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not be a good indicator of minimum wage effects, since labor-force participation may also be affected. A more thorough study, with special attention paid to the lagged patterns of response to minimum wages, is planned in the future.

Masanori Hashimoto

4. HUMAN RESOURCES AND SOCIAL INSTITUTIONS

Introduction

During the past year work has proceeded on three broad research programs: education, the economics of the legal system, and the economics of health.

Some ongoing programs in education are being directed by Gary S. Becker (personal income distribution, consumption-labor supply decisions), while others are under the direction of F. Thomas Juster (net returns to education, savings, obsolescence of educational capital, school production functions, and agricultural productivity). Becker is primarily responsible for the legal economics studies, and Victor R. Fuchs is directing studies in the health area, which are reported on in Section 7 of this report.

Education Studies. A volume with contributions by three authors on the effects of human capital on the personal distribution of income is almost ready for a staff reading committee. One essay, by Barry Chiswick, deals with the effects of differences in the distribution of schooling on differences between regions and countries in inequality and skewness in the distribution of income.[1] Jacob Mincer has almost completed his study of the influence of schooling and postschooling investment on the structure and age profile of earnings. Becker's study of the theory underlying the observed distribution of schooling and other human capital was published as a Woytinsky Lecture at the University of Michigan.[2]

Gilbert Ghez, Robert Michael, and Becker are examining the influence of education on consumption and labor supply decisions. Michael's study, which concerns the influence of education on a household's "efficiency" in utilizing goods and time, has been through a reading committee and is being revised for publication as an Occasional Paper. Ghez's study, based on the household production function model, is designed to explain variations in consumption with age. It emphasizes the interdependence over the life cycle between consumption decisions and labor supply decisions. Becker's companion study uses the household production function model to examine life-cycle patterns in the amount of time spent by males in the labor force.

Both the income distribution and consumption-labor supply studies are being financed with the aid of a grant from the Carnegie Corporation.

Considerable progress has been made during the past year on a series of education studies being conducted with the aid of a grant from the Carnegie Commission on Higher Education. Paul Taubman and Terence Wales, who are studying net returns to education, have completed a paper on the historical relation between mental ability (as measured by the usual test scores) and educational attainment. Their results are surprising in some respects: the data show that the average ability of those entering college has increased steadily during the past several decades—a period when the proportion of high school seniors entering college has also increased. Thus the widely expressed fear that expansion of college enrollments to accommodate a rising fraction of the high school population would inevitably lead

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[1] See the *1969 Annual Report,* pp. 69-70, where Chiswick's work is discussed.

[2] See his *Human Capital and the Personal Distribution of Income,* Institute of Public Administration, University of Michigan, 1967.

to a deterioration in the average quality of college students seems, at least so far, to be without foundation.

Another part of the Taubman-Wales study, which deals with estimates of the financial return to higher education after adjustment for the influence of ability on earnings, is partly in manuscript form. Examination of one data set (Wolfle-Smith) indicates that, while ability has a significant influence on earnings, its exclusion from the education-earning relation has little effect on the net influence of education, because ability appears to have an approximately equal influence on all education levels. Other data sets are yet to be examined, including the NBER-Thorndike sample of Air Force veterans discussed below.

Sherwin Rosen, who is examining the depreciation and obsolescence of educational "capital," has completed the analytical part of the study and is now testing the model on various sets of earnings data. Rosen is using the one-in-a-thousand 1960 Census sample, and hopes to make extensive use of the National Science Foundation registry data on professional earnings. Rosen's model essentially specifies that both current income and "learning" (which yields future income) are purchased as an inseparable package, that different kinds of jobs have different proportions of income and learning, and that these job packages are bought and sold in the labor market with prices determined in the usual way.

The study of savings behavior as it relates to educational attainment, being carried out by Lewis Solmon, has been handicapped to some degree by data problems which now appear to have been resolved. Solmon's preliminary results suggest that, while more educated individuals save more than others, the difference may be fully explainable by factors like current and prospective income that are strongly influenced by educational attainments. Solmon is also examining the question of allocative efficiency in portfolio composition, where the net influence of educational attainment may be both easier to identify and of greater consequence.

Robert Michael is exploring the relation between education and family size, focusing on how educational attainment influences contraceptive knowledge and use. Technical changes in contraceptive methods might be expected to influence behavior differentially for those with different amounts of education, for the same reasons that efficiency in processing any type of new information might be related to educational level.

Other studies in the economics of education are being conducted by Finis Welch, John Hause, and V. K. Chetty, the last in conjunction with Roger Alcaly. Welch is looking at agricultural data with an eye toward determining whether the presumed greater efficiency in processing and using new information shows up as a return to more highly educated farm operators. Chetty and Alcaly are using data from the growth study originated by the Educational Testing Service at Princeton to examine school production functions—relating teaching and other inputs to various measures of student output (largely test scores). The growth study data have the unique advantage of permitting good estimates of the "value added" by schools, since the study contains standardized test scores for a number of successive years. Hause, who is an NBER Research Fellow for 1970, is also working on the problem of net returns to education and ability. He is using a collection of exceptionally good ability and earnings data from Sweden, and is also examining the Project Talent[3] data.

During the next year we hope to extend our analysis of data from the NBER-Thorndike sample, in addition to exploiting it for measurement of net returns. These data can be used to examine the influence of education and ability on the distribution of income, the influence of several different dimensions of ability on both financial returns and other aspects of behavior, the relation between "quality" of higher-education institutions and financial returns, and related topics.

Legal-Economic Studies. We have continued

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[3] See footnote, Section 2, p. 45, for a description of Project Talent.

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our analysis of some economic aspects of the legal system. William Landes' study of the courts, with emphasis on court delays, pretrial settlements, and the bail system, has been accepted for publication in the *Journal of Law and Economics*. Isaac Ehrlich is studying the rate of participation in illegal activities. His hypothesis is that the frequency of illegal behavior is determined by the relative gains and costs as visualized by potential participants.

Since we consider our initial investigations into the legal system to be highly rewarding, we plan to expand our work in this area. In particular we hope to begin a study of the effectiveness of various kinds of legislation. For example, how do the antitrust laws deter collusions, and how successful are they? We plan to add a lawyer to our staff to aid in this work.

