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MODELS AND STRATEGIES IN RESEARCH ON
ATTAINMENT AND OPPORTUNITY

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Abstract

This paper discusses the different research strategies on attainment and mobility presented by status attainment research and Boudon's recent book on education and mobility. It is argued that the interpretation of results of status attainment research is ambiguous because the static and linear models employed are not derived from consideration of the mechanism that produces observed outcomes. A simple dynamic model of the attainment process is used to identify these ambiguities. This model has the typical equation of status attainment research as the equilibrium solution. Boudon presents an alternative way of modeling mechanisms of attainment processes. His use of simulation techniques as a language for his models does however, it is argued, lead to implausible outcomes.

MODELS AND STRATEGIES IN RESEARCH ON ATTAINMENT AND OPPORTUNITY

Introduction

Two recent books on the relation between social origin, education, and occupational attainment have attracted considerable attention for their pessimistic conclusions regarding the possibility of reducing inequality and inequality of opportunity using educational policies. They are Inequality: A Reassessment of the Effect of Family and Schooling in America by Christoffer Jencks and associates, from 1972, and Education, Opportunity and Social Inequality by Raymond Boudon, which appeared in an English translation in 1974.[1] The two books are likely to be cited together for their similar conclusions. They do, however, differ in important respects. The structure of the arguments differ: Jencks's argument represents an interpretation of existing research findings while Boudon, in contrast, presents the implications of a set of assumptions concerning mechanisms of the educational and occupational attainment process. With respect to substantive emphasis, both are concerned with inequality of educational opportunity, but Jencks et al. are primarily concerned with the impact of schools on inequality of opportunity, while Boudon is primarily concerned with the impact of changes in the distribution of education. An even more important difference in substantive emphasis concerns the aspect of

inequality focused upon. While Jencks focuses on the importance of education for the unequal distribution of status and income, Boudon explicitly focuses on inequality of social or occupational opportunity.

A striking difference between the two books is in the research strategies they represent. Jencks et al. rely heavily on the research tradition known as status attainment research. This research originated in the U. S. in the sixties and particularly important has been the work of O. D. Duncan (e.g., Blau and Duncan, 1967) and William Sewell (e.g., Sewell and Hauser, 1975) and their associates. This research is characterized by the use of systems of linear algebraic equations as models for the attainment process, in particular path-models. There is a strong emphasis on estimating the magnitude of causal effects, and little emphasis on specifying the mechanisms of the social processes by which these causal influences are brought about. In contrast, Boudon's work relies on the tradition of classic mobility research; outstanding examples are the studies published in the fifties (e.g., Rogoff, 1953; Glass, 1954; Carlsson, 1958; Svalastoga, 1959). However, while the aim in much traditional mobility research is largely descriptive, Boudon's major concern is to formulate mechanisms of mobility processes and to assess their long range consequences. Little emphasis is placed on measuring magnitudes of causal influences transmitted by mechanisms of mobility processes. Indeed, parameter estimation is not attempted in Boudon's book and empirical data serve mainly to justify assumptions and to evaluate the major patterns predicted from the models.

The difference in research strategies represented by status attainment research and by Boudon's book is the topic of this paper. It is likely that

the merits of these different strategies will be a major source of disagreement. Boudon, in various places (e.g., p. 202), criticizes the models of status attainment research, and Hauser (1976) has recently presented a very critical review of Boudon's book relying heavily on status attainment research. Such disagreements are at least entertaining and may be very productive. If they are to be productive it is necessary to identify the limitations and promises of the two approaches. This paper is an attempt in that direction. It will be argued that status attainment research, while certainly a very valuable enterprise, has certain limitations that may be overcome using the strategy presented by Boudon's book. It will also be argued that the specific implementation of the alternative strategy using simulation models presented by Boudon, weakens rather than strengthens the case made by Boudon.

It may seem unproductive to compare status attainment research to Boudon's contribution, if it is the case that status attainment models are models for the inequality of results, as Jencks implies. Boudon, in contrast, clearly states that he is concerned with inequality of opportunity, and focuses on social mobility, i.e., the attainment of sons relative to the attainment of fathers. However, nothing in the status attainment models implies the interpretation given by Jencks, although nothing contradicts it either. These models might equally well be seen as models for the allocation of persons to unequal positions in an exogenously determined structure of inequaltiy, i.e., as models for the effect of personal characteristics on opportunities. Whether one focuses on mobility or level of attainment is unimportant for the interpretation. The typical equation of a status attainment model is of the form

$$y_1 = c_0 + c_1 x + c_2 y_0 \qquad (1)$$

where y_1 is occupational status obtained by a person, x his education,

and y_0 his father's status. But this equation may be written as

$$y_1 - y_0 = c_0 + c_1 x + (c_2 - 1)\, y_0 \quad , \qquad (2)$$

subtracting y_0 from both sides of the equation. The dependent variable is now a measure of the mobility between father and son. This manipulation does not affect the size of c_1 -- the coefficient to education.[2] Hence, while Jencks interprets the models to say something about the contribution of education to inequality, the models might as well be interpreted to say something about the contribution of education to mobility, if that is the preferred measure of inequality of opportunity. The literature on status attainment research does not indicate which interpretation is the appropriate one.

