THE JOURNAL OF
POLITICAL ECONOMY

Volume LXVI AUGUST 1958 Number 4

INVESTMENT IN HUMAN CAPITAL AND PERSONAL INCOME DISTRIBUTION

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I. INTRODUCTION

ECONOMISTS have long theorized about the nature or causes of inequality in personal incomes. In contrast, the vigorous development of empirical research in the field of personal income distribution is of recent origin. Moreover, the emphasis of contemporary research has been almost completely shifted from the study of the causes of inequality to the study of the facts and of their consequences for various aspects of economic activity, particularly consumer behavior.

However, the facts of income inequality do not speak for themselves in statistical frequency distributions. The facts must be recognized in the statistical constructs and interpreted from them. Perhaps the most important conclusion to be drawn from research into the influence of income distribution on consumption is that the effects of inequality depend upon its causes.[1] Thus factors associated with observed inequality must be taken into account before the data can be put to any use.

Since income inequality is observable in terms of the shapes or parameters of statistical frequency distributions, theories of the determinants of personal income distribution, if they are to be operational, must predict features of the observable statistical constructs.

Probably the oldest theory of this type is the one that relates the distribution of income to the distribution of individual abilities.[2] A special form of this theory can be attributed to Galton, who claimed that "natural abilities" follow the Gaussian normal law of error. This, it appeared to Galton, was a simple consequence of Quetelet's findings that various proportions of the human body are normally distributed. A seemingly natural corollary of this logic was the hy-

[1] This is brought out in the distinction between the "permanent" and the "transitory" components of income as applied to the analysis of consumption in Milton Friedman, *A Theory of the Consumption Function* (Princeton, N.J.: Princeton University Press, 1957).

[2] A more detailed review of these theories can be found in H. Staehle, "Ability, Wages, and Income," *Review of Economics and Statistics*, XXV (February, 1943), 77–87.

pothesis of a normal distribution of incomes. Although the invention of intelligence quotients appeared to confirm conclusions derived by a non sequitur, the hypothesis of a normal distribution of incomes was definitively shattered by Pareto's famous empirical "law" of incomes.

For a long time this refutation of a logically weak hypothesis was considered to present a strange puzzle. Pigou termed it a paradox:[3] How can one reconcile the normal distribution of abilities with a sharply skewed distribution of incomes? This became the central question around which thinking on the subject subsequently revolved.

One answer, of comparatively recent origin, is that the abilities relevant to earning power should not be identified with I.Q.'s. Indeed, relevant abilities are likely not to be normally distributed, as I.Q.'s are, but to be distributed in a way resembling the distribution of income.[4] This amounts to saying that income distributions should not be deduced from psychological data on distributions of abilities but, conversely, that the latter, which are not observable, should be inferred from the former, which are. This reversal of independent and dependent variables may be of interest to psychologists, but income analysts are not left with much more than a tautology.

A more general and traditional answer, given by Pigou himself, is that income-determining factors other than ability intervene to distort the relation between ability and income. Thus, given a definition of the former independent of income, the relation between the two can be discerned only in subgroups homogeneous with respect to all other factors. Ability is relegated to a residual role, and the emphasis is shifted to other factors. Pigou pointed to the distribution of property as the most important of the other factors. This position resolves the paradox, but it is not a theory of income distribution until the other factors are built into models with predictive properties.

Curiously enough, the one factor consistently selected for such constructive purposes in the recent literature is "chance," a concept as difficult to define as "ability." The earliest and basic version of the stochastic models is that of Gibrat.[5] Its logical construction is as follows: Start with some distribution of income, with mean M_0 and variance V_0, and let individual incomes be subjected to a random increase or decrease over time as a result of "chance" or "luck." Let the variance of the annual changes in income in year t be v_t, and let those changes be uncorrelated with the levels of income on which they impinge. Then the variance of the income distribution at time $(t + n)$ will be

$$V_n = V_0 + \sum_{t=1}^{n} v_t .$$

With n increasing without bounds, any v_t becomes very small in comparison with $\Sigma_t v_t$, and similarly V_0 becomes small in comparison with V_n. Under these conditions, probability theory guarantees that in time the distribution of income will approach normality, regardless of the form of the initial distribution.

[3] A. C. Pigou, *The Economics of Welfare* (London: Macmillan & Co., Ltd., 1932), p. 648.

[4] C. Burt, "Ability and Income," *British Journal of Educational Psychology*, XIII (June, 1943), 95 ff.; A. D. Roy, "The Distribution of Earnings and of Individual Output," *Economic Journal*, LX (September, 1950), 489–505. For the origin of the hypothesis see C. H. Boissevain, "Distribution of Abilities Depending on Two or More Independent Factors," *Metron*, XIII (December, 1939), 49–58.

[5] R. Gibrat, *Les Inégalités économiques* (Paris: Sirey, 1931).

Personal income distributions are not normally or symmetrically distributed, but the distribution of logarithms of income is rather symmetric and in a rough way approximates normality. The process of "random shock" just described generates a log-normal distribution if applied to the logarithms of income rather than to income itself. Thus the proper assumption to be made is that the random shock consists of relative or percentage, rather than absolute, income changes, which are independent of income levels. This is Gibrat's "law of proportionate effect."

Kalecki has pointed out a serious defect in Gibrat's approach.[6] The model implies that, as time goes by, aggregate income inequality increases because each subsequent random shock adds a term to the sum on the right side of the expression

$$V_n = V_0 + \sum_{t=1}^{n} v_t .$$

This, however, is empirically false.

Subsequent models correct this defect in either of two ways. One is to postulate a negative correlation between the size of the random shock and the level of income, to be interpreted as a decreasing likelihood of large negative changes with a decreasing level of income.[7] This restriction assures constancy of the variance of the distribution. Another way is to apply the random shock, without restriction, separately to age cohorts throughout their life-histories.[8] The income variance increases with time for each age cohort but, given a stable population, the aggregate variance remains unchanged.

Unless we assign specific interpretations to the "chance" factor, it is difficult to see how the stochastic models increase our understanding of the processes underlying the formation of personal income distributions. If the "chance" factor is to be understood as a net effect of all kinds of causes, this approach is an admission of defeat in the efforts to gain insight into systematic factors affecting the distribution of income. Moreover, the operational scope of the stochastic models has not kept pace with the increasing empirical knowledge about the multidimensional structure of the personal income distribution. With few exceptions,[9] the sole purpose of the models is to rationalize a presumed mathematical form of the aggregate.

From the economist's point of view, perhaps the most unsatisfactory feature of the stochastic models, which they share with most other models of personal income distribution, is that they shed no light on the economics of the distribution process. Non-economic factors undoubtedly play an important role in the distribution of incomes. Yet, unless one denies the relevance of rational optimizing behavior to economic activity in general, it is difficult to see how the factor of individual choice can be disregarded in analyzing personal income distribution, which can scarcely be independent of economic activity.

The starting point of an economic analysis of personal income distribution must be an exploration of the implications of the theory of rational choice. In

[6] M. Kalecki, "On the Gibrat Distribution," *Econometrica*, XIII (April, 1945), 161–70.

[7] *Ibid.*; see also D. G. Champernowne, "A Model of Income Distribution," *Economic Journal*, LXIII (June, 1953), 318–51.

[8] R. S. G. Rutherford, "Income Distributions: A New Model," *Econometrica*, XVIII (July, 1955), 425–40.

[9] *Ibid.*

a recent article[10] Friedman has pointed out two ways in which individual choice can affect the personal income distribution. One, around which Friedman built his model, is related to differences in tastes for risk and hence to choices among alternatives differing in the probability distribution of income they promise. Friedman has shown that such a model is, no less than the others, capable of reproducing the more outstanding features of the aggregative distribution of income. The other, and more familiar, implication of rational choice is the formation of income differences that are required to compensate for various advantages and disadvantages attached to the receipt of the incomes. This principle, so eloquently stated by Adam Smith, has become a "commonplace of economics."[11]

What follows is an attempt to cast one important aspect of this compensation principle into an operational model that provides insights into some features of the aggregative personal income distribution and into a number of decompositions of it which recent empirical research has made accessible. The aspect chosen concerns differences in training among members of the labor force.