<div style="text-align:right">

F. Thomas Juster
Gary S. Becker

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Education Studies

Human Capital Analysis of Personal Income Distribution

A first draft of my study of the effects of individual investments in human capital on the distribution of earnings was completed in May. The study separates components of earnings attributable to schooling from those resulting from postschool investments, such as training on the job and other forms of improvement. "Earnings profiles" of individuals are interpreted as growth curves produced by the staggering of investment over the working life. The familiar Gompertz growth function provides a good statistical fit to typical profiles.

The implications of individual differences in self-investments are differences in levels and slopes of the earning profiles. The study shows that these implications yield a consistent interpretation of the systematic differences in means, variances, and skewness parameters of earnings in different schooling and age groups of the labor force.

Beyond such qualitative or comparative analysis, the study contains attempts at econometric estimation of the proportion of earnings inequality attributable to individual differences in investment in human capital. A by-product of this analysis is a regression method for estimating rates of return and volumes of investment.

The bulk of the empirical analysis is based on the 1960 Census one-in-a-thousand sample and is confined to earnings of white urban males. However, the study concludes with some comparisons of earnings distribution of race and sex groups, as well as of persons and families.

One finding of particular interest in the quantitative analysis is that as much as two-thirds of the observed inequality in the 1959 earnings of urban males can be attributed to the distribution of investments in human capital. This result suggests that the return on human capital is already a more important explanation of income inequality in the United States today than the return on physical and financial capital.

Together with contributions by Becker and Chiswick, this study will be included in a monograph on the relation between human capital and the distribution of income. The monograph will represent a summing up of insights obtained from ongoing research in human capital at the National Bureau. This research is supported by grants from the Carnegie Corporation and from the Economic Development Administration of the U.S. Department of Commerce. Much of this research and some of the findings of the current study were reviewed in my survey paper "The Distribution of Labor Incomes: A Survey, With Special Reference to the Human Capital Approach." This paper was published in the March issue of the *Journal of Economic Literature*.

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Jacob Mincer

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A Theory of Life-Cycle Consumption

A model of life-cycle consumption is developed which carries markedly different implications than the standard Fisher-Modigliani-Brumberg model. In this new view of consumption, not only permanent income but also the price of

time plays a major role. The model specifies that households achieve their consumption aims by combining the services of market goods and their own time. The demand for market goods (as well as the demand for consumption time) thus appears as a derived demand for a factor of production: it therefore depends not only on real wealth, but also on the price of time.

The equilibrium conditions of the model explain why consumption and earnings are correlated over a life cycle, even in the absence of unexpected changes in income. This dependence arises because temporal variations in the price of time generate substitution effects (1) between market goods and consumption time, and (2) between nonmarket activities at different points in time.

By contrast, under the Modigliani-Brumberg life-cycle hypothesis, whether consumption rises or falls with age is completely independent of the actual shape of the earnings profile, provided that income expectations are fulfilled. Earnings there are important only in determining the level of wealth.

The implications of the model were tested with data from the BLS 1960-61 Survey of Consumer Expenditures and the one-in-a-thousand sample taken from the 1960 Census of Population. Households were grouped by year of age of the family head because no measure of real wealth is available and because it is reasonable to assume that, although each household's income expectations may be disappointed, cohort income expectations are likely to be unbiased. For each year of age of the family head, average family consumption, average earnings, and average family size were computed. Average family consumption by age of head was then regressed on average earnings by age of head, family size, and age itself (all variables in logarithms except age). Under the assumption of constant and age-neutral growth, the cross-sectional estimate of the wage rate effect is an unbiased estimate of the life-cycle substitution effect.

The results show that the wage rate effect is significantly positive (a point estimate of .23 with a standard error of .02), thereby throwing considerable doubt on the Modigliani-Brumberg life-cycle hypothesis. Furthermore, the wage rate effect is generally stable across education classes, i.e., across groups differing in permanent income, as the model predicts.

The variable "age of family head" was introduced into the regressions to capture the stimulating effect of positive interest rates on future consumption, as well as the effect of the upward trend in earnings over time. The implied estimate of the elasticity of substitution between nonmarket activities at different points in time is relatively small, less than .3.

The elasticity of substitution between time and goods is considerably higher, a point estimate of about .6, thereby accounting for the positive correlation between consumption and earnings over a life cycle. These results can also explain the procyclical sensitivity of both consumption and labor supply, without the necessity of resorting to models of biased group-income expectations.

Gilbert R. Ghez

Education and Consumption Patterns

Since last year's report on this project, which analyzes the effect of education on efficiency in nonmarket consumption, additional empirical work has been completed. The 1960 BLS Consumer Expenditure Survey data were analyzed for some fifty detailed consumption categories, thus disaggregating the dozen or so items previously studied. The new results are not easily summarized except for the observation that the neutrality model (which assumes that education has a technologically neutral productivity effect on all nonmarket production functions) appears to be much more consistent with the expenditure pattern for nondurable goods and services than for durable goods. One explanation for this finding is suggested. From the nondurables alone the implied effect of education on real, full income through nonmarket efficiency is approximately three times as great as previously estimated for all goods: a 1 per cent increase in the education level raises income by

about one-third of 1 per cent, aside from its effect through market earnings.

The manuscript is currently in the hands of a reading committee.

Robert T. Michael

Time Spent In and Out of the Labor Force by Males

This study is a companion to that reported on by Ghez, and concentrates on the implications of the same model for time spent in and out of the labor force by males. The percentage increase or decrease in nonworking time with respect to a 1 per cent rise (or decline) in the wage rate would be a weighted average of the elasticities of factor and commodity substitution discussed in Ghez's report. This weighted average is estimated at about +0.25.

If we combine this figure with our estimate of the effect of a positive interest rate and with Ghez's estimates, we can conclude that the elasticity of substitution between goods and time is about .5 or .6, while the elasticity of substitution between commodities over time is much smaller, say, less than .25. The share of time in the total cost of producing commodities is substantial, on the order of one-half. The interest rate has a large effect on the growth of nonworking time over the life cycle: it explains a growth of about 1 per cent per annum.