This is only one of the ambiguities presented by status attainment models. It will be shown that because no emphasis has been placed on deriving models from a theory about how observed outcomes are produced, the interpretation of estimated parameters in status attainment research presents serious difficulties. In order to make this argument convincing, it is necessary to show how a model that attempts to mirror fundamental attainment mechanisms can identify the interpretational ambiguities in status attainment research. Boudon's contribution cannot serve this purpose, for it does not present an explicit mathematical model of the attainment process. The next two sections will therefore attempt to derive an explicit formalization of some simple, but it seems reasonable,

assumptions about the mechanisms of the process. This formalization will be used to identify limitations of status attainment research, and will also be useful for the evaluation of Boudon's contribution, which may be seen as an alternative solution.

The main part of this paper will deal with the occupational attainment process. A brief note in the last part of the paper will indicate how the considerations applied to the occupational attainment process may also be useful for analysis of the educational attainment process.

Attainment as a Causal Process

Educational attainments, social mobility, and occupational attainments are outcomes of over-time processes. Schooling beyond the compulsory age represents the outcome of a set of events where, at various points in time, youngsters either continue their schooling and change their educational attainment or leave the educational system. Social mobility is the outcome of movements of persons among positions in social structure -- movements that will result in an observed association between father's and son's occupational and social status. This movement may be registered in a cross-classification of son's social class by father's social class as Boudon prefers, or it may be expressed as the degree of linear dependence of son's status on father's status -- measured as continuous variables in status attainment research. The son's level of attainment compared with the father's is the outcome of a process that takes place on time, over the lifetime of the son. It is a process where a set of events produces status changes for the son.

In sociology, the educational and occupational attainment process has been conceived of as a causal process with outcomes produced by the operation of a set of causal forces acting on individuals. This mechanistic conception is the dominant one in empirical sociology in general, and may seem especially appropriate here, where a dominant concern is for the effect of some variable (social origin) on some other variable (educational or occupational attainment). The alternative would be to conceive of the process as outcomes of purposive actions, that are actions carried out to achieve some desired state of affairs. Such a framework, common in economics, has in fact been applied to attainment processes in the form of Human Capital Theory (Becker, 1964; Mincer, 1974). However, neither status attainment research nor Boudon apply this framework, though some notions similar to purposive actor theory are used by Boudon in places (e.g., in the discussion of aspirations). The purposive actor framework indeed seems less suited to analyze major problems in social mobility and attainment research, such as the effect of education and equality of opportunity. The framework of a causal process model will therefore also be used in this paper.

Because a causal process model is needed, we should derive a model of the form

$$y = F(x_1, x_2 \ldots x_n) \ , \qquad (3)$$

where y is the dependent variable (attainment) and $x_1, x_2 \ldots x_n$ are independent causal variables. Specifying the functional form F amounts

to specifying a model for the process that may be tested on observations on the variables and/or may be used to draw qualitative inferences on the behavior of the process, for example, to find equilibrium conditions. The classic strategies for obtaining the functional form is to formulate a differential equation mirroring assumptions about how changes in y are produced, i.e., specifying the mechanisms of the process. This amounts to setting up one or more equations of the form:

$$\frac{dy(t)}{dt} = f(t, x_1, x_2 \ldots x_n) \qquad (4)$$

where $dy(t)/dt$ is the rate of change in the dependent variable. If change only takes place at discrete intervals in time, the fundamental equation may alternatively be set up as a difference equation, but the distinction is unimportant for the present purpose. In some instances it will be the case that change in one or more of the x_i variables will be a function of y, and a system of simultaneous differential equation is needed. There seems to be no need for this complication at the present state of knowledge about attainment processes.

Solving the differential equation (if possible) will give F which will enable us to calculate the time path of y as a function of the independent variables. In some instances, the system will reach a steady state or equilibrium as t increases, that is $dy(t)/dt = 0$ for some values of the variables. If such a state exists, time may be ignored and the model may be used to study how change in independent variables produce change in the dependent variable.

The method of theory building using differential equations is modeled on Newtonian mechanics and is of obvious importance in the history of science. For the argument that follows, it is particularly important to note that deriving a model from a set of assumptions embodied in a differential equation assigns precise meaning to the parameters, given the particular assumptions. The solution to the differential equation not only may be used to empirically test the model, but may be used to gain insights about the behavior of the process that would not be obtainable from a verbal formulation.[3] These insights may in particular serve to evaluate the consequences of the assumptions and identify needed corrections in the model.

While this certainly is a powerful strategy for model building, it is not a common one in sociology.[4] In particular, status attainment research has not derived its models of attainment processes from any considerations of how outcomes -- observed as correlations between variables -- come about. The functional form employed is a linear one, but this specification is arrived at ad hoc with no theoretical justification, although there seems to be some empirical justification (cf., Blau and Duncan, 1967). For this reason, the dynamic nature of the process under investigation is ignored except with regard to the causal ordering of variables, and cross-sectional data are employed to estimate parameters. The consequence is that the interpretation of parameters is ambiguous, as this paper hopes to demonstrate.

A major contribution of Boudon is the explicit concern for modeling the mechanism of attainment processes. However, Boudon does not use

differential equations to mirror these mechanisms. Rather they are formulated as algorithms in a computer simulation program. This is an attractive strategy in situations where an explicity formulation seems impossible. However, no explicit solution to the "quasi-differential" equation can be given. What would correspond to a solution would be to do extensive simulations over the domain of the values of variables and parameters. This is cumbersome, and Boudon chooses instead to approximate empirical observations. The check on the assumptions about mechanisms given by the solution of a differential equation model is thus not available. This has some unfortunate consequences, as this paper also hopes to demonstrate.

