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