Although these estimates have been entirely derived from life-cycle data, we have been examining their implications for secular, seasonal, and cyclical changes in the working and nonworking time of males. Preliminary calculations suggest that they can predict the secular changes in working time (and in the consumption of goods) remarkably well.

Gary S. Becker

Economic Growth and the Distribution of Labor Income

I am studying some of the determinants of personal income distribution, on both a national and a statewide level. In particular, the study investigates the effects of economic growth on a number of key parameters (mean, variance, and skewness) of the distribution of labor income.

The theoretical model, based on the human capital approach to the distribution of earnings as formulated by Mincer (*JPE,* Aug. 1958) and Becker and Chiswick *(AER Proceedings,* May 1965), has now been completed. This approach can be summarized by two equations. The first states that the earnings of an individual at a moment in time are a return to untrained ability and a series of productivity-improving investments in human capital. The second states that the inequality of earnings among individuals is a function of the average level of investment in human capital, the average rate of return to this investment, and the variance of both these magnitudes.

My analysis concentrates on schooling, which is only one form of investment in human capital. I examine how the growth process, i.e., changes in factor ratios and technology, developments in the capital markets, and increased demand for output, may affect the costs and returns to investment in education. Empirical work will attempt to explain changes in the distribution of earnings over time by three variables: the average level of schooling, the average rate of return to schooling, and the variance in years of schooling. All the necessary data are contained either in published Census statistics for the period 1940-60, or in Census tapes in the possession of the National Bureau. The procedure will also enable me to make some projections of the future distribution of labor income.

I am now devoting most of my time to fitting the model to data for the United States and for the individual states and regions. I intend to further disaggregate according to age, sex, race, and urban-rural residence, where possible.

Michael Tannen

Net Returns to Education

The primary purpose of the study is to investigate the relationships among education, mental ability, and income. The following aspects of

the study have been completed.

First, we have traced the relationship between mental ability and education over time, where education is the fraction of high school graduates entering college, and ability is percentile rank on IQ tests. In regressions of ability on education, we find a significant monotonic decline over time in the education coefficient. We find also that the average ability level of high school graduates entering college was higher in the late 1950's and early 1960's than it was in the 1920's and 1930's. This results from a significant increase in the fraction of high school graduates continuing to college at high-ability levels, with little or no increase at low-ability levels.

These results have important implications. The change over time in average ability for high school graduates entering (or not entering) college means that age-income profiles for a given education level, drawn from a cross-section sample that spans various cohorts, will reflect ability differences. Next, since the ability-education relation has changed over time, the bias in the education coefficient estimated from cross-section regressions of income on education must also have changed. And the fact that the ability-education relation has shifted over time may allow us to estimate and thus correct for the bias.

Second, we have analyzed previously unpublished details of data collected by D. Wolfle and J. Smith. Their sample consists of graduates of Minnesota high schools (1938) for whom ACE test scores and 1953 income data are available. We find that both education and the ACE test score measure of mental ability contribute significantly to income, and that the combination of high scores and high education is particularly important. On the other hand, mental ability as measured by rank in class performs very poorly in explaining income differences. When income-education relations are estimated, both including and excluding an ability variable, the difference in the education coefficient is very small—less than 4 per cent. This finding is of particular importance, since we also find that the coefficient on education in the regression of ability on education is higher in the Wolfle-Smith sample than in almost all others. Thus, the bias in the income-education relation due to the omission of ability should be larger in the Wolfle-Smith sample than in most others, suggesting that this bias may be negligible in general.

Third, we have studied the income-education relation for a group of top corporate executives over the period 1940-63. The sample was first drawn by W. G. Lewellen in an effort to obtain good estimates of after-tax income for high-ranking executives. We find that those with one or more degrees generally earn significantly more income than high school graduates in the years 1950 to 1958. After 1958 there is no significant relation between income and education.

A major part of the study currently under way is the analysis of the NBER-Thorndike sample. The original sample was drawn from a group of volunteers who took the air cadet qualifying examinations in 1943. In the mid-fifties, Thorndike obtained income and subsequent education data for nearly 10,000 of these individuals. The National Bureau has recently completed a follow-up survey, which contains, among other variables, individual earnings data at various points in time, including 1969 and the first year of full-time work.

One of the major purposes of our study is to determine the extent to which education is used as a licensing or screening device by firms. We demonstrate that screening—defined as restricted entry into high-paying occupations, where the restrictions vary with education—does not affect the social or private return to educating one individual, but may greatly affect the return to educating many. A test for screening has been developed, along with a method of estimating the social returns to a policy designed to increase the educational attainment of large numbers of people. The Wolfle-Smith data suggest that screening does exist, and that it may be important.

Paul Taubman
Terence Wales

Learning and Knowledge
in the Labor Market

The ultimate objective of this research is to estimate rates of obsolescence and depreciation on human capital among various professions and across broad educational groups. These calculations may be useful for several important problems. For example: (1) It has been argued that higher education makes its recipients more "flexible" in adapting to new situations. If so, higher-education capital should depreciate at a lower rate than that of other levels. (2) On some assumptions, obsolescence rates can be interpreted as approximate measures of rates of change of knowledge. The extent to which it is sensible to standardize labor inputs in terms of years of schooling in time-series production studies depends on how the content of education changes over time. If the rate of change of knowledge is sufficiently rapid, the standardization criterion is not invariant over the sample period; hence, productivity calculations and imputations may be biased and misleading. (3) Cross-specialty comparisons should be extraordinarily interesting in and of themselves. For example, has the rate of advance of knowledge in medicine outstripped that in mathematics? Can these differences be explained largely in terms of different research support among fields?

Knowledge cannot be measured directly, and human capital assets are not traded in markets. But for some purposes, the labor market can be interpreted as a rental market for human capital. Thus, almost all available information is contained in observed age-income data, and obsolescence-depreciation parameters must be inferred from them. My approach is to specify a "vintage" human capital investment model and estimate a function related to hedonic price indexes. To make an analogy with automobiles, one has information on market rentals (equivalent to asset prices), school of graduation and specialty (make and model number), year of graduation ("vintage") and age (depreciation).