It is necessary to have an explicit model of the attainment process in order to demonstrate the ambiguity of status attainment research. A simple such formulation is attempted in the next section.

A Model for the Status Attainment Process

It is an old and widely shared notion in traditional mobility research that mobility is a question of structural as well as individual characteristics. Since attainment is the outcome of mobility processes, this notion would apply to attainment processes as well. Social structure is seen as a set of positions or slots that may or may not be occupied by persons. Persons, on the other hand, are more or less likely to be able to gain access to vacant slots depending on characteristics such as their ability, ambition, and background.

In traditional mobility research it was often assumed that the creation or elimination of positions would force some persons to be mobile. Others

would be mobile because their personal characteristics would make them able to move. This notion lead to numerous attempts at separating "individual" from "structural" mobility. Such attempts have only been partially successful, and may not be meaningful. The reason is that even in an unchanged social structure, positions are vacated continuously because persons leave the structure and because the movement of persons creates chains of vacancies in organized hierarchies (White, 1972). If no person can move unless there is an available slot to move to, then all mobility is "structural," and the role of personal characteristics is to determine whom among the candidates for a position is the one to obtain the position.

The notion that no person can move to a position, unless it is vacant, implies that social structure does not reflect the distribution of personal characteristics. This assumption seems acceptable to most sociologists and is explicitly stated by Boudon. Status attainment research is, as mentioned, more ambiguous. The interpretation by Jencks given to this research -- that it deals with the contribution of origin and education to inequality in society -- assumes that the structure of inequality does reflect the distribution of personal characteristics. Much work in economics on the distribution of personal incomes, particularly human capital theory, also assumes that inequality could be modified by changes in the supply of persons with different skills. But, as already shown, status attainment research does not necessarily demand this interpretation.

Whether one assumes that the structure of inequality is exogenously determined or not has important

implications for a model of the process of attainment. Surprisingly little research has been done relevant for this assumption. There is even a scarcity of speculation (see however, Treiman, 1970; Thurow and Lucas, 1972), although most sociological theories of inequality would imply a conception of social structure not determined by the distribution of personal characteristics. Here, such a conception shall also be adopted, and its consequences now explored.

With the conception of social structure being determined exogenously, the distribution of attainments will reflect the distribution of available positions. The personal characteristics relevant for attainment -- education, ability, family background, etc., -- may be said to constitute a person's level of occupational resources. The relation between such resources and attainment will differ in different societies depending on the structure of inequality, and it may vary over time in a society for the same reason. There will in general be a function F that relates measures of occupational resources to attainments where this function is determined by the structure of inequality. In other words, if z denotes a person's level of occupational resources there will be a function F that relates y -- the level of attainment -- and z, i.e., $y = F(z)$.[5]

That F is determined by the structure of inequality has important implications for the measurement of the effect of individual characteristics on the attainment process -- for example, the measurement of inequality of opportunity or measurement of the effect of education on attainment. The various individual characteristics make a contribution to z, the level

of resources. This quantity is in turn transformed into attainment by F. Hence, if a zero-order measure of association (say a correlation coefficient) between an individual characteristic and attainment is observed, its variation from one society to another will depend on both the contribution of the individual characteristic to the overall level of resources, and on F. If, for example, F is linear, so that $y = cz$ where c is a measure of the overall return on resources in a particular society, and if furthermore z is linearly decomposed into contributions from various personal characteristics, one obtains:

$$\begin{aligned} y &= cz \\ &= c(a_0 + a_1x_1 + a_2x_2 + \ldots a_nx_n) \end{aligned} \qquad (5)$$

where a_i is the contribution of the x_i variables measuring single characteristics to z.[6] Hence, observed coefficients to x_i will be a function of both c and a_i. This may not prohibit comparisons of relative effects (if the linearity assumption is valid), but will hinder comparisons of zero-order or overall effects. Because of this, it seems most reasonable to measure such concepts as equality of opportunity as the contribution of the relevant individual characteristic (say father's status) to the overall level of resources independently of the particular transformation of resources into attainments that prevail in a given society. But this of course demands that F can be identified.

In order to identify F, it is necessary to develop a model for the process of attainment in an exogenously determined structure. A simple such model can be derived by noting that the structure of inequality is such that the higher the level of a position (in terms of status and income) the more difficult it will be for a person with a given level of resources

to gain access to it. This means that for a given level of resources, the higher the attainment already obtained the fewer opportunities for additional gains in status there will be. A differential equation model for change in status that has these properties is

$$\frac{dy(t)}{dt} = z + by(t) \qquad (6)$$

where $y(t)$ denotes a person's attainment at time t. The quantity b constrains growth in attainment if it is negative and reinforces it if it's positive. In a structure with finite opportunities b must be negative. The closer b is to zero the more growth will be allowed in attainment, other things equal. Hence, b may be seen as a measure of the structure of opportunities in society.