II. A SIMPLE MODEL

Assume that all individuals have identical abilities and equal opportunities to enter any occupation. Occupations differ, however, in the amount of training they require. Training takes time, and each additional year of it postpones the individual's earnings for another year, generally reducing the span of his earning life. For convenience, assume that a year of training reduces earning life by exactly one year.[12] If individuals with different amounts of training are to be compensated for the costs of training, the present values of life-earnings must be equalized at the time a choice of occupation is made. If we add a provisional assumption that the flow of income receipts is steady during the working life, it is possible to estimate the extent of compensatory income differences due to differences in the cost of training.[13]

The cost of training depends upon the length of the training period in two ways. First and foremost is the deferral of earnings for the period of training; second is the cost of educational services and equipment, such as tuition and books, but not living expenses.

For simplicity, consider the case in which expenses for educational services are zero. Let

l = length of working life plus length of training, for all persons = length of working life of persons without training,

[10] M. Friedman, "Choice, Chance, and the Personal Distribution of Income," *Journal of Political Economy*, LXI (August, 1953), 277–90.

[11] Thus termed by J. R. Hicks in *The Theory of Wages* (New York: P. Smith Co., 1941), p. 3.

[12] According to a recent study, the average length of working life in eight broad occupational groups is as follows:

Occupation	Mean No. Years in Labor Force
Professional and technical workers	40
Managers and officials	41
Craftsmen and foremen	44
Operatives and kindred workers	45
Clerical and sales workers	47
Non-farm laborers	51
Service workers	52

Similar patterns were observed in 1930, 1940, and 1950. Commenting on the findings, the authors of the study observe: "In general men spend, on the average, fewer years in what may be termed the better jobs. The three occupations with the shortest working life are those in which greater training, education and experience are required. These are also the jobs which in general afford larger earnings. Clearly the men in the better jobs—as measured by earnings and education—spend a shorter period of their lives in the working force" (A. J. Jaffe and R. O. Carleton, *Occupational Mobility in the United States, 1930–1960* [New York: King's Crown Press, 1954], p. 50).

[13] With minor exceptions, the procedure is basically a generalization of the one used by Friedman and Kuznets in *Income from Independent Professional Practice* (New York: National Bureau of Economic Research, 1945), pp. 142–51.

a_n = annual earnings of individuals with n years of training,
V_n = the present value of their life-earnings at start of training,
r = the rate at which future earnings are discounted,
$t = 0, 1, 2, \ldots, l$—time, in years,
d = difference in the amount of training, in years, and
e = base of natural logarithms.

Then

$$V_n = a_n \sum_{t=n+1}^{l} \left(\frac{1}{1+r}\right)^t,$$

when the discounting process is discrete. And, more conveniently, when the process is continuous,

$$V_n = a_n \int_n^l (e^{-rt})\, dt = \frac{a_n}{r}(e^{-rn} - e^{-rl}).$$

Similarly, the present value of life-earnings of individuals with $(n - d)$ years of training is

$$V_{n-d} = \frac{a_{n-d}}{r}(e^{-r(n-d)} - e^{-rl}).$$

The ratio, $k_{n,\ n-d}$, of annual earnings of persons differing by d years of training is found by equating $V_n = V_{n-d}$:

$$k_{n,\ n-d} = \frac{a_n}{a_{n-d}} = \frac{e^{-r(n-d)} - e^{-rl}}{e^{-rn} - e^{-rl}} = \frac{e^{r(l+d-n)} - 1}{e^{r(l-n)} - 1}.$$

It is easily seen that $k_{n,\ n-d}$ is (a) larger than unity, (b) a positive function of r, and (c) a negative function of l. In other words, as would be expected, (a) people with more training command higher annual pay; (b) the difference between earnings of persons differing by d years of training is larger, the higher the rate at which future income is discounted, that is, the greater the sacrifice involved in the act of income postponement; (c) the difference is larger, the shorter the general span of working life, since the costs of training must be recouped over a *relatively* shorter period.

These conclusions are quite obvious. Less obvious is the finding that $k_{n,\ n-d}$ is a positive function of n (d fixed); that is, the relative income differences between, for example, persons with 10 years and 8 years of training are larger than those between individuals with 4 and 2 years of training, respectively. Hence the ratio of annual earnings of persons differing by a fixed amount of schooling (d) is at least as great as

$$k_{d,\ 0} = \frac{e^{rl} - 1}{e^{r(l-d)} - 1},$$

the ratio of earnings of persons with d years of training to those of persons with no training. However, since the change in $k_{n,\ n-d}$ with a change in n is negligible,[14] it can be, for all practical purposes, treated as a constant k.

This result can be summarized in the following statement: Annual earnings corresponding to various levels of training differing by the same amount (d) differ, not by an additive constant, but by a multiplicative factor (k).

This important conclusion remains basically unchanged when, in addition to the cost of income postponement, expenses of training are taken into account. The additional cost element naturally widens the compensatory differences in earnings particularly at the upper educational levels, where such costs are sizable.[15]

[14] Assuming the values of r and l to be in a rather wide neighborhood of 0.04 and 50, respectively.

[15] The percentage increase in relative income differences between persons with (n) and $(n - d)$ years of training resulting from the introduction of schooling expenses can be measured by the ratio of annual schooling expenses to annual earnings in groups with $(n - d)$ years of training.

For example, if average earnings of high-school graduates are \$4,000 and the annual expenses of a college education are \$1,000, then to the compensatory income differences due to the deferral of income for 4 years ($k^4 - 1$) we must add (1,000/4,000) ($k^4 - 1$) to compensate for the cost of tuition. This increases the differences by 25 per cent (see my unpublished Ph.D. dissertation, "A Study of Personal Income Distribution" [Columbia University, 1957], chap. ii, Note 2).

It is, of course, the purpose of the model to make the distribution of annual earnings a sole function of the distribution of training among members of the labor force. It follows from what we have just shown that this function is of a very simple form: given the distribution of training, the multiplicative constant k serves as a "conversion factor" which translates it into a distribution of earnings. In order, therefore, to make statements about the theoretical distribution of earnings, we must first consider the distribution of training within the universe of this model.

Under the most stringent assumptions of identical abilities and equal access to training, the distribution of occupational choice, defined as choice of particular lengths of training, would become a matter of tastes, specifically those concerning the different activities in the different occupations and time preferences. It is not clear what form the distribution of training would assume in this conjectural state of affairs, even with the usual assumption of a symmetric, or normal, distribution of tastes.

Suppose, for the sake of argument, that the resulting distribution of training is symmetric. The point which this model brings home is that, even in that case, the annual distribution of earnings will depart from symmetry in the direction of positive skewness.

As we have seen, the annual earnings corresponding to various levels of training differing by the same length of time differ by a multiplicative factor k. Were this factor constant for all levels of training, a normal distribution of absolute time differences in training would reflect itself in a normal distribution of percentage differences in annual earnings, that is, in the familiar, positively skewed logarithmic-normal income distribution. Strictly speaking, the model implies that the factor k increases somewhat with the level of training, so that even the logarithms of income would be slightly skewed.

Formally, the existence of positive skewness introduced by compensatory income differences due to differences in training can be shown, and its extent can be estimated, in a rather simple way.

Let the quartile deviation in the symmetric distribution of training be d years, and let Y be the first quartile income, Q_1. It follows from the previous argument that the median, Q_2, equals Y times k^d and the third quartile, Q_3, equals Y times k^{2d}.

Hence Bowley's measure of skewness[16] is

$$Sk = \frac{(Q_3 - Q_2) - (Q_2 - Q_1)}{Q_3 - Q_1} = \frac{k^{2d} - 2k^d + 1}{k^{2d} - 1}$$

$$= \frac{(k^d - 1)^2}{k^{2d} - 1} = \frac{k^d - 1}{k^d + 1} > 0 .$$

Since k is greater than 1, Sk must be positive.

If we now relax the assumption of identical abilities, a positive correlation between the amount of training and some ability traits is plausible. Given freedom of choice, persons with greater learning capacity are more likely than others to embark on prolonged training. Insofar as earnings are positively related to such qualities, aggregative skewness is augmented.