The analogy with tangible goods is far from complete, however, and major conceptual difficulties remain. Most important, education is not produced only in school and does not cease after graduation. In other words, individuals can "retool" or invest in more than one vintage, and have incentives to do so in order to maintain their capital intact. Evidently, there is insufficient information in age-income data to solve this problem in full, and certain outside restrictions must be imposed.

Most of my efforts to date have been concerned with attempting to specify reasonable a priori restrictions on rates of learning over an individual's lifetime. What is the optimum path for the accumulation of knowledge or human capital? The logical basis for the model rests on the assumption that *learning is a joint product of working experience.* Firms can be thought of as producing not only marketable output sold to the public at large but also learning opportunities sold to their own employees.

Workers are willing to purchase these opportunities in order to increase their marketable knowledge and subsequent income. Payments take the form of equalizing differences among jobs offering different investment values (at varying cost), and the market provides a wide range of choice to workers, depending on what job they choose. Given this market determined trade-off between current income and learning, lifetime incomes can be maximized by choosing among work activities in the optimal way. The solution to this problem yields optimum rates of investment over the worker's lifetime. Under fairly general conditions, it has been shown that the age-investment function can be well approximated by four or five parameters (instead of the original forty or fifty).

This particular learning model has some interesting properties, quite independent of the depreciation-obsolescence problem. In essence it is an analysis of "markets" for lifetime income opportunities, in which market equilibrium conditions determine entire age-income profiles. As usual, the rate of change of income with respect to age is explained in terms of supply and demand—costs of providing various learning opportunities and distributions of

worker characteristics such as "ability" and motivation, as well as capital market imperfections and labor market restrictions.

As an example, consider the effects of a minimum wage. The difference between the market rental value of a worker's existing skill and his actual wage is the price he pays for new knowledge. But this difference is also the return to the firm for providing the worker with an investment opportunity. A minimum wage puts a ceiling on the worker's demand price for investment opportunities. Thus, a worker coming to the labor market with a sufficiently small endowment of knowledge and skill will be literally priced out of the market for learning opportunities. This may be part of the explanation for the observed high concentration of nonwhite workers in low-skilled occupations, even apart from discrimination. This phenomenon may also explain why so few nonwhites have gone through formal or informal job training programs. If this is so, a program such as the "wage subsidy" would raise the ceiling on investment opportunities and allow more knowledge to be bought, thus increasing the upward occupational mobility of disadvantaged groups.

After the model is fully constructed, I intend to estimate the relevant parameters for various academic fields, using income data available from the National Science Foundation Registry. For medicine, there are data from other sources; and for general education classes, data are available from U.S. Census sources. To date I have drafted one paper entitled "Learning by Experience and Joint Production," concerning optimum accumulation of a firm-specific capital good (knowledge about its production function) produced jointly with marketable output. It is shown that various learning phenomena can be specified empirically in terms of "progress functions," using cumulated output or inputs. The rate of learning is endogenously determined, given the parameters of the system.

Sherwin Rosen

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Education and Savings Behavior

This study examines the influence of education on observed savings behavior for individuals and families. Educational differences might be associated with differences in the amount saved as a fraction of income, and also with differences in the composition of any size savings portfolio. People save in order to accumulate financial assets and to purchase consumer durables, which will provide service flows in the future. Moreover, people may choose an income stream which involves the acquisition of postschool human capital in the form of on-the-job training, and this is also a form of saving.

The principal data for the inquiry are from the Consumers Union questionnaires answered between 1958 and 1960. These surveyed attitudes, expectations, expenditures, and savings patterns of families who were members of this national organization. In addition to providing information on several current income measures, earnings of various family members, expenditures, and the amount of various types of savings (both financial assets and consumer durables), the survey furnished income data over a period of years, beginning in the first year of full-time employment of the family head. Moreover, the data set contains a collection of attitudinal questions which might provide clues about time preference, taste for risk, goals for saving, and ability to accomplish these goals. Data on education, age, family size, and occupation are also available.

Since the respondents are members of Consumers Union, the quantitative data are probably more accurate than for most such surveys. In addition, a number of consistency checks have been built into the empirical analysis; because there are over 6,000 observations for families answering four successive questionnaires, it is possible to eliminate seemingly irregular observations which do not pass these tests without seriously worrying about degrees of freedom.

The first part of the study has considered whether educational differences result in differ-

ent savings/income ratios; that is, at a given point in the life cycle, do more-educated people save more or less than less-educated people? One underlying cause of differential aggregate savings patterns by education might be that the educational process alters individual time preference. Responses to several of the attitude questions may throw some light on the association between time preference and education. If saving is a function of time preference, and if people with low time preference also choose to obtain more schooling, then an observation that more educated groups save more, *ceteris paribus,* need imply nothing about the effect of education on saving. The educated (low time preference) individuals would have been relatively large savers even without education, due to their inherent low time preference.

Differences in education also appear to result in differences in the *nature* of subsequent income. Various aspects of income might differ because of education or because of the type of occupation entered after education; these include level, time path, variance over time, source (whether from physical or human capital), and split between wages and fringe benefits. Many of these characteristics have been thought to influence the proportion of income saved. For example, consumption theory leads to the conclusion that savings will be a larger part of income when reliance is on human (versus nonhuman or physical) capital to earn income.

Aspects of both consumption theory and human capital theory suggest that savings as a fraction of income will tend to increase as education increases, and, other things being equal, as age increases up to retirement. To test this hypothesis, I divided the Consumers Union Survey respondents into education-experience cells, and estimated consumption functions for those in each cell. The expectation was that marginal and average propensities to consume would be negatively correlated with both level of education and labor force experience. The latter conclusion was generally confirmed, but there did not appear to be a strong pattern

across schooling groups. However, saving in this test was defined to include only saving in the form of financial assets.

According to Mincer's theory and evidence, saving in the form of on-the-job training rises with formal education and declines with age. Since younger and more educated members of the labor force save more of their incomes in the form of on-the-job training, they will save correspondingly less in the form of financial and durable assets to attain any total amount of saving. Since older workers invest less in on-the-job training, they should invest more in other forms of saving to result in the equivalent amount of total savings. If we expect the savings/income ratio to rise with labor force experience, there should be a positive relationship between age and financial saving. On the other hand, although it might be expected that more educated people save more in total, they also invest more in on-the-job training (at the same age). Hence, it is unclear which way the relationship between financial saving and education will go. Estimates of actual investment in on-the-job training by members of the sample will be constructed, using Mincer's definition, and "full" savings functions will be estimated.