If z -- the measure of a person's level of resources -- is seen as a linear composite of various characteristics of the individuals, inserting in (5) gives

$$\frac{dy(t)}{dt} = a_0 + by(t) + a_1x_1 + a_2x_2 + \ldots a_nx_n \quad . \qquad (7)$$

The solution to (7) with $b \neq 0$[7] is

$$y(t) = e^{bt}y(0) + \frac{a_0}{b}(e^{bt} - 1) + \frac{a_1}{b}(e^{bt} - 1)x_1 + \frac{a_2}{b}(e^{bt} - 1)x_2 + \ldots \frac{a_n}{b}(e^{bt} - 1)x_n \qquad (8)$$

where $y(0)$ is the attainment of entry into the labor force. The parameters of the solution may be obtained by estimating the lagged equation (8), and from these estimates the a_i and b coefficients may be obtained (cf., Coleman, 1968). Hence this formulation does enable

the identification of the contribution of various single resource variables to the overall level of resources, independent of b -- which reflects the opportunity structure.

The quantity b can, as mentioned, be assumed to be negative in empirical systems, for if $b \geq 0$, growth in attainment would go on forever, and at an ever increasing rate. With $b < 0$ the career will eventually reach a stable level, and the equilibrium level of attainment will be

$$y(e) = \frac{a_0}{b} - \frac{a_1}{b} x_1 - \frac{a_2}{b} x_2 \quad \ldots \frac{a_n}{b} x_n \quad . \qquad (9)$$

If quantities $c_i = -\frac{a_i}{b}$ are defined, they will have the same sign as a_i but be proportional to b. Inserting c_i in (9) will produce the typical equation of the status attainment models. In other words, the linear equations used in status attainment research may be seen as equilibrium solutions to (7). But from these equations b cannot be identified.

The model (7) will produce a career in terms of status attainments that is concave to the time axis. Such career patterns have been observed empirically on life-history data (e.g., Sørensen, 1975b). However, (7) is clearly the simplest possible model for the attainment process. It assumes that a person's level of resources remains constant over time, that is, that there are no additions to resources as a result of on-the-job training and the like. It introduces the simplest possible mechanism for allocating persons to unequal positions. Boudon's Box model goes further in specifying these mechanisms, but this model has not been given an explicit formalization.

Despite these objections, the model seems to work reasonably well. Not only does it reproduce empirically observed career patterns, but model implies that the rate of change in status should decline with time in the labor force, and since status changes entail jobs shifts, the model predicts a particular dependent of rate of job shifts on time. This pattern has been established on observed rates of job shifts (Sørensen, 1975b). Also, the parameter, b, of the model should vary with the opportunity structure confronting persons. Empirical support for this has also been obtained (Sørensen, 1974).

The conceptualization of the occupational attainment process and the model derived from it shall be used in the next sections to analyze some issues raised by status attainment research and by Boudon's model. Both the substantive insights and the formal properties of models for change will be used. The basic concepts introduced apply equally well to the educational attainment process to be briefly discussed after the review of these topics. However, the particular model seems less reasonable. This is because equation (7) predicts rapid change at the start of the process and less change later on. If educational attainments are measured in years of schooling, this pattern does not conform to what is observed in bureaucratic school systems.

Status Attainment Models Reconsidered

Status attainment research from the start has been identified primarily with its methods -- especially its use of the powerful statistical techniques available for linear algebraic models in continuous variables.

Further, the use of path-diagrams and the associated use of recursive models provided a strategy for analyzing causal systems, where causal effects of some exogenous variable may be partly mediated by other intervening variables. The attainment process -- a result both of a person's background and of achieved characteristics partly determined by a person's background, such as education, clearly needs such a system of equations to represent its causal structure.

In relation to traditional mobility research, status attainment research not only represents the use of more powerful methods, it also is a reconceptualization of the process from seeing mobility, that is, change between origin and eventual attainment, as the phenomenon to explain, focusing on level of attainment as the dependent variable, with origin as one of the independent variables.

The effort has been eminently successful. The basic seven-variable model formulated by Blau and Duncan has been replicated in several countries, and the original study is currently being replicated after a ten-year interval in the U. S. (Featherman and Hauser, 1975). In a similar framework, the early attainment process has been extensively analyzed by Sewell and his associates (e.g., Sewell and Hauser, 1975). Status attainment research may indeed be said to provide one of the few examples of a cumulative research effort in sociology (Land, 1971). The methods used have also provided an influential model for work in other areas, such as the sociology of organizations.

It is sometimes held that this research is descriptive. There is indeed a heavy emphasis on measurement and estimation problems, and

typically results are reported in terms of standardized coefficients that are population specific. This does not mean that the models only summarize observed patterns of association, as factor analysis does. Theoretical assumptions enter the models concerning the temporal sequence of variables, the direction of effects, and the choice of variables. The enterprise of formulating models of causal structures can hardly be compared to carrying out factor analysis, and the label descriptive does not seem entirely appropriate.

But there is no concern, in the status attainment models, for the mechanisms of the attainment process. Hence there is no basis for formulating hypotheses concerning the sources of variation in the parameters of the models. Presumably, knowledge about this will be gained from the replications of the basic model in different societies and at different points in time. Status attainment research seems, in other words, engaged in providing basic reliable knowledge about some important processes in society, leaving it for the future to integrate this knowledge in a theory of occupational attainment processes. This is an honorable objective; the tempting analogy is to the collection of observational records on the movements of cellestial bodies that subsequently were accounted for by Newton's formulation of classical mechanics. The problem is whether the strategy will work, with the prevailing lack of attention to the problem of why it is that a variable, say education, may be observed to have a certain association with occupational attainment.