But whether or not the distribution of training depends on distributions of abilities,[17] the mere existence of dis-

[16] By the same procedure, a simple measure of relative dispersion is

$$\frac{Q_3 - Q_1}{Q_2} = \frac{k^{2d} - 1}{k^d} = k^d - \frac{1}{k^d} .$$

[17] Differences in abilities introduce additional dispersion into the income distribution. In particular, any degree of positive correlation between ability and differences in training magnifies the extent of "interoccupational" income differences.

persion in the amount of training implies that aggregative skewness is greater than it would be in its absence. In particular, even if it were true that abilities are distributed in a way which, *ceteris paribus*, implies a symmetric distribution of earnings, positive skewness would appear in that distribution as soon as choice of training was admitted into the model. Thus Pigou's paradox would persist even in the absence of the institutional factors that he invoked to explain it.

EXTENSION OF THE MODEL

Primarily for mathematical convenience, I have expressed differences in training in terms of definite time periods spent on formal schooling. However, the process of learning a trade or profession does not end with the completion of school. Experience on the job is often the most essential part of the learning process.

Just as formal training can be measured by the length of time spent at school, the other part of the training process—experience—can be introduced into the theoretical model in terms of the amount of time spent on the job. When this is done, "intra-occupational" patterns of income variation, previously abstracted from, must emerge. By definition, the amount of formal training is the same for each member of an occupation. However, the productive efficiency or quality of performance on the job is a function of formal training plus experience, both measured in time units; hence it is a function of age. We are thus forced to relax another assumption, previously adopted for convenience, namely, that earnings are of the same size in each period of an individual's earning life.

Clearly, as more skill and experience are acquired with passage of time, earnings rise. In later years aging often brings about a deterioration of productive performance and hence a decline in earnings, particularly in jobs where physical effort or motor skill is involved. Thus, in general, the "life-cycle" of earnings exhibits an inverted U-shaped pattern of growth and decline typical of many other growth curves.

We have already seen that differences in formal training result in compensatory differences in *levels* of earnings as between different "occupations," the latter defined in terms of length of formal training. This compensatory principle must, of course, also remain valid when life-paths of earnings are sloped. An important new question arises: What specific assumption is to be made about differences between these slopes in the different occupations, since these in turn imply differences in the *dispersion* of earnings within the occupational groups?

Casual observation suggests that patterns of age-changes in productive performance differ among occupations as well as among individuals. The exploration of such differences is a well-established subject of study in developmental psychology. A survey of broad, rather tentative findings in this field indicates that (*a*) growth in productive performance is more pronounced and prolonged in jobs of higher levels of skill and complexity; (*b*) growth is less pronounced and decline sets in earlier in manual work than in other pursuits; and (*c*) the more capable and the more educated individuals tend to grow faster and longer than others in the performance of the same task.[18]

These findings suggest that experience influences productivity more strongly in jobs that normally require more training. The steeper growth of performance throughout the span of working life in occupations with higher levels of train-

[18] See Mincer, *op. cit.*, chap. ii, Note 1.

ing implies that the growth of earnings is also greater.

These considerations point to the replacement of the previous assumption of horizontal life-paths of earnings with the assumption that the slopes of time-paths of earnings vary directly with the amount of formal training, that is, with "occupational rank."

IMPLICATIONS

In brief, we are led to the following conclusion: Differences in training result in differences in levels of earnings among "occupations" as well as in differences in slopes of life-paths of earnings among occupations. The differences are systematic: the higher the "occupational rank," the higher the level of earnings and the steeper the life-path of earnings.

Two implications of basic importance for empirical investigation follow immediately from these findings.

1. Since, under our assumptions, intra-occupational differentials are a function of age only, the statement that life-paths of earnings are steeper for the more highly trained groups of workers means that income differences between any two members of such a group differing in age are greater than income differences between their contemporaries in an occupational group requiring less training.

In itself, this conclusion does not necessarily imply a systematic difference in income dispersion within the two groups. It points to age distributions within the respective groups as another factor that must be considered. Clearly, if one group consists of members with very similar ages and in another there is a wide range of ages, there may be less income dispersion in the first group, even though its life-path of earnings may be steeper than that of the second group.

Observe, however, that such a phenomenon is in part ruled out by our previous assumptions. Membership in an occupational group was defined by the number of years of the individual's formal training, which is determined once for all by the calculus of occupational choice (the equalization of present values) *before* entry into the labor force. In other words, if we define "vertical occupational mobility" as the movement from a group with, say, $n - d$ years of training to a group with n years of training, this is, by definition, impossible after the training period is over. If, in addition, secular occupational shifts are abstracted from, occupational distribution must be alike in all age groups after all training periods are over; a fortiori, age distributions must be alike in all occupational groups.[19] With this qualification, the direct translation of slopes of life-paths of earnings into patterns of income dispersion is achieved: dispersion must increase with "occupational rank."

2. Now consider income recipients classified into separate age groups. In our model, income differences within each age group are due to differences in the occupational characteristics of its

[19] Actually, the assumptions need not be so rigid, as a certain amount of dissimilarity in age distributions will not affect the systematic effects of differences in the steepness of life-paths on intra-group dispersion. Indeed, 1950 Census data indicate that the dissimilarity is rather small among broad occupational groups when comparisons are restricted to the ages between 25 and 65:

PERCENTAGE DISTRIBUTION OF AGES BY OCCUPATION, U.S. MALE WAGE AND SALARY EARNERS, 1950*

Occupation	Age Groups 25–35	35–45	45–55	55–65	Total
Professional and managerial	30.6	31.1	23.8	14.5	100.0
Clerical and sales	35.8	28.0	21.8	14.4	100.0
Craftsmen and foremen	29.9	30.0	24.1	16.0	100.0
Operatives and service	33.8	29.8	21.6	14.8	100.0
Non-farm laborers	32.4	28.2	22.7	16.7	100.0

* Source: *Occupational Characteristics* (Census Special Rept. P-E, No. 1B), Table 5, pp. 53–59.

members. The income differences corresponding to those occupational categories, however, increase with age. Life-patterns of earnings are not parallel; their divergence becomes more pronounced with added years of experience, so that income dispersion increases as we move from younger to older age groups.

For convenience, divide the labor force into two broad groups of "occupations," those requiring very little training, characterized by a practically flat life-pattern of earnings (*ABU* in Fig. 1), and those requiring a considerable amount of training, with a pronounced positive slope of life path (*CBT* in Fig. 1). First, we may

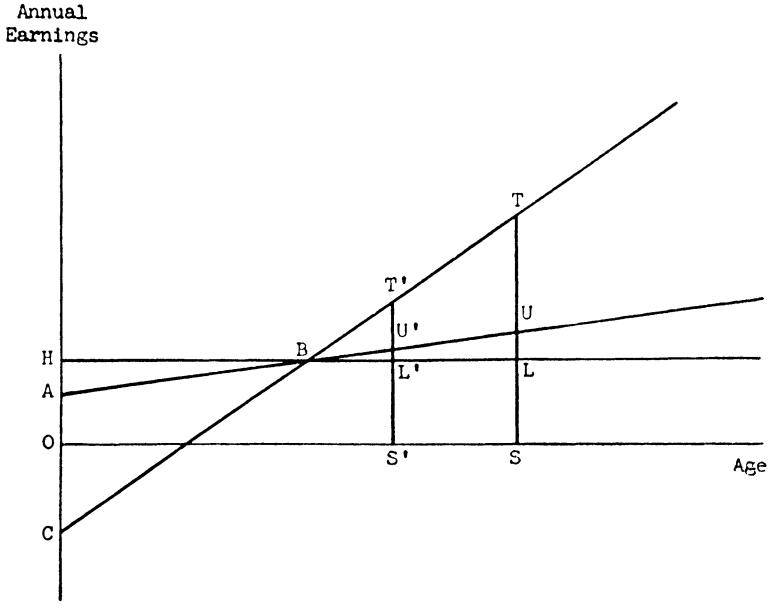


FIG. 1.—Hypothetical life-paths of earnings in occupations differing in the amount of training they require.