Currently I am looking at responses to attitude and behavior questions to find clues as to how time preference and investment efficiency vary with schooling. The data should indicate whether there is a systematic relationship between education and savings portfolio decisions. Some of these questions concern ways in which purchase of services of durables differ from purchase of the durables themselves; that is, the holding of durable versus financial assets, the holding of long-run versus short-run securities, and the holding of variable versus fixed price assets. This part of the study is in a preliminary stage.

In addition to the savings study, I am working on several other projects during my year as a Research Fellow. Papers entitled "On Equality of Educational Opportunity" and "Opportunity Costs and Models of Schooling in the Nineteenth Century" have been completed and

are to be published in the *American Economic Review* and the *Southern Economic Journal,* respectively. I have analyzed measures of quality of colleges and expect that these results can be used in conjunction with the NBER-Thorndike data sample. I have also begun a study of the effects of compulsory schooling laws on nineteenth century education.

Lewis C. Solmon

Education and Family Size

Empirical research has shown that the effect of education on productivity in the labor market is positive, and the theory of human capital has tended to focus upon those incentives to invest in education that result from a positive net return. Thus relatively little work has been done on the manner in which education enhances productivity. Little attention has been paid to the question, "How or why does education affect productivity?" One hypothesis is that education has an "allocative" or cognitive effect, whereby it fosters an awareness of alternative methods of production or increases the capability of the more highly educated to adopt new production techniques.

What little evidence there is on education's effect on productivity in the nonmarket sector also indicates a positive relation. The objective of this study is to analyze, within the context of a set of household production functions, how this cognitive effect of education might operate within the nonmarket sector to alter commodity prices and real income, and thereby affect behavior. The specific productive process examined is the use of contraceptives in limiting family size. The approach is to view the derived demand for children as a joint-products problem involving nonmarket commodity production.

Empirically the effect of education on family size may reflect several factors, principally the higher permanent money income level (with its corresponding shift in demand toward higher-priced units or "quality"), the higher time value

of family members, and the effect of education on contraceptive knowledge and use. The fact that previous studies have observed conflicting net effects of education on family size may simply be the result of a dominance of one or the other of these separate factors. The empirical analysis in this project will attempt to isolate these three effects, with the emphasis on the net influence of education.

The first set of data to be analyzed will be the 1968 NBER-Census Bureau Consumer Anticipations Survey of some 4,500 households. These data should permit separate estimates of the partial effects of income and time value and the residual education effect. In addition, recent empirical findings by demographers are being reviewed to provide further direct evidence of education's effect on the desired family size and on the use of contraceptives.

Robert T. Michael

NBER-Thorndike Sample

Analysis of several important and interesting questions will be greatly facilitated by the forthcoming availability of the NBER-Thorndike sample of Air Force veterans. With the assistance of Dr. Robert Thorndike (Columbia University), the Veterans Administration, and the U.S. Air Force we have managed to obtain a data set that promises to be of exceptional value for research in the economics of education.

We have now completed and processed four separate mailings to the roughly 9,700 men in the original Thorndike sample. After the first two mailings, which yielded approximately 2,500 returns, we were able to obtain updated addresses for close to 4,000 of approximately 7,000 nonresponse cases (roughly 300 of the original sample proved to be deceased). Subsequent mailings to these new addresses yielded another 2,000 returns, hence our current total is about 4,500. We have now successfully updated another 1,000 or more addresses, using public telephone directories, and plan a fifth and final mailing to these new addresses as

well as to all remaining nonrespondents. On the basis of experience to date, it appears that the sample of returns will eventually reach between 5,500 and 6,000 cases.

Not only have response rates been exceptionally high, given the usual standards for mail surveys of this type, but the quality of the information appears to be well above average. Virtually all respondents have provided an estimate of current earnings in dollars, and well over 90 per cent have provided earnings on the first job held after termination of formal schooling. There are a substantial number of income reports for the years between initial job and the present. The survey contains information on schools attended, years of attendance, and degrees received. For about three-quarters of the higher-education institutions attended by sample respondents, we have been able to obtain a measure of college "quality." Thus, it will be possible to analyze the returns to different qualities of higher education.

In addition to the basic earnings and schooling data, information was obtained on nonearning activities of sample respondents: these data indicate type of organization, kind of activities, and amount of time involved. We also have extensive data on demographic and family characteristic variables, as well as on socioeconomic attitudes, family background, etc. Some limited data were obtained on total holdings of financial and other types of assets, as well as on savings; this information is of unknown completeness and reliability, although it appears to be less extensive than the basic earnings and schooling data.

The basic ability data were obtained from a series of twenty tests administered to all sample respondents by the U.S. Air Force in 1943. Factor analysis of these test scores suggests the presence of at least four, and possibly five, identifiable dimensions of "ability": one factor apparently represents general reasoning ability, another quantitative aptitude, another spatial perception, another general physical dexterity, and the last may represent taste for risk. The spatial perception and physical dexterity measures are, of course, a consequence of the interest of the tester (the U.S. Air Force) in identifying individuals with an aptitude for pilot training. The availability of this collection of ability dimensions will make it possible to estimate the economic returns to several dimensions of ability, and possibly to explore whether or not the returns to these ability dimensions have changed over the years. It will also permit investigation of the particular dimensions of ability associated with financial success in any given occupation.

F. Thomas Juster

The Use Value of Education

This study is a continuation of a series of studies concerning the nature—in production and consumption—of education. The fundamental idea is that a large part of the return to education may have its roots in the decision process. If education facilitates the collection, evaluation, and storing of information, then increased education should be associated with propensities toward correct choice. For static analysis it is not informative to distinguish between education as a factor contributing to allocative efficiency and education as an ordinary good which directly increases either utility or physical production. But in a dynamic setting, where abilities to learn and adjust are important, the distinction is relevant.

The theoretical analysis is concerned with identifying the value of information, where learning is defined as the erosion of ignorance and ignorance refers to either subjective or objective uncertainty as reflected in error variance. The role of scale economies associated with the collection and application of information is stressed, as are such factors as the rate of technical change and product differentiation, which increase both the rate of obsolescence of knowledge and the value of learning.