There are methodological reasons why observed variation in parameters of the status attainment models may be difficult to interpret -- and

hence integrate in a theory -- without an explicit formulation of the mechanisms of the attainment process. If the process is described by the differential equation (7), regressing occupational attainment on resource variables amounts to assuming that the process is in equilibrium; so that equation (9) holds. This means that in the cross-sectional samples typically used in status attainment research, everyone no assumed to have a stable level of occupational attainment and experience growth. This assumption is untenable for the younger age groups. There is evidence that occupational attainments tend to increase systematically, at least until the middle thirties for most persons. When the process is not in equilibrium, the coefficients to a resource variable will be of the form [cf., equation (8)]:

$$c_i = -\frac{a_i}{b}(e^{bt} - 1) \qquad (10)$$

dependent on t, that is, time spent in the labor force. Estimates of coefficients will therefore depend on the age distribution of the sample, and observed variations in coefficients from one population to another may be due simply to different age distributions.

This problem of age variation may seem to be easily circumvented by carrying out separate estimates for each age group. However, in cross-sectional data, an age group represents a birth cohort that has entered the labor force at a particular point in time. The observed coefficient will be a function not only of time, but also of b. This coefficient cannot be identified on cross-sectional data. Since b represents a negative feedback that constrains the amount of

change in attainment and therefore reflects the distribution of opportunities in society, it probably will differ from one cohort to another. This further complicates the interpretation of coefficients in status attainment models. Even if the process should be in equilibrium and if these problems do not arise, the impossibility of identifying b from cross-sectional data means that when comparing attainment processes in different structures, the interpretation of observed coefficients is ambiguous. These problems are discussed in further detail in Sørensen (1976).

Granted the model (7), observed coefficients in status attainment models are a function of b , the measure of the opportunity structure of a_i , the contribution of a single resource variable to the overall level of resources, and possibly of the amount of time a respondent has spent in the labor force. This has implications for important substantive issues. Suppose the coefficient measuring the overall contribution of education to attainment is observed to have increased in a replication of the basic status attainment model. Does this mean that education has become more important in the sense of access to jobs being more dependent on a person's education? Not necessarily, the increase may simply be due to a change in b , that is the opportunity structure of society. If this structure changes in such a way that b decreases in absolute value, more opportunities for change in status are present. Since education presumably is important for the magnitude of the gains realized in status changes, it has more to act on, and the observed coefficient to education [corresponding to c_i of equation will be higher than in a society with fewer opportunities.

This explanation is very different from an explanation stating that because of technological change (or whatever), education has become more important for access to positions in society. It seems, in fact, unlikely that the alternative explanation, in terms of changing opportunity structure, could have been arrived at without departing from an explicit, dynamic model of the processes of attainment.

This is all predicated on the validity of the model developed for the process here. However, even if this model is not found tenable, the fact that attainment is an outcome of a change process implies that an algebraic equation estimated in cross-sectional data cannot be used to identify parameters of the basic mechanisms of the process. Hence, observed parameters in such equations will be difficult to interpret, however precisely they are measured.

As mentioned in the introduction, the ambiguity of the status attainment research is ingerent even with respect to fundamental problems such as whether the models represent the contribution of origin and education to inequality in society, or whether they represent the outcome of an allocation of persons to unequal positions in a predetermined structure. These ambiguities can only be resolved, it seems, by deriving models from considrations of the mechanisms that generate the processes. Boudon proposes a way of modeling mechanisms of the process that is quite different from the one presented in the preceding section. This approach will be discussed next.

The Box Model

The attainment process has been conceptualized here as a continuous time, continuous variable process. Boudon's Box model is in contrast a discrete time (time being a generation), discrete variable (three social classes) process. Relying on the tradition of mobility research all intermediary positions between origin and eventual attainment are ignored, and society is conceived of as composed of discrete classes or occupational groups. Conceptually, the difference is not fundamental. What is to be modeled is the allocation of persons unequally endowed with occupational resources, in particular education and father's social status, to unequal positions in social structure. Although a different language is used, the so-called Box model represents an attempt to mirror basic mechanisms of attainment processes in the same way as equation (7). It is therefore a proposal for satisfying the need for fundamental models that was previously identified in the discussion of status attainment research.

Boudon motivates his effort somewhat differently. Chapter 1 presumably lays the groundwork for the rest of the book by giving a preliminary formulation of the Box model in order to account for an apparent paradox identified by Anderson (1961). The paradox is that social mobility seems very weakly related to educational mobility (son's education in relation to father's education). This seems to be the case even if education is the only determinant of social status, that is, even if all influence of origin on eventual attainment is mediated by education through inequality of educational opportunity.