Both statements can be made stronger by specifying that they apply not only to absolute but also to relative dispersion. The former follows directly from the model. If we now include in the assumption about the slopes of life-paths of earnings in various "occupations" the observation that these slopes are negligible or even negative in occupations requiring little or no formal training, as in many manual jobs, then the two propositions must also apply to relative dispersion.

The argument underlying these propositions can be presented quite simply with the help of a geometric illustration. note that absolute differences in earnings are small within untrained groups (life-path *ABU*), but they become pronounced in groups with higher levels of training (*CBT*). These differences (absolute dispersion) may be measured by the slopes of the paths or by the segments *UL* and *TL*, respectively. Income levels are represented by the heights *US* and *TS*, respectively. Clearly $UL/US < TL/TS$. That is, relative dispersion increases with "occupational rank." Second, the ratio *TS/US* increases with age: $TS/US > T'S'/U'S'$. That is, percentage differences and hence the relative dispersion of earnings increase as we move

from a younger to an older "occupation-mix."

We may now return to the aggregative income distribution and explore the implications for the total of the hypothesis about patterns of income in component groups.

First, it is obvious that the addition of "intra-occupational" differences to the "interoccupational" differences increases aggregate inequality. Moreover, "inter-occupational" differences themselves must increase: The present value of a life-flow of income of given size is smaller, the steeper the positive slope of the age-income relation. Hence the equalization of present values requires larger "inter-occupational" differences in income than those derived on the assumption of horizontal income flows in all "occupations."

Finally, it can be shown that the conclusions about "intra-occupational" patterns of income dispersion reinforce the implication of aggregative positive skewness reached on the basis of "interoccupational" differences alone (in the simple model). This finding provides an answer to an important question frequently raised in discussions of personal income distribution.

Before invoking the distribution of property as a decisive explanation of positive income skewness, Pigou considered the possibility that positive skewness of the income distribution may arise from merging of a number of homogeneous, non-skewed subgroups into a non-homogeneous, positively skewed total.[20] Recently, H. P. Miller has offered evidence to suggest that "the skewness of income distributions is largely due to merging several symmetrical distributions which differ primarily with respect to level and dispersion."[21] He found that there is considerably more symmetry in component income distributions than in the aggregate. For example, the distributions for sets of the three broad occupational groups of employed males, "blue-collar workers," "white-collar workers," and professionals, managers, and proprietors, had less skewness when considered separately than in the aggregate.

Pigou's hunch about the anatomy of personal income distributions, even when confirmed by Miller's empirical investigations, however, cannot explain the phenomenon of aggregative positive skewness. It leaves unanswered the basic question why a merger of relatively symmetric distributions should result in a positively skewed aggregate. Clearly, without further specifications, a merger of component symmetric distributions could very well produce a negatively skewed or a symmetric aggregate.[22]

My model provides specifications which insure that a merger produces positive skewness in the aggregate. The aggregative skewness was already implied by the simple model. In that form, however, income dispersion within occupations was implicitly assumed to be zero. But if its existence is admitted, patterns of "intra-occupational" dispersion might easily affect the aggregative, positive skewness previously derived. This would be the case, for example, if dispersion within less trained groups were systematically and considerably greater than that within more highly trained groups. Geometrically, this would mean shortening the right tail of the aggrega-

[20] Pigou, *op. cit.*, p. 246. Other writers have followed Pigou along these lines.

[21] H. P. Miller, "Elements of Symmetry in the Skewed Income Curve," *Journal of the American Statistical Association* (March, 1955), pp. 55–71.

[22] For a formal statement and discussion of the necessary and sufficient conditions for positive skewness see Mincer, *op. cit.*, chap. ii, Note 4.

tive income distribution and extending the left tail—a change in the direction of negative skewness. However, this contingency is ruled out by my findings about component groups. In fact, I have derived patterns of "intra-occupational" dispersion that are exactly the opposite of those given in the preceding extreme example. This positive relation between income levels and income dispersion in component groups reinforces the effect of intergroup ("interoccupational") skewness to produce an even greater positive skewness in the aggregate.

THEORETICAL CONCEPTS AND THEIR EMPIRICAL COUNTERPARTS

Ultimately, it is the degree of conformity of empirical observations with the conclusions suggested by the model that establishes its usefulness. We must note, however, that properties of the income structure specified by the model do not in themselves constitute a "prediction" about the empirical income distribution. The validity of such an interpretation depends on the way in which theoretical concepts like training, income, and life-paths of income are translated into empirically identifiable, measurable counterparts.

The translation is necessarily imperfect, in the sense that an exact empirical representation of theoretical concepts is seldom possible, available, or even desirable. For example, the relevant income differences in a given annual income distribution are those among individuals differing in age and not those due to the aging of the same individuals. While the theoretical concepts of training and compensation thus involve a longitudinal view of individual income, they must be brought to bear on cross-sectional data.

The discrepancy between the dynamic concept and the cross-sectional measure is, however, not so serious as it would seem. Abstraction from secular trends in income imparts a downward bias to the slopes of life-paths of income. On the other hand, cyclical and seasonal forces impinging on the economy are largely eliminated by the cross-sectional "life-path." In this respect, it fits the theoretical construct in which these disturbances are removed by assumption. Moreover, the relevant income expectations are likely to be shaped by the contemporary cross-sectional picture.

Another translation problem that bears directly on the selection of data is presented by the concept of training. It will be recalled that I have subdivided this concept into "formal training," defined by the time spent primarily in preparation for the job, and informal training or experience on the job. Given the former, the latter is conveniently measured by age. The identification of experience with age should not create much difficulty, since the existence of central tendencies is to be expected in the timing of both training and entry into the labor force.

More difficulty arises in measuring "formal training." Years of school completed as reported by the census do not, unfortunately, include time spent in vocational, trade, and business schools, not to speak of apprenticeships and various forms of on-the-job training programs.[23] Moreover, the schooling classification is of limited usefulness, since it is rarely cross-classified with other relevant characteristics of the population.

A meaningful, though not easily quantifiable, indicator of "formal training" is occupational status. We can think of the set of occupations among

[23] *U.S. Census of Population 1950*, Vol. II: *Characteristics of the Population*, Part I: *U.S. Summary*, Introduction, pp. 44–46.

which the labor force is divided as constituting a hierarchy ranging from occupations requiring little training up to highly specialized occupations whose practice presupposes a great deal of investment in human capital. If we can order occupational groups in such a "vertical" way, we can use their ranks as indexes of the amount of formal training.

Despite the shortcomings of the educational classification and the difficulties in occupational ranking, I have used both education and occupation to measure the amount of formal training.

For defining units of income and income recipients, it is clear that earnings rather than total incomes and persons rather than families correspond to the theoretical concepts. It is also desirable to restrict the income recipients to persons between the ages of twenty-five and sixty-five years, so as to include all training groups after most have entered the labor force and before a sizable number have retired. Furthermore, in order to avoid variations in income introduced by variation in man-hours or weeks of work during the year—a factor about which the model is silent—either earnings of full-year workers or hourly rates should be studied.

Unfortunately, data fulfilling all these requirements are practically non-existent. I was forced, therefore, to use data with varying definitions of income and income recipient. The extent to which the measures deviate from the requirements must be kept in mind as possible sources of discrepancy between theory and fact.

LIFE-PATHS OF INCOME

Available data on the variation of earnings and incomes by age within broad population groups classified by educational and occupational status indicate rather clearly that earnings are not only higher but also increase more rapidly with age (or decline more slowly after the peak of earnings is reached) in the more highly trained groups than in the less trained ones. A statistical study of the 1939 and 1949 income data provided by the decennial censuses of population reveals that the income differential between young men and those who have reached the age of peak income is much greater for college graduates than for men with less schooling.[24] According to the same study, similar differentials are found when racial groups or sex groups are viewed separately. They exist in incomes from all sources as well as in wage and salary earnings. The same differentials persist in incomes of spending units classified by the schooling of the head.[25]

When occupation, rather than education, is used as a classificatory principle, the occupational groups must be ranked with respect to the amount of training they presuppose. With broad occupational groups, the vertical ordering from unskilled to highly skilled groups as shown in census tabulations is reasonably appropriate for our purposes. By and large, skill is an end-product of training, and the occupational ranks roughly follow the levels of education and of earnings in the groups.