The empirical analysis concentrates on U.S. agriculture, where a rapid rate of technological change has lent value to discretionary capacities. The major questions asked are: To what

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extent has the interaction between agricultural research and farm operator education "created" the returns to scale commonly found in empirical estimates? And, is there evidence that federal extension activities and increasing farmer education have speeded the diffusion of the products of agricultural research? Data are now available to address these questions. The 1964 Census of U.S. Agriculture provides output and input data, including farm operator education, which is cross classified by value of sales, age of operator, tenancy (full or part owner, managers, and tenants), and type of farm. This detail, previously unavailable, permits an analysis of questions concerning the rate of appreciation or obsolescence of abilities associated with schooling (the age cross classification), returns to scale (value classes), incentive structures (tenancy), and an analysis of the differential impact of research activity by type of farm. The results of several models will be compared, ranging from full income, in which appreciation of land values and income from off-farm work are included as output, to the now standard gross revenue and value-added models.

Finis Welch

Aptitude, Education, and Earnings Differentials

A major problem arising in the empirical analysis of costs of and returns from formal education is the isolation of the earnings increment that can be attributed to an increment of formal education. The imputation of the return from the investment is usually made by controlling for several demographic variables, such as sex, race, age, and geographic location, and then attributing the differences in the earnings' streams of individuals with various levels of formal schooling to differences in the amount of schooling. Most studies have been based on information with two important limitations. First, there is usually no independent measure of individual ability, and this leads to an unknown bias in the apparent returns from school-

ing. Second, the earnings profile plays an important role in analyzing the returns from investments in formal education. Since most studies are based on cross-sectional data at a single point in time, some assumptions are made to generate pseudo-earnings profiles. Cohort (longitudinal) data would enable one to avoid these somewhat arbitrary assumptions about secular growth and its effect on individual earnings.

Two samples are being studied which contain information usually not available for the analysis of return from education. The first is a sample of all Swedish third graders from Malmö, who were given a four-part intelligence test in 1938. Information on school grades, formal education, social class, measured intelligence ten years later (for some), and follow-up information including taxable income was obtained in 1963 for the cohort. The basic data tape was made available by Professor T. Husén of the Pedagogisk-Psykologiska Institution at the University of Stockholm's School of Education. In addition, data were gathered from individual tax records in the Swedish archives on earnings, income from capital, taxable income, and income of wife for males in the sample. These data cover 1949-68, at five-year intervals. The original sample size was 835; earnings profile information was obtained on 500 to 600.

The second source of data is a sample of 10,500 respondents to a Project Talent[1] follow-up survey, carried out with the aid of a grant from the National Science Foundation. The original survey provides 130 background items from the time when respondents were in the 11th grade, including various aptitude test scores, family background, high school attitudes, and high school information. The follow-up survey made six years later includes information on earnings, weeks worked, weeks unemployed, and additional formal training.

These two unique samples will make it possible to test directly a number of hypotheses

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[1] See footnote, Section 2, p. 45, for a description of Project Talent.

about the way measured intelligence, family background, and attitudes affect the returns from schooling, as well as their direct influence on earnings.

Initial calculations with the Project Talent high school graduates who had no additional formal training suggest that differential measured aptitude has a small but positive effect on earnings five years after graduation. Some people had conjectured that higher-aptitude individuals might well have obtained significantly higher incomes even without college education. The conjecture, if it had been correct, would have implied an understatement of the opportunity costs of acquiring more education.

John C. Hause

Comparison of Measures of the Growth in Educational Output

As a first step in our analysis of so-called educational production functions, we compare various alternative measures of the growth in educational output during a particular period of schooling. The specific output measures we are concerned with are:

(1) $$T_{ij+1} - T_{ij}$$

(2) $$T_{ij+1} - \hat{T}_{ij+1}$$

(3) $$D_{ij+1} - D_{ij},$$

where T_{ij} = the actual score on the ith test in the jth period, $\hat{T}_{ij}$ = the predicted score in the ith test in the jth period, D_{ij} = the percentile achieved on the ith test in the jth period.

The first measure, raw differences in test scores, is probably the most commonly used growth index, yet it is clearly far from ideal. Its principal shortcoming is the failure to adjust for the arbitrary scaling of test scores.[1] The second procedure, on the other hand, at-

tempts to make such an adjustment by removing the arbitrarily determined growth in the mean test scores (the trend in test scores) from one period to the next. Thus each individual's test score is assumed to grow in the same (linear) fashion as the mean score, yielding a predicted or expected test score for each individual. The "true" growth in test scores is then the difference between actual and expected test scores. Even this procedure is inadequate, however, if the variances in the distributions of test scores are changing over time, or if the distributions are not normal and other moments are allowed to vary.

The final measure to be considered, the change in the percentile in which a given student's test scores fall, is truly ordinal but is strongly related to the second measure, if test scores are normally distributed with constant variance. In this case, the relationship between the second and third measures depends directly only on the "fineness" with which the third measure is specified; for example, changes in percentiles, deciles, or quintiles. If the variances of other properties of the distribution are changing over time, the third measure is clearly superior to the second.

The primary concern of the present phase of our investigation is not, however, with a theoretical comparison of measures of output growth. We are interested in the *actual* relationships among these growth indexes.

We have been exploring data obtained by the Educational Testing Service at Princeton in connection with their "Growth Study." Approximately 34,000 school children were given a battery of tests requiring about ten hours of testing time. The sample included approximately 9,000 public school students in the fifth grade, 9,000 in the seventh grade, 9,000 in the ninth grade, and about 5,000 in the eleventh grade. In independent schools, the sample included 1,000 ninth-grade and 1,000 eleventh-grade students. These students were enrolled in 140 elementary feeder schools and 33 secondary schools. Samples of the original 34,000 students were retested at two-year intervals during the eight-year course of the study. There

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[1] All these problems arise because the measures of education are ordinal rather than cardinal, that is, there is neither a zero point nor a well-defined unit of measurement for educational achievement (or ability). See Samuel Bowles, "Towards an Educational Production Function," in *Education, Income, and Human Capital,* W. Lee Hansen, editor, Income and Wealth Conference 35, New York, NBER, 1970.

are thus five sets of data describing the educational achievements of those students who were in the fifth grade in 1961.