The "paradox" seems to reflect the mechanics of change processes more than any existing substantive phenomenon. This was shown by Blau and Duncan (1967, pp. 195-196) in what could be seen as a main justification for their reformulation of the problem that was the beginning of status attainment research. In the Blau and Duncan formulation, social mobility is measured as the difference $y_1 - y_0$ between father's and son's statuses, and educational mobility is similarly a difference -- $x_1 - x_0$. The correlation between these two difference variables seems to be an appropriate operationalization of what is meant by the relation between occupational and educational mobility, although Anderson and Boudon rely on cross-tabulations. This correlation can be written as (Blau and Duncan, 1967, p. 195):

$$r_{(y_1 - y_0)(x_1 - x_0)} = \frac{r_{y_1x_1} - r_{y_0x_1} - r_{y_1x_0} + r_{y_0x_0}}{2\sqrt{1 - r_{y_1y_0}}\ \sqrt{1 - r_{x_1x_0}}} \qquad (11)$$

Blau and Duncan argue that since the correlation in question is a complicated function of the simple correlations, one should rather analyze the simple correlations as they have done. The expression shows that the correlation between son's status and education ($r_{y_1x_1}$) , and the correlation between father's status and son's education ($r_{y_0x_1}$) may both be high and the correlation between social mobility and educational mobility still be low. But the expression(11) is so complicated that not much is learned other than it is possible for a correlation between change variables to behave in peculiar ways.

A possibly more instructive formulation may be derived from a slight reformulation of the model for the attainment process formulated above.

Instead of letting $y(0)$ of equation (8) denote attainment at entry into the labor force, let $y(0)$ denote the origin attainment, that is, the social status of the father. Without loss of generality the constant term and the resource variables other than education may be dropped. In this more abstract and slightly modified form, equation (8) becomes:

$$y(t) = e^{bt}y(0) + \frac{a}{b}(e^{bt} - 1)x \quad . \tag{12}$$

This expression relates occupational attainment at a certain age t to origin and educational attainment, x. The parameters have the same interpretation as before. Subtracting $y(0)$ from both sides of (12) gives:

$$y(t) - y(0) = (e^{bt} - 1)y(0) + \frac{a}{b}(e^{bt} - 1)x \quad . \tag{13}$$

Now, in a society with finite opportunities for growth in attainment, $b < 0$. It follows that $(e^{bt} - 1) < 0$ always. The quantity will be -1 when the process reaches equilibrium. Mobility, that is, the difference $y(t) - y(0)$, will be negatively related to origin status. This will not affect the coefficient to education <u>if</u> $y(0)$ is included on the right-hand side of the equation. But statements about the relation between education and mobility exclude $y(0)$ from the right-hand side of the equation. This will be reflected in the coefficient to education. Education itself has a positive relation to $y(t) - y(0)$, and a positive relation to $y(0)$; but when $y(0)$ is omitted from the equation, education will pick up some of the negative effect of that variable, and be biased downward. The coefficient to education will be

small, and may in fact be negative without reflecting anything particularly paradoxical about the effect of education.

It should be noted that the equilibrium level of status obtained by the son, for $t \to \infty$, will be a function of education alone. This seems to be a reasonable definition of a meritocracy.

The phenomenon described is a kind of regression-toward-the-mean effect, but not caused by measurement error as is usually the case.

There seems little reason to introduce anything as innovative as the Box model to account for the weak relation between education and mobility. The major contribution of the Box model seems instead to be the formulation of a mechanism for allocating persons to unequal positions in a structure where the distribution of positions is not influenced by the distribution of variables that influence the allocation process. Very important implications for the future of inequality of opportunity and for educational development are derived from this model. In particular, the observation that growth in educational attainment is self-stimulating seems important, with obvious policy implications.

The basic idea of the Box model is that persons are ranked according to education and social origin, that is, their occupational resources. Further, they are assigned to social positions in the order established by that ranking, so that persons with top ranks get top positions, persons with the next highest rank obtain the remaining top positions, if any, and then the next highest positions. The assignment is, however, not carried out completely in accordance with this scheme. Instead a "bias parameter" is applied, and it works differently according to whether the top social class is filled or not. If positions remain

in the highest social class, the parameter is applied to persons; when the top class is filled, it is applied to positions.

This implementation of the scheme produces some anomalous results. In the meritocratic situation, where education is the only criteria of ranking, it will be seen from Table 8.4 of Boudon's book that in the first period simulated, 70 percent of those with the highest level of education gain access to top positions. But so do 70 percent of those with the next highest, and the third highest level (there are six levels in all). This pattern prevails over the periods.[8] This does not seem to be a meritocracy at all. That only 70 percent of those with top level education gain access to top positions must mean that something besides education is important. More importantly, it introduces a genuine paradox. The major thrust of the argument is to study the impact of increased educational attainment on mobility. But it seems hard to explain why there should be an increase in educational attainments where it does not make any difference in social status whether one obtains the highest or the third highest level of education. Instead, we should then expect a decline in enrollment in higher education, not growth as is postulated. Education in Boudon's societies is acquired primarily because of the status it provides, not because of any intrinsic satisfaction provided.

The outcomes of the simulation are mobility tables. It is shown that there is no apparent systematic variation in mobility patterns even though educational attainment increases, and inequality of educational opportunity declines. This result is presented as a major one by Boudon

and used to "explain" why there seems to be no apparent change in inequality of opportunity and why mobility is the same all over.

The simulation presented by Boudon corresponds to presenting a numerical solution to a differential equation model only for certain values of the parameters and variables. Furthermore, the dependent variable, that is, mobility, happens to show very little variation. It is obviously not difficult to obtain little or no variation in a variable for a set of parameters, even though the underlying model is wrong. It would have been more convincing to show under which conditions mobility patterns would change, and then -- if Boudon's argument had to be made -- to show that these conditions do not, in fact, prevail. This would seem to be particularly important in this instance where the relation of education to mobility is at issue. As shown above, this relationship is difficult to analyze because of the omitted variable -- father's status.

