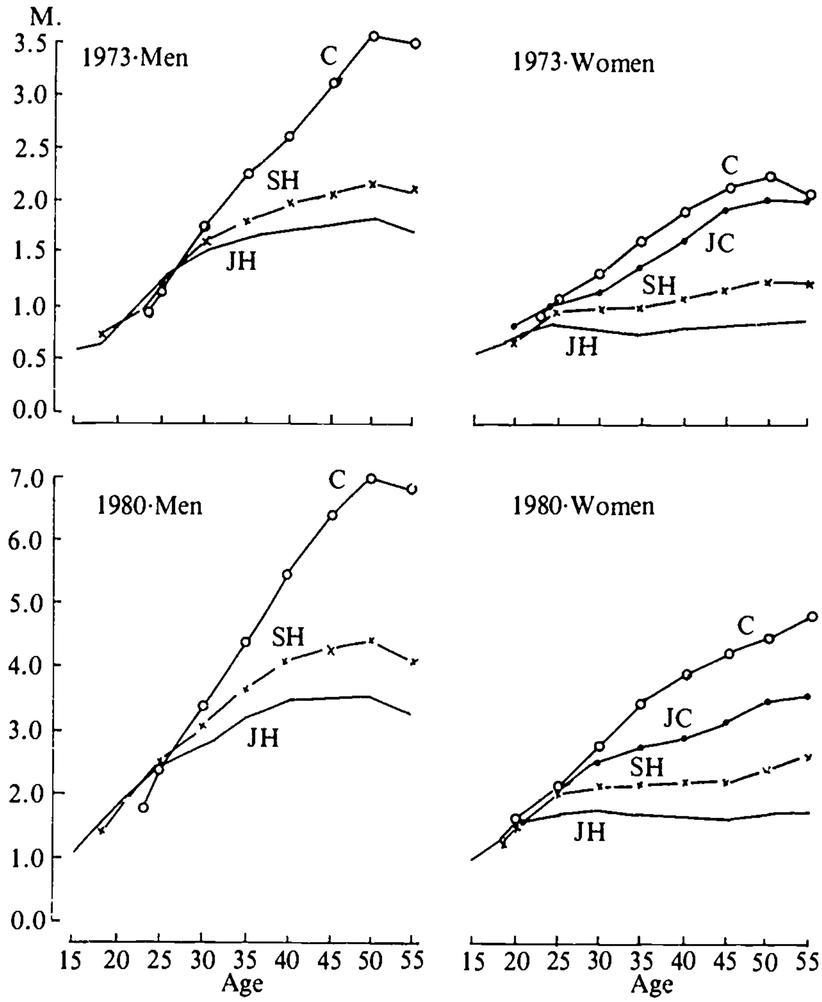
3. COMPARISON OF WAGE PROFILES FOR MEN AND WOMEN

The above analysis revealed that the differences in $\hat{R}$ by sex should be attributed rather to the differences in the benefit of education. But why the money benefit of education should be greater for women than for men, if the wages for men are generally greater for all educational levels?

An answer to this question may be obtained from Figure F-1, where the age-earnings profiles of men and women are drawn by education for 1973 and 1980. It is shown that while there were not much differences in the wage levels by sex at younger ages, the wage-profiles for women render much flatter slopes than those for men, thus creating substantial differences in wages at the middle and higher ages brackets. It is the wage differentials in those age brackets that contributed to the differences by sex in average wages or in the life-time earnings.

It should be observed, however, that the slope of wage-profiles of women were depressed particularly at the lower educational levels. Whereas male junior high school graduates at the "peak" ages earn about three times more than those at the starting age (15-years old), female junior high school graduates would expect little increase over age.[3] Hence, even though the wage-profiles of female senior high school graduates were depressed relative to those for males, the wage differential between female junior high school graduates and female senior high school graduates were at least comparable to the corresponding differences for men.

Since the benefit of education is derived not from the wage levels but from the difference in the wage levels, the benefit of education for women becomes at least comparable to that for men. Moreover, while the wage differential for men tended to become greater at higher ages, the wage differential for women grew wider at relatively younger ages. Since in the evaluation of the present value of the benefit of education the wage-differentials at lower ages are weighted more, the difference in the relative timing of the wage-differentials also tended to augment the *b/c* ratio for women. The same reasoning is also applicable to the wage-differences between female college or junior-college graduates and senior high school graduates.



Notes: C Stand for College; JC, Junior College; SH, Senior High school; and JH, Junior High school.

FIG. F-1: AGE-EARNING PROFILES OF MEN AND WOMEN

Hence, although the wage levels were generally lower for female workers, the economic returns to education have not been lower for women because the wages for less-educated female workers were particularly depressed relative to those for types of workers.

TABLE F-1

COMPARISON OF BENEFIT AND COST OF EDUCATION BY SEX

		Senior High School			College		
		$\hat{R}$	$\hat{b}$ (M.Yen)	$\hat{c}$	$\hat{R}$	$\hat{b}$ (M.Yen)	$\hat{c}$
1960							
	Men (1)	0.924	260	282	1.542	985	639
	Women (2)	1.260	343	272	—	—	—
	(2)/(1)	1.36	1.32	0.97	—	—	—
1970							
	Men (1)	0.407	257	630	0.890	1132	1273
	Women (2)	0.764	442	579	1.137	1226	1078
	(2)/(1)	1.88	1.72	0.92	1.28	1.08	0.85
1980							
	Men (1)	0.531	438	825	0.617	1040	1685
	Women (2)	0.827	637	771	1.010	1525	1511
	(2)/(1)	1.56	1.45	0.93	1.64	1.47	0.90

Note: $\hat{b}$ and $\hat{c}$ are in 1951 price.

Notes

1 The exact condition for $\hat{R}_1 > \hat{R}_2$ is derived from Eq (F 2) as

$$\pi^c > 1 - (1 - \pi^s)(I^s/I^c)$$

2 Consider the following identity

$$\frac{\hat{R}^f}{\hat{R}^m} = \left(\frac{\hat{b}^f}{\hat{c}^f}\right) / \left(\frac{\hat{b}^m}{\hat{c}^m}\right) = \left(\frac{\hat{b}^f}{\hat{b}^m}\right)\left[1 / \left(\frac{\hat{c}^f}{\hat{c}^m}\right)\right],$$

where superfix m refers to men and f for women Hence the ratio of $\hat{R}$ for men to that for women is the product of the corresponding ratio of b and the inverse of the corresponding ratio of $\hat{c}$

3 The wage-profiles for female junior high school graduates were steeper in the 1950s and 1960s The ratio of the wage at age 40 to that at age 15 was 2 2 in 1957, 1.6 in 1965 and 1 2 in 1973 The flat profiles in the 1970s were the consequence of the rapid increase in the wage of young junior high school graduates in the 1960s The wage profiles for senior high school graduates, however, were constantly steeper than those for junior high school graduates.

These speculation may be tested through close comparative studies on the changes in enrollment rates in postw orld

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