The analysis of these data could be begun by calculating these measures for the tests administered in September-October 1961 and September-October 1963 (January-February 1963 for those who were in the eleventh grade initially). In the case of the third measure we intend to try several alternatives: (a) standard deviation units, two on each side of the mean, yielding four classes; (b) half-standard deviation units, four on each side of the mean, yielding eight classes; and (c) deciles, yielding ten classes.

Roger E. Alcaly
V. K. Chetty

Economics of the Legal System

An Economic Analysis of the Courts

In the folklore of criminal justice a popular belief is that a person arrested for a crime will have his case decided in a trial. Empirical evidence does not support this belief. Most cases are disposed of without a trial through negotiations between the prosecutor and the defendant, resulting in either a guilty plea or a decision not to charge the suspect. What factors determine the choice between a pretrial settlement (hereafter denoted by PTS) and a trial? What accounts for the large proportion of PTS's compared with trials? In particular, how are certain aspects of the criminal justice process, such as the bail system and court delay, related to the decision to settle or to go to trial? The main purpose of this study is to answer these questions by means of a theoretical and empirical analysis of the criminal justice system, using standard tools of economic theory and statistics.

A theoretical model has been developed to identify the variables relevant to the choice between a PTS and a trial. The model's basic assumption is that both the prosecutor and the defendant maximize their utility, appropriately defined, subject to a constraint on their resources. It is shown that the PTS-trial decision depends on estimates of the probability of conviction by trial, the severity of the crime, the availability and productivity of the prosecutor's and defendant's resources, trial versus PTS costs, and attitudes toward risk. The model is then used to analyze the existing bail system and court delay, and to predict the effects of a variety of proposals designed to improve the bail system and reduce court delay. These proposals include "preventive detention," monetary compensation to defendants not released on bail, and the imposition of a money price for the use of the courts.

An additional feature of the model is its usefulness in analyzing the frequently expressed belief that the criminal justice system discriminates against low-income suspects. This proposition is analyzed by relating a defendant's income or wealth to his decision to settle or go to trial, the probability of his conviction, and his sentence if convicted. The interactions of these factors with the bail system and court delay are also examined. Finally, the model is applied, with some modifications, to civil cases.

The second major part of this study is an empirical analysis using data from two main sources: (1) a survey conducted for the American Bar Foundation on the disposition of felony cases in state courts in 1962, and (2) yearly data on criminal and civil cases in federal courts contained in the *Annual Report of the Director of the Administrative Office of the U.S. Courts*. Multiple regression techniques are used to test a number of important hypotheses derived from the model. These include the effects on the demand for trials (or conversely PTS's) and on the probability of conviction of the following variables: (1) the bail system; (2) court queues; (3) the size of the potential sentence; (4) judicial expenditures; (5) subsidization of defendants' legal fees; and (6) demographic variables, such as population size, region, county income, per cent nonwhite, and urbanization.

Some of the empirical findings are that:
1. The propensity to go to trial in state

courts was larger for defendants released on bail than for other defendants, holding constant the average sentence and several demographic variables. This is predicted by the model, since the opportunity cost of a trial compared to a PTS is greater for a defendant not released on bail than for one released as a result of court delays. Moreover, differences in wealth among defendants had no observable effect on trial demand.

2. Trial demand was negatively related to trial delay, and positively related to PTS delay, across U.S. district courts for 1960, 1967, and 1968. Thus, a widening differential between trial delay and PTS delay will tend to reduce the demand for trials, as the model predicts.

3. The subsidization of defendant's legal fees in the U.S. district courts increased the demand for trials. This is consistent with the hypothesis that a reduction in the cost differential between a trial and a PTS will increase the demand for trials.

4. Regression analysis of civil cases across U.S. district courts for the 1957-61 period indicated that the demand for civil trials was also a negative function of court delay.

5. The probability of conviction in state courts, as measured by the proportion of defendants sentenced to prison, was greater for defendants not released on bail than for those released. Regressions using the proportion of defendants acquitted and dismissed as the dependent variable supported the finding that defendants not released on bail were more likely to be convicted.

6. Convictions leading to prison sentences were *lower* in U.S. district courts where defendants had relatively high average wealth, while convictions resulting in monetary fines were *greater* in the same districts. These results are consistent with the model's prediction that a wealthier defendant has a stronger incentive to invest financial resources in his case if the penalty is a jail sentence, and a lesser incentive if the penalty is a fine.

In addition to a more intensive analysis of the above results, further work is planned along three lines.

1. The American Bar Foundation data used in the preliminary analysis were limited to data published in two volumes. However, the basic data (available on IBM cards) on the characteristics of over 11,000 felony defendants in state courts are still in existence. These data indicate sex, age, race, years of school completed, amount of bail, type of offense, time from arrest to disposition, sentence received, and type of legal service provided—a set of characteristics that can be incorporated into the empirical analysis to determine their relation to the frequency of trials, the likelihood of conviction, and the sentences received if convicted.

2. Data on the disposition of defendants in other countries, for example, England and Canada, are available from selected samples. A comparison of the workings of court systems in these countries with the United States will provide us with additional empirical tests of the model.

3. Widespread criticism of the existing bail system and proposals for bail reform play an important role in current policy debates over effective law enforcement. Proposals for bail reform generally focus on eliminating the traditional reliance on income as an indirect criterion of pretrial release. When these policy considerations are added to the findings described above (that pretrial detention is an important determinant of the trial versus settlement decision and the probability of conviction), a thorough analysis of the present bail system and proposed alternatives seems justified. This project consists of three parts. First, a theoretical model is developed to determine the optimal amount of bail and the optimal number of defendants released for various offenses in order to minimize the community's losses from a bail system. Such factors as the direct costs of detention (e.g., costs of maintaining persons in prison), the reduction in expected losses from crime, the losses to defendants, and the degree of uncertainty in predicting which defendants will commit additional crimes during pretrial release are relevant in determining the optimal bail system. Second, the present bail system and various reforms will be compared

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with an optimal system. Third, an empirical analysis is planned to explain the factors that give rise to variations among defendants, both in the amount of bail charged and in the likelihood of their release.