The positive association between occupational rank, level of earnings, and the amount of age change in earnings stands out very clearly in figures of earnings of employed males in the United States.[26] Similar differences in occupational life-paths of income can be found

[24] H. P. Miller, *Income of the American People* (New York: John Wiley & Sons, 1955), pp. 65–68.

[25] *Federal Reserve Bulletin*, XLI (June, 1955), 615, Supplementary Table 3.

[26] Miller, *op. cit.*, Table 24, p. 54.

in a number of other sets of empirical data.[27]

AGGREGATIVE SKEWNESS

Ability to explain the existence of aggregate skewness is a preliminary test that any theory of personal income distribution must meet. The usefulness of my approach does not end with meeting this test, which can be and has been met in so many other ways. Its main merit lies in the guidance it provides for interpreting disaggregations of income distributions. Even on the aggregate level, however, the model not only indicates the existence of positive skewness but enables us to gain a rough impression of the quantitative importance of the set of factors on which we have focused.

An estimate of the extent of aggregative skewness and dispersion which is ascribable to differences in training and experience was obtained in the following fashion.

Hypothetical coefficients of relative dispersion and skewness were calculated that would obtain if differences in earnings were exclusively of a compensatory nature.[28] These are shown in row *a* of Table 2 under the assumption of a uni-

[27] See H. F. Lydall, "The Life Cycle in Income, Saving, and Asset Ownership," *Econometrica*, April, 1955, pp. 131–50; *BLS Bulletin 643*, p. 55; M. Leven, *The Income Structure of the U.S.* (New York: Brookings Institution, 1938), pp. 50–156; Friedman and Kuznets, *op. cit.*, p. 247; and *Survey of Current Business*, April, 1944, Table 4, p. 19, and July, 1951, Table 8, p. 15.

[28] See formulae on p. 286.

TABLE 1*

WAGE AND SALARY INCOME OF MALE WORKERS IN THE EXPERIENCED CIVILIAN LABOR FORCE WHO WORKED 50–52 WEEKS IN 1949

Income brackets ($000's)	0–0.5	0.5–1	1–1.5	1.5–2	2–2.5	2.5–3	3–3.5	3.5–4	4–4.5	4.5–5	5–6	6–7	7–10	10 or more
Per cent distribution	1.8	2.7	4.8	7.7	14.0	15.0	18.0	11.9	8.2	4.5	5.6	2.3	2.0	1.4

* Source: *Occupational Characteristics* (Census Special Rept. P–E No. 1B), Table 23, p. 245.

TABLE 2

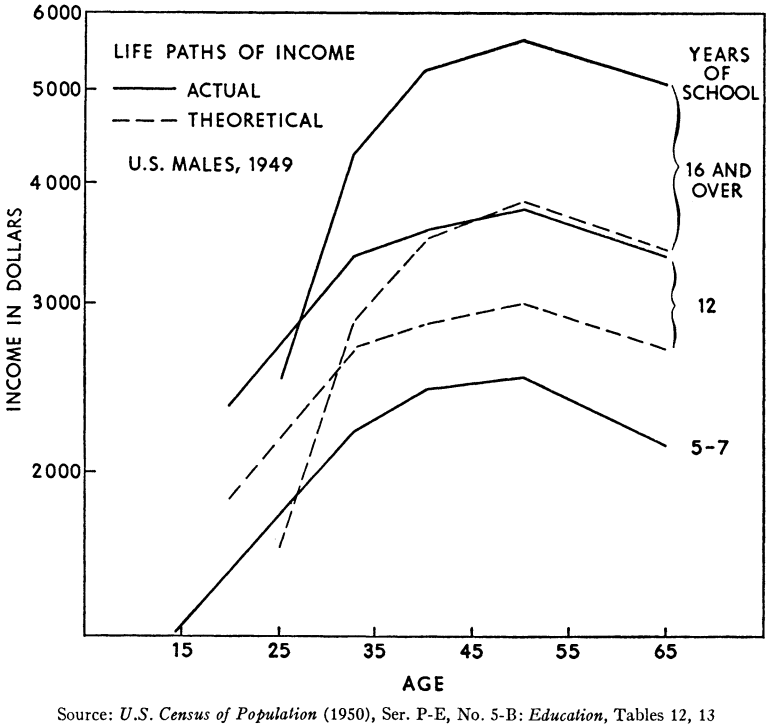
ACTUAL AND THEORETICAL COEFFICIENTS OF DISPERSION AND SKEWNESS

		ALL WORKERS (1)	"FULL TIME" WORKERS (2)	(3)
Coefficient of dispersion $\frac{Q_{95} - Q_5}{Q_{50}}$	Theoretical* (*a*)	0.43	0.43	0.43
	Theoretical* (*b*)	0.48	0.48	0.48
	Actual†	1.68	1.45	1.36
Coefficient of skewness $\frac{(Q_{95} - Q_{50}) - (Q_{50} - Q_5)}{Q_{95} - Q_5}$	Theoretical* (*a*)	0.11	0.11	0.11
	Theoretical* (*b*)	0.22	0.22	0.22
	Actual†	0.24	0.39	0.39

* The measures of dispersion and skewness are based on differences between the 5th and 95th percentiles in the distribution of training. These measures are more sensitive and of greater interest in our context than the standard ones based on quartiles. Differences between the 5th and 95th percentiles in the educational distribution of the male U.S. population amounted to 14–16 years of schooling, according to the 1950 Census (Vol. II, Part I: *U.S. Summary*, Table 115, p. 236). A more appropriate estimate is that of 11 years obtained from occupational data (see n. 12 above) as the difference between the length of working life of professional and technical groups and the least-trained laborers, which is interpreted as the number of years of income postponement. These occupational groups are approximately coextensive with the lowest and highest deciles of the occupational distribution; hence the 5th and 95th percentiles used in my measures correspond to their median positions. Since the highest schooling classification in the census data is 16 years or more, the lowest for our purposes is 5–7 years, and the middle figure is 12. Income figures by age for these three training levels were shown in Fig. 2. The discount rate was conservatively put at 4 per cent and the length of working life of unskilled workers at 51 years (cf. n. 12).

† Actual measures are computed from the distribution in Table 1. Unfortunately, that distribution includes males who worked part-time (though during the full period). This factor tends to impart a downward bias to "actual" skewness. A rough correction for this bias is achieved by eliminating all earnings below $1,500 (col. 2) and below $2,000 (col. 3), even though this may result in an upward bias.

form flow of earnings during the working life, in row *b* under the assumption that the shapes of the 1949 cross-sectional life-paths (as shown in Fig. 2) constitute the expectation which is discounted.[29] These theoretical coefficients were then compared with corresponding coefficients calculated from the actual distribution of earnings of fully employed workers in 1949 (Table 1). From the comparison in Table 2 it appears that when age variation of earnings is abstracted from (row *a*), the training factor "explains" about a third of the existing dispersion and skewness; when age variation is introduced (row *b*), the theoretical dispersion is increased only slightly, but the extent of skewness "accounted for" by the theory is increased considerably.



Source: *U.S. Census of Population* (1950), Ser. P-E, No. 5-B: *Education*, Tables 12, 13

Fig. 2.—Actual and theoretical life-paths of income, U.S. males, 1949

[29] The dashed lines in Fig. 2 were obtained by shifting the upper two solid lines downward to the level at which all present values are equalized (at age fourteen). For purposes of discounting, the lowest income path was extrapolated back to age fourteen, the middle one to age nineteen. The use of income rather than earnings figures may bias the slopes upward; abstraction from similar trends in education and earnings may impart a counteracting bias. The procedure is clearly to be viewed as groping for some orders of magnitude rather than as estimating in any more rigorous sense of the word.