The use of observed mobility tables as a criterion for whether the simulation is reasonable poses another problem. These tables represent the mobility experiences of a complete sample irrespective of the ages of respondents. The main pattern of career movement is up. Including younger ages therefore probably exagerates the amount of downward mobility in relation to what would be observed if only equilibrium attainments were registered. To use the ability of being able to predict downward mobility as a criterion for the model, as Boudon does, therefore seems somewhat dubious.

The major problem is, however, one of having some anomalous omplications of the model ignored, because the model seems empirically

reasonable. The anomalies are due to the operation of the bias parameters, which might have been designed to make the whole simulation appear more reasonable. The result is the opposite, and this points to a fundamental weakness of the simulation technique. While this technique allows you to develop models without mathematics, and though it allows you to incorporate empirical observations as parameters, only with great difficulty does it allow you to see the full range of implications of a set of assumptions. This is simply because it is such a cumbersome technique. Each outcome of the simulation corresponds to a particular set of values of variables and parameters. Only through variation in these values are the properties of a model understood. Mathematics provide a very powerful language for this task, while simulation is a very cumbersome language. Boudon utilizes the attractive features of the simulation technique, but refrains from evaluating the model. Thus the properties of his model are obscured rather than revealed.

That the simulation produces "reasonable" results is no strong support for the model. These results could have been brought about by meaningless as well as meaningful models with Boudon's use of the simulation technique. The irony is that Boudon's argument in fact does not demand empirical validation. It is a typical "If . . . then . . ." argument that represents the joint implications of a set of assumptions. If these assumptions are believable in a qualitative sense and the argument adheres to the rules of logic, it is to be taken seriously. Formalization need not be introduced, but can be of great help. Thurow (1972), in fact, makes an argument very similar to Boudon's

without using an explicit model (or a simulation). Boudon (and Thurow) points to an important mechanisms for the allocation of persons to unequal positions in society. Boudon does not add much, and may in fact have weakened the argument, by using the simulation technique in a way that may seem to produce reasonable outcomes, but involves logically implausible intermediary results such as Table 8.4.

A Note on Inequality of Educational Opportunity

It seems appropriate to briefly note how some of the points raised above apply to research on inequality of educational opportunity. Educational attainment has been treated by the same methods -- linear regression and path models -- as occupational attainment, and it is a matter of convention whether this research should or should not be seen as part of status attainment research. Boudon, as well, devotes major attention to inequality of educational opportunity, although with a quite different approach.

Educational attainment can be conceptualized much like occupational attainment. Children are endowed with a certain level of educational resources, and the structure of the educational system determines how these resources are transformed into educational attainment. Research using linear models of educational performance has used a variety of outcomes as dependent variables -- academic achievement, educational aspirations, and attainment. Major emphasis has been on estimating the influence of family background, as in the parallel research on occupational attainment. However, in addition, an important problem has been whether school characteristics,

such as instructional resources and social organization, have an impact on educational performance. This is a crucial problem, for if school characteristics do have an impact on educational performance, a way of reducing inequality of educational opportunity will have been established. The standard finding is that school characteristics do not have much of an impact, that is, they add little to a person's educational resources. A review of the pertinent research is given by Jencks et al.

It should be noted however, that adding school characteristics to an equation, with measures of family background already included as independent variables, may not be an appropriate representation of the possible impact of schools. Typically equations are estimated on a sample of children in a single age cohort using static models. However, the outcome measure -- for example, academic achievement -- is a change variable. Hence if the process of change in this variable is described by anything similar to equation (7), which seems plausible, one obtains:

$$\frac{dy(t)}{dt} = a_0 + by(t) + a_1x_1 + a_2x_2 \cdot \cdot \cdot a_nx_n \qquad (14)$$

where $y(t)$ may be academic achievement, and the x variables are measures of educational resources, family background and the like. The quantity b, again assumed to be negative, can here be given an interpretation as a measure of the opportunities for learning. If b is large in absclute value, little change in achievement will take place, that is, little learning will take place. If b is close to zero, much learning will take place.

Estimating coefficients to the various x variables in static equations will, as was shown in the case of status attainment models,

confounds the a_i coefficients, b, and time (the latter since the process cannot be assumed to be in equilibrium) in the way described by equation (10). This means that in good schools, with respect to opportunities for learning, the observed coefficients will be observed to be large, while in bad schools, with few opportunities and b large in absolute value, family background and other educational resource variables will be observed to have a small impact. This is not what is ordinarily meant by school effects, and is an insight that can only be obtained by formulating the mechanisms of the process under investigation. Failure to do so, as is commonly the case, will here as in research on occupational attainment, result in ambiguities and probably misinterpretations of what causes parameters to vary in different systems.

Boudon formulates an explicit model of the educational attainment process. This process is seen as a set of "branching points" that are events where the outcome is either staying in school or leaving. The model generates a distribution of attainments for a particular group characterized by their social origin and ability. This is a geometric distribution since the branching points take place at discrete points in time, and the probability of leaving is the same at each branching point. Without loss of generality, the same process may be described in a continuous time framework.