William M. Landes

Participation in Illegitimate Activities and the Effectiveness of Law Enforcement

The President's Commission on Law Enforcement and the Administration of Justice estimated the economic costs of reported crime in the United States in 1965 at $21 billion (about 4 per cent of the national income), which is more than the estimated economic cost of unemployment in that year. In the same year, public expenditure on police, criminal courts, defense council, and "corrections" at the federal, state, and local levels amounted to $4.2 billion. In view of the economic and social significance of crime, it is important to determine whether the public's scarce resources are being wisely allocated to law enforcement. Is there at present "too much" or "too little" enforcement of existing laws?

The answer to these questions can be obtained by investigating two related issues. First, what is likely to be the effect, on the level and severity of criminal activity, of an increase in the probability of apprehending and convicting offenders, in the punishment imposed on those convicted, and in other measures for combatting crime? Second, to what extent would additional public expenditure on law enforcement agencies increase their effectiveness in apprehending and convicting offenders?

1. My study on participation in illegitimate activity has attempted to investigate the first issue by setting up an economic model of the decision to engage in unlawful activities and testing it against the empirical evidence. The novelty of this approach, as distinguished from traditional sociological approaches, lies in its attempt to separate "taste for crime" from objective opportunities and other environmental factors, both analytically and empirically, and

to investigate the extent to which illegal behavior could be explained by the effect of opportunities, given "taste." This framework is used, for example, to explain why many offenders allocate their "working time" to both legitimate and illegitimate activities, rather than to criminal activity alone, and why many offenders tend to repeat their crimes even after being apprehended and punished, without resorting to assumptions regarding unique motivation. It is also used to explain why those with specific legitimate skills have relatively little incentive to engage in offenses punishable by imprisonment, and those with higher nonwage income may have a greater incentive to commit offenses punishable by fines. More importantly, the analysis offers behavioral implications regarding the effect of some measurable factors on the frequency of illegal behavior. The main testable hypotheses are that, on the one hand, crime is deterred by an increase in the probability of apprehension and conviction, in the rate of punishment if convicted, and in the returns from alternative legal activity, and, on the other, is enhanced by an increase in the probability of (legal) unemployment and in the size of illegal payoffs. Attitudes toward risk are expected to play an important role in determining the relative effect of probability and severity of punishment. It is shown that a 1 per cent increase in the probability of apprehension and conviction has a greater, a smaller, or the same deterrent effect in comparison with a 1 per cent increase in severity of punishment as offenders are risk preferrers, risk avoiders, or risk neutral, respectively. Moreover, it is shown that if offenders were risk preferrers, the effect of punishment might be negligible in absolute magnitude. The observation that punishment has little deterrent effect on some offenders need not, therefore, be interpreted as evidence of irrationality; it can be explained by preference for risk. The analysis also shows that the degree of response of "full time" and "professional" offenders to changes in variables reflecting deterrents and gains is likely to be lower than that of "part time" offenders. Law enforcement may therefore be less effective in

the case of "hard core" criminals relative to occasional offenders.

The hypotheses regarding the deterrent effect of law enforcement on crime follow from the basic thesis that offenders behave rationally. However, in the case of crimes punishable by imprisonment, an increase in the probability and severity of punishment would reduce the frequency of illegal behavior even if offenders were irrational, for those imprisoned are prevented from committing further crimes, at least temporarily. While both deterrence and prevention may equally well serve the basic purpose of law enforcement (i.e., to reduce total crime), it is important to establish the independent deterrent effect of imprisonment, both to verify the validity of our approach with respect to crimes punishable by imprisonment and to determine the effectiveness of punishment by imprisonment relative to alternative penal modes (probation and fines) which are expected to have only a deterrent effect.

By considering a model in which offenders are assumed a distinct subpopulation, unaffected by deterrents and gains, we are able to estimate an upper bound for the preventive effect of imprisonment on the frequency of specific crime categories. The elasticity of this latter effect is shown to be the same for probability and severity of punishment and necessarily lower than unity (in practice it has been generally estimated to be lower than 0.1). Since some of our empirical estimates of the elasticity of offenses with respect to probability and severity of punishment exceed the magnitude attributable to a preventive effect (some exceeding unity), and since the elasticities are significantly different in relative magnitude (e.g., the elasticity of burglaries and larcenies with respect to a change in severity of punishment exceeds that with respect to probability of punishment), the existence of an independent deterrent effect of law enforcement is clearly confirmed.

The empirical investigation employs a cross-state regression analysis of the seven felony crimes reported by the F.B.I.'s Uniform Crime Reports. Since my last report, the empirical

work has extended along three lines. First, a simple multiple regression framework was employed in the analysis of data from 1950 and 1940. The results proved consistent with those obtained from 1960 data, reported in last year's *Annual Report*. Second, a two-stage least squares regression analysis was employed in the investigation of specific offenses and broad crime categories. The results confirmed the significant deterrent effect of the probability and severity of punishment on all offenses and the significant positive effect of income inequality and unemployment on the incidence of crimes against property. Finally, a three-stage least squares technique was employed to estimate simultaneously the "seemingly unrelated equations" of specific offenses. The results proved to be consistent with those obtained by using the two-stage least squares technique. It should be noted that our emphasis on simultaneous equation estimation techniques has been due not only to the presumed simultaneity relations between the frequency of reported offenses and the probability of apprehension and conviction but also to errors of measurement in the estimates of these variables. The fact that the results are consistent with the hypotheses and confirm our initial results is quite encouraging.

2. Some preliminary work has been done to determine the "productivity" of public expenditure on law enforcement. A simultaneous equation model of law enforcement and crime has been developed. The frequency of offenses, the probability of apprehension and conviction, and per capita expenditure on law enforcement are treated as endogenous variables, jointly determined by the system of equations. The model was then tested against data on total felonies in 1960. The results show a positive and significant effect of expenditure on police on the probability of apprehending and convicting felons. These results, combined with estimates of the effect of probability of punishment on total felonies, make it possible to estimate the effectiveness of law enforcement in reducing crime and the resulting social losses.

Isaac Ehrlich