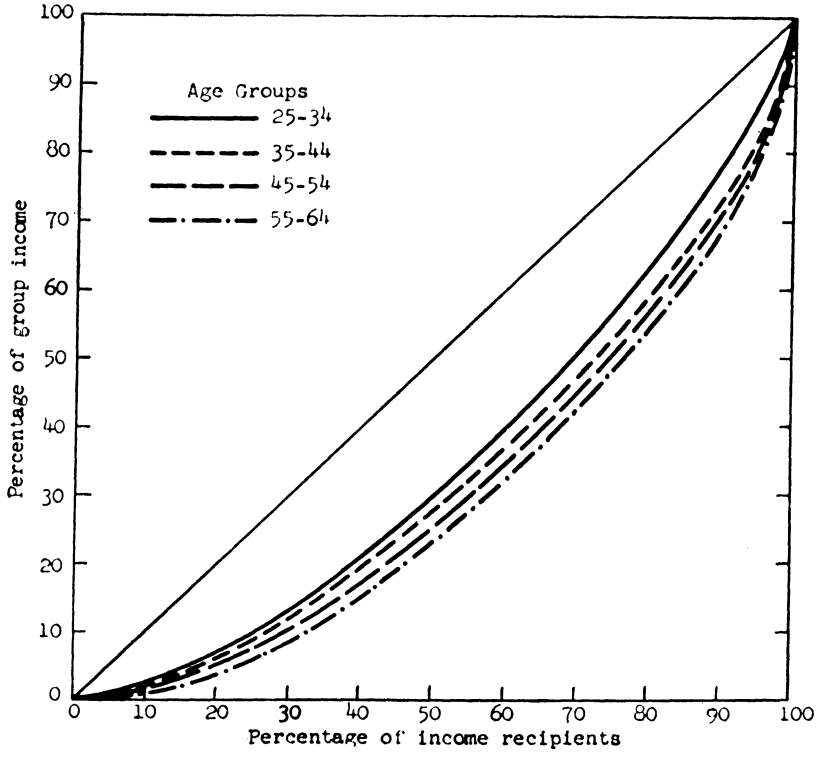
AGE AND INCOME DISPERSION

A striking demonstration of the increase in income dispersion with age when the aggregate of spending units is partitioned into age groups is provided in a recent study based on 1948 data compiled by the Federal Reserve Board's annual Survey of Consumer Finances. The systematic positive relation between age and family income inequality is reflected in a consistent and pronounced drift of Lorenz curves away from the line

of equality with increase in age.[30] According to the author, "this relation between the degree of income concentration and age is one of the most interesting and perhaps important findings of the study." That this relation between income inequality is just as pronounced in

EDUCATION AND INCOME DISPERSION

When income recipients are classified by educational background, that is, by years of schooling as defined in the census, the expected increase in income dispersion with level of training appears as shown in Figure 4.[32]



Source: U.S. Census Bureau, *Current Population Reports, Consumer Income*, Ser. P-60, No. 16, Table 3, p. 13

FIG. 3.—Lorenz curves of 1953 income of males, by age, United States

incomes of persons as in those of families is seen in Figure 3. The same phenomenon appears in a variety of data differing in time, place, and definition of income or recipient unit.[31]

OCCUPATION AND INCOME DISPERSION

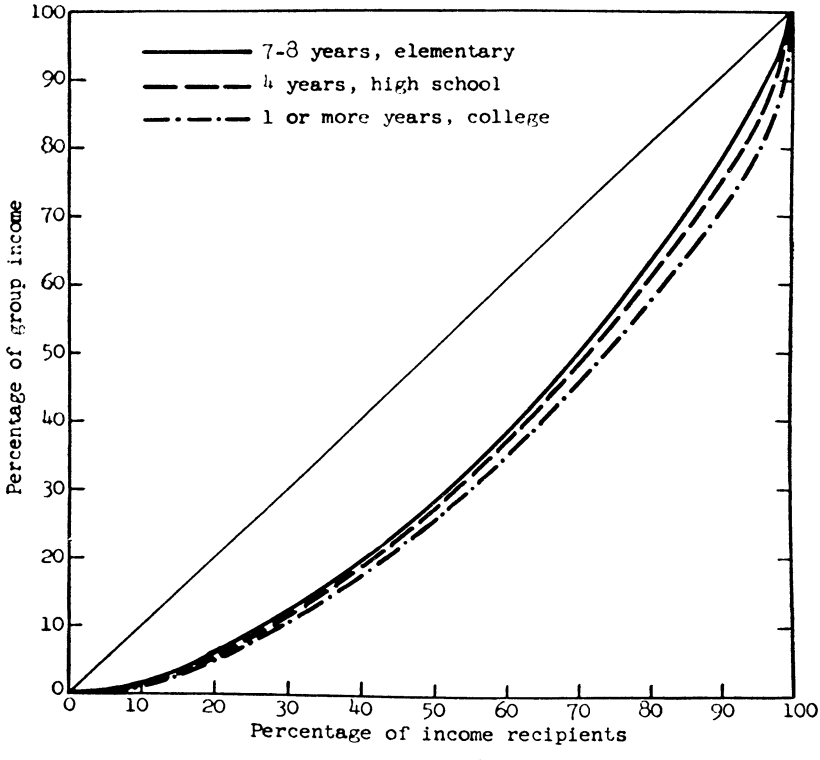
Let us now turn to an occupational classification of income recipients. Figure 5 presents Lorenz curves of earnings of male workers in several broad occupa-

[30] J. Fisher, "Income, Spending, and Saving Patterns of Consumer Units in Different Age Groups," *Studies in Income and Wealth*, XV (New York: National Bureau of Economic Research, 1952), 83.

[31] See Mincer, *op. cit.*, pp. 79–81.

[32] The same mean ($12,000) was assigned to the upper, open-ended class in the three distributions. Consequently, inequality of groups with greater education is underestimated relative to the others. For additional empirical instances of the relation between education and income inequality see Mincer, *op. cit.*, pp. 81–85.

tional groups in the United States in 1953.[33] These conform to theoretical expectations insofar as income inequality within professional and managerial groups is greater than within clerical and skilled manual workers. Unskilled workers, however, show a greater inequality than the other groups, particularly at the lower ranges of the distribution. This partial discrepancy between theory and fact appears in most data that include all workers regardless of the length of their employment during the year. I have shown elsewhere[34] that the variation in man-hours introduced by the inclusion of part-period and part-time workers is bound to create an "excess" income dispersion (relative to the theory) at the lower levels of the occupational and educational classifications. The more effective the exclusion of part-year incomes from the annual distributions of the groups under study, the more closely do the results conform to theoretical predictions.



Source: U.S. Census, *Current Population Reports*, Ser. P-60, No. 3, Table 13, p. 22

FIG. 4.—Education and income inequality, United States, 1946 (urban males, 25–65 years old)

Some doubts about the meaningfulness of the findings for occupational groups presented in Figure 5 are raised by the heterogeneity of these broad occupational groups. In each such group income dispersion might be largely a product of concealed interoccupational income differences among more detailed and homogeneous occupations included

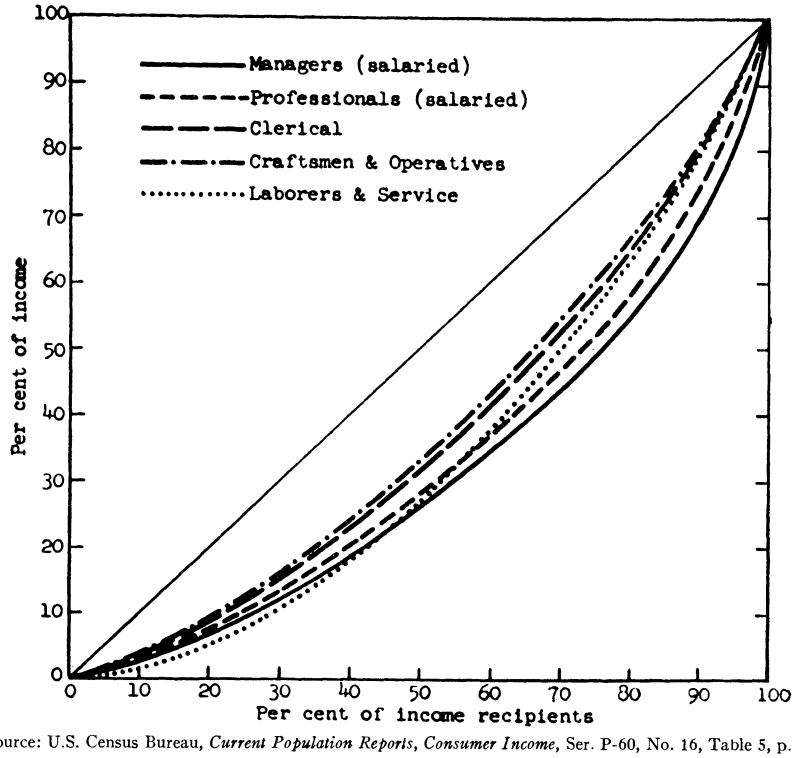
[33] For comparable information about intra-occupational income dispersion for various dates, places, and definitions see *ibid.*, Table III—8, p. 87.