Suppose that in any small time interval a person characterized by various characteristics has a probability $q_i dt$ of dropping out of school, constant over time. The probability that this person still be in school by time t will change according to the equation:

$$\frac{dP_i(t)}{dt} = -q_i P_i(t) \qquad (15)$$

with $P_i(0) = 1$, the differential equation has the solution:

$$P_i(t) = e^{-q_i t} \tag{16}$$

The probability of leaving school before time t' will be $1 - P(t')$. This is an exponential distribution, the continuous time analog to the geometric one Boudon uses. The important thing to note is that all information about the process is contained in q_i ; in particular, anything that reflects inequality of opportunity will be expressed as variation in q_i among different groups. (For a similar approach, see Sørensen, 1971.)

Boudon does not present an explicit formulation of the process, instead the parameters are entered in a simulation. For each historical period in the simulation the parameters remain unchanged over the educational career of a person. Hence Boudon assumes a priori that schools cannot have any impact on inequality of opportunity. But the parameters for everyone change with system time according to the formula (here in continuous time notation):

$$q_i(T + 1) = (1 - a)q_i(T) \tag{17}$$

where the index T denotes system time, and a is a constant (in Boudon's application $a = .1$). This difference equation has the solution:

$$q_i(T) = (1 - a)^T q_i(0) \quad . \tag{18}$$

Since $0 < 1 - a < 1$, $q_i(T)$ approaches zero as T approaches infinity. This is how inequality of educational opportunity is reduced -- by making all differences between groups in the q_i's that govern the

process smaller and smaller. Using the simulation technique, Boudon however generates a number of particular outcomes, and relies instead on the behavior of percentage differences between various groups in attainments. This obscures the fact that all information about the processes, in particular all percentage differences, is determined by the q_i's and equation (18) .

It may be appropriate to assume a priori that schools cannot do anything about inequality of educational opportunity, but it is not clear to the reader that it is an assumption of the model. Further, Boudon makes a major point of identifying two sources of inequality of opportunity -- cultural inequality and exponential stratification effects. This may be confusing for there is indeed only one source of inequality of opportunity -- the differences between the q_i's among different groups. To recognize that educational attainment is a time dependent process does not, it seems, amount to identifying a source of inequality of opportunity.

As with the Box model, the simulation obscures rather than reveals the properties of the model. In this instance it obscures why the numbers behave the way they do. Although focusing on mechanisms of processes is held here to be badly needed to remove the ambiguity of the research that uses linear algebraic equations, the simulation technique seems only to introduce new ambiguities.

Conclusion

This paper has tried to accomplish two tasks. First a case was made for the formulation of models of attainment processes that not only

model the outcomes of such processes, but also attempt to directly mirror the mechanisms that produce observed outcomes. Second, the paper presented an evaluation of Boudon's contribution toward constructing such a model of the attainment processes. In connection with the first task, a simple dynamic model of the attainment process was formulated that revealed important ambiguities in the interpretation of status attainment models. These models, which now dominate research on occupational and educational attainment, are typically static, applied to cross-sectional data, and not derived from an explicit conception of how observed outcomes are brought about. But only within the framework of such an explicit model do results have an unambiguous interpretation.

Boudon's attempt to construct models of the same processes dealt with in status attainment research has been faulted, not for the basic ideas, which are important indeed, but for the implementation of these basic ideas in computer simulation models. This is an attractive technique because it makes model building possible where explicit formalization does not seem possible, and allows the incorporation of "realistic" values of parameters. It has been shown, however, that the technique obscures rather than clarifies properties of models in Boudon's application. This seems to be because Boudon is mainly interested in producing realistic outcomes of the simulation, rather than understanding the properties of his models for ranges of values of parameters and variables. Simulation is a cumbersome technique for evaluating properties of models. Still such evaluations are needed if anything is to be added to a purely verbal formulation.

There seems indeed no adequate substitute for mathematics as a language for models of social processes. A mathematical formulation of the queuing process embodied in the Box model is badly needed in order to fully capture the implications of the important ideas advocated by Boudon, and in a similar framework by Thurow (Thurow and Lucas, 1972). These ideas are controversial as they go against much conventional wisdom, especially in economics. But they should be discussed on their merit, not on the basis of an implementation in a computer simulation model, with logically implausible features, like Boudon's model.

NOTES

1. The English language version is a revision of the French from 1973. All references to Boudon's books given here are to the English language version.

2. Status attainment research usually uses standardized coefficients (path coefficients). These coefficients would be different when estimated in equation (1) and equation (2). However, the difference is unimportant for the argument presented here.

3. A well-known example is Simon's (1957) analysis of Homan's theory.

4. The lack of very many continuous variables in sociology is sometimes held responsible for this state of affairs. However, the same logic applies to stochastic process models -- defined over discrete state spaces -- as demonstrated by Coleman (1964).

5. See Sørensen (1975a) for further detail.

6. Equation (3) is of the same form as the typical equation of status attainment research. These models then may be seen as assuming that F is linear and z is a linear composite.

7. If $b = 0$ the solution will be $y(t) = y(0) + t(a_0 + a_1x_1 + \ldots a_nx_n)$.

8. A similar anomaly occurs in Table 8.7, where origin is allowed to have a direct impact. Also as pointed out by Hauser (1976), different results obtain according to whether one starts from the top or the bottom in filling up society.

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