[34] *Ibid.*, pp. 66–70, and *passim*.

in the broad classification. The problem may be rephrased in the following terms: Does the hypothesized relation between occupational rank and intra-occupational dispersion, which seems to exist in broad occupational groups, also hold true for more detailed occupations?

they separate wage and salary incomes of full-period[36] workers from those of all workers.

Using income shares of top quintiles of workers in each detailed occupation as a measure of intra-group inequality, we can examine the existence of a rela-



Source: U.S. Census Bureau, *Current Population Reports, Consumer Income*, Ser. P-60, No. 16, Table 5, p. 16

FIG. 5.—Wage and salary incomes of employed males, non-farm, United States, 1953 (14 years of age and over).

An attempt to answer such a question involves breaking down the broad occupational groups into more detailed component occupations and studying their income distributions. Fortunately, a recent census monograph breaks down the large groups into 118 more detailed occupations and gives income distributions and measures of income dispersion for each of the component groups.[35] The data are suitable for our purposes, since

tion between such inequality and the occupational rank of the groups. One way of doing this is to inquire whether most detailed occupations in the "top" broad groups (professional, managerial) tend to have larger quintile shares than occupations in the intermediate groups, and so on. Table 3 indicates a positive answer in terms of median shares and mid-ranges of shares for component occupations within the broad groups. Thus

[35] Miller, *op. cit.*, Table C-5, pp. 193–96.

[36] Persons working 50 weeks or more in 1949.

when the shares of top quintiles are arrayed in order of increasing size for the 28 subgroups of "craftsmen and foremen," the median quintile share is 30.2, and the 14 central subgroups have quintile shares running from 28.0 to 31.4 per cent of the aggregate income of the subgroup. As is seen, the medians follow the occupational rank. However, the wide mid-range for clerical workers deprives the median of that group of much significance, since it indicates an absence of central tendency.

ences in levels of earnings in the hierarchy of occupations are due to differences in training required by them. Thus, within the framework of the model, the statement that the amount of intra-occupational dispersion is positively related to occupational rank can be replaced by an equivalent one, namely, that dispersion is positively related to levels of earnings in the occupational groups.

Thus we could, in effect, use average earnings of groups as indicators of their

TABLE 3*

INCOME INEQUALITY IN DETAILED OCCUPATIONS AND OCCUPATIONAL STATUS, U.S., 1949
(Male Full-Year Wage and Salary Workers)†

Group	Professional and Managerial	Clerical and Sales	Craftsmen	Operatives	Laborers and Service
Median quintile share	38.2	35.6	30.2	29.6	28.7
Midrange of quintile shares.....	35.8–44.2	26.3–42.8	29.1–32.7	28.0–31.4	28.0–30.9

* Source: Miller, *op. cit.*, Table C-5, pp. 193–96.

† Weeks worked, as defined in the 1950 Population Census includes all weeks in 1949 during which any work was performed. Persons who did any amount of work during each of 50 weeks in 1949 were counted as full-year workers. The variation in man-hours due to the sizable proportion of part-time workers in many occupations obscures the relation we are studying. No direct information is available on the extent of part-time work in the detailed occupations. Frequency distributions of earnings provided in Miller, *op. cit.*, Table C-2, pp. 179–81, were used to exclude 12 occupations in which more than 10 per cent of workers earned less than $1,000, working 50 weeks or more in 1949. Such low earnings in groups of male, non-farm, full-period workers can only be a reflection of part-time work or of income received to a large extent in a non-monetary form. The excluded occupations are: clergymen; musicians and music teachers; messengers; newsboys; attendants; private household workers; charmen; janitors and porters; service workers (n.e.c.); fishermen and oystermen; lumbermen, raftsmen, and woodchoppers; laborers in wood production; and laborers in wholesale and retail trade.

An alternative approach to the study of the relation between occupational rank and income inequality in detailed occupational groups is to rank these groups independently instead of fitting them into the broad ranks, as in Table 3. However, with over a hundred occupations, ranking by the amount of training or skill is a formidable task. Direct information about the ranking criterion is not available in any quantitative form, and, with so many groups, "common sense" will not lead different investigators to the same results.

One "objective," though indirect, ranking procedure is implicit in the theoretical model. In the model, differ-

occupational rank and correlate those with the shares of top quintiles in the respective occupations. In reality, of course, the simplifying assumption that levels of earnings reflect occupational rank (training) *exclusively* is untenable. Many other factors, compensatory or not, influence these levels, especially in the short run, and more so when small differences in levels are distinguished. Yet, despite the impossibility of identifying and eliminating all such disturbing factors from the data, when this procedure was followed, a positive correlation coefficient of $r = +0.77$ was obtained.[37] "Occupational rank," in our

[37] After excluding the twelve occupations listed in the note to Table 3.

sense, is a factor that cannot be dismissed in studies of income inequality within component population groups.

MIXED COMPONENT GROUPS

When the aggregate income distribution is broken down by any criterion other than occupation or age, it yields component groups which generally differ in occupational composition and age distribution. When such differences in composition are pronounced, the findings that the more highly trained workers are characterized by both higher income levels and greater income inequality can be utilized to predict the rank order of income inequalities of the component groups.

Let each component group consist of several occupational strata. It can be shown that inequality in a component group is a "weighted" sum of the inequalities within strata, with "weights" reflecting the relative sizes and relative income levels of the strata.[38] Therefore, the larger the proportion[39] of "top" occupational strata, such as professionals and managers, in a group, the larger the income dispersion in the group. Geometrically speaking, a greater weight attached to upper occupational groups extends the right-hand tail of the income distribution of the occupation-mix.

DISTRIBUTIONS BY INDUSTRY

When the distribution of wages and salaries is disaggregated by industrial origin, the component distributions of earnings must, to some extent, reflect differences in the occupational compositions of the various industries. Such differences exist, no matter what boundaries are imposed on the concept of industry.

From the point of view of organization of the production process, an industry is a particular combination of factors of production. When labor is subdivided by occupations differing in training and skill, it can be viewed as a set of distinct factors of production differing in the extent of capital accumulated in them. As with non-human capital, some industries have high "capital ratios," other low ones, the state of the arts in each industry being what it is. Given full utilization of labor (that is, abstracting from variations due to part-period earnings), we should expect a greater dispersion of earnings in industries with relatively many professional and managerial workers than in those with relatively few.

That the occupational composition, or what may be called the average level of human capital, is an important factor in determining the extent of intra-industry income dispersion is evident on several levels of aggregation:

Table 4 presents data on income inequality and the occupational composition within ten major industrial groups. The occupational composition is that of 1950 as reported in the census. The inequality measure, the income share of the top quintile of workers, refers to wages and salaries in 1949 and total money incomes in 1953 and 1954. In all three years inequality is positively associated with the proportion of highly trained occupations (professional, technical, and managerial): the coefficient of rank correlation is +0.85 in 1949, +0.93 in 1953, and +0.80 in 1954.

At a more detailed level of aggregation,[40] the role played by occupational

[38] For a mathematical formulation see Mincer, *op. cit.*, chap. iv, Notes 1–3.

[39] Up to a point, depending on the number and sizes of parameters distinguished in the group (see *ibid.*).

[40] Miller's study quoted in Table 4 contains further breakdowns of the census wage and salary statistics into 91 intermediate industry groups. These are subdivided into 117 more detailed industries. The study provides frequency distributions of 1949 wages and salaries as well as corresponding

composition in creating patterns of intra-industry wage and salary differentials, while obscured by many other factors, is still unmistakable. When the occupational factor represented by the proportion of professional and managerial workers[41] in seventy-five census intermediate industry groups[42] in 1949 is correlated with income shares of top quintiles of workers in those industries in that year, the correlation coefficient is +0.72.

COLOR, SEX, FAMILY STATUS, AND CITY SIZE[43]

When members of the labor force are classified by color, sex, family status, or city size, the resulting groups exhibit pronounced differences in occupational and age characteristics. As before, differences in the training-mix produce predictable patterns of income inequality. Roughly speaking, the greater the average amount of training in the group, the greater the inequality in its income distribution.

Thus earnings of full-year employed non-white workers show less inequality than those of similar white workers; earnings of female workers are less dispersed than earnings of male workers, when part-period earnings are excluded; earnings of male full-period workers who are heads of families are more unequal than those of single men; and, finally, in-

TABLE 4*

OCCUPATIONAL COMPOSITION AND INCOME INEQUALITY IN INDUSTRIES U.S. MALE WORKERS, TEN BROAD INDUSTRY GROUPS, 1949, 1953, 1954

Industry	Proportion of "Top" Occupations	Share of Top Quintile 1949	1953	1954
	(1)	(2)	(3)	(4)
Mining	6.7	36.5	34.4	38.7
Construction	7.7	39.1	39.3	41.4
Manufacturing	10.0	38.0	37.4	38.1
Transportation	9.0	34.4	34.8	37.2
Wholesale trade	17.5	43.1	46.8	44.8
Retail trade	15.6	41.6	43.5	46.3
Finance and Insurance	25.9	45.4	47.0	48.0
Entertainment and recreation	40.2	52.6	59.5	n.a.
Business service	12.8	41.8	44.6	45.3
Professional service	60.0	42.8	47.7	50.8

* Sources: Col. 1: *Occupational Characteristics* (Census Special Rept. P-E, No. 1B), Table 134, p. 290. Col. 2: H. P. Miller, "Changes in the Industrial Distribution of Wages in the U.S., 1939–1949," *Conference on Research in Income and Wealth* (National Bureau of Economic Research, 1956), Appendix Table B-3. Col. 3: *Census Current Population Reports*, P-60, No. 16, Table 6, p. 18. Col. 4: *Census Current Population Reports*, P-60, No. 19, Table 6, p. 18.

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means, medians, quartiles, and income shares of quintiles for each industry. The recipient units are males, fourteen years of age and over, including part-period and part-time workers (Miller, *op. cit.*, Appendix Tables B-1 and B-3).

[41] Proportions were computed from *Occupational Characteristics* (Census Special Rept. P-E, No. 1B), Table 134, p. 290.

[42] These contained over 90 per cent of all male wage and salary workers. The exclusion of sixteen industries from the correlation is the result of a crude, but conservative, attempt to eliminate part-period workers from the distributions: industries with over 20 per cent of workers receiving less than $1,000 during the year were excluded as being too strongly affected by the part-period income variable. These were agriculture, forestry, fisheries, lumber and wood, printing and publishing, food-stores, five and ten cent stores, gasoline service stations, drugstores, eating and drinking places, retail florists, private households, hotels and lodgings, dress and shoe repair, theaters and motion pictures, and miscellaneous entertainment.

[43] For statistical details and sources see Mincer, *op. cit.*, pp. 109–27.

come inequality increases with city size.[44]

III. SUMMARY

The implications for income distributions of individual differences in investment in human capital have been derived in a theoretical model in which the process of investment is subject to free choice. The choice refers to training differing primarily in the length of time it requires. Since the time spent in training constitutes a postponement of earnings to a later age, the assumption of rational choice means an equalization of present values of life-earnings at the time the choice is made. As Adam Smith observed, this equalization implies higher annual pay in occupations that require more training.

Interoccupational differentials are therefore a function of differences in training. According to the model, this function is of a very simple form and can be summarized in the principle that absolute differences in the length of training result in percentage differences in annual earnings. It follows that, as long as the distribution of training is not substantially negatively skewed, the distribution of earnings must be positively skewed.

Intra-occupational differences arise when the concept of investment in human capital is extended to include experience on the job. Age measures both the process of acquiring experience and biological growth and decline. The growth of experience and hence of productivity is reflected in increasing earnings with age, up to a point when biological decline begins to affect productivity adversely. The important difference among occupational groups is that, on the whole, increases in productivity with age are more pronounced, and declines are less pronounced, in jobs requiring greater amounts of training.

When the positive relation between investment in human capital and the growth of productivity is incorporated in the model, the following results are produced: First, interoccupational differences increase, because the present value of a life-flow of income of given size is smaller, the steeper the positive slope and the later the peak of the age-income curve. Second, because of the increasing age gradient, intra-occupational dispersion must increase with "occupational rank." In other words, "vertical" occupational groupings exhibit a positive correlation between income levels and income dispersion. This correlation, even when restricted to absolute dispersion, once more introduces positive skewness in the aggregative distribution. Thus the skewness is due to patterns of interoccupational as well as intra-occupational income differences. Moreover, the increasing divergence with age of life-paths of earnings among different occupations implies that inequality of income within age groups increases with age. Finally, any decomposition of the aggregate by criteria other than age, education, and occupation produces groups which constitute training and age "mixes." The previous conclusions imply that income dispersion in such groups must be positively related to the average amount of investment in human capital in them. Breakdowns by industry, color, sex, and city size were analyzed in these terms. As we have seen,

[44] The same explanation holds for the systematic increase in income levels with city size, which is a more familiar phenomenon. The increase in income level with city size is more apparent in the statistics that do not separate full-period from part-period workers. The greater proportion of part-period workers in smaller communities accentuates the differences in income levels, while it obscures the differences in income variances.

the empirical evidence is clearly consistent with all the implications of the model about the effects of education, occupation, and age on patterns of personal income distribution.

It is useful, in conclusion, to point out some limitations of the present study so as to avoid possible misinterpretations. In terms of predictive power, the limitations are quite obvious. The model predicts the existence of empirical regularities such as aggregative skewness and ordinal patterns of dispersion in some broad classifications of income. It was not adapted to predict absolute or even relative magnitudes of parameters in the component distributions. It does not tell, therefore, how much of the observed sizes of parameters or of the difference between parameters of relevant components is accounted for by the factors built into the model.

Regarding the distinction between compensatory and restrictive income differences, it was shown that, even under perfectly free choice, differences in training would produce a number of features of the frequency distributions of income which are actually observed. This does not mean, however, that these features are a reflection of such compensatory income differences exclusively.

Interoccupational differences in income levels are not entirely compensatory, once a distribution of "abilities" is introduced. If there is some degree of positive association between ability and choice of longer training, the compensatory differences are augmented by a differential ascribable to ability alone. The financial outlays incurred in training increase the compensatory differences in a way that magnifies dispersion and particularly skewness in the aggregative distribution. They may, indeed, increase the differences beyond the amount necessary for equalization of present values by sharply restricting supply. Finally, when incomes rather than earnings are considered, the positive association of property incomes with occupational level and age magnifies income differences in a way which is likely to accentuate the empirical regularities implied by the training factor alone.

It is thus the consensus of all the factors just listed that produces the empirical results. The purely compensatory factor around which the model is built was chosen for its inherent significance, its analytical convenience, and the theoretical interest attaching to the result that even perfect equality of ability and opportunity implies neither income equality nor symmetry[45] in the income distribution.

[45] In this connection, recall the statement of Allyn Young to the effect that it is not income inequality but skewness that is a symptom of the distortion (in a normative sense) of the income scheme of society (Allyn Young, "Do the Statistics of the Concentration of Wealth in the United States Mean What They Are Commonly Assumed To Mean?" *Journal of the American Statistical Association*, March, 1917, pp. 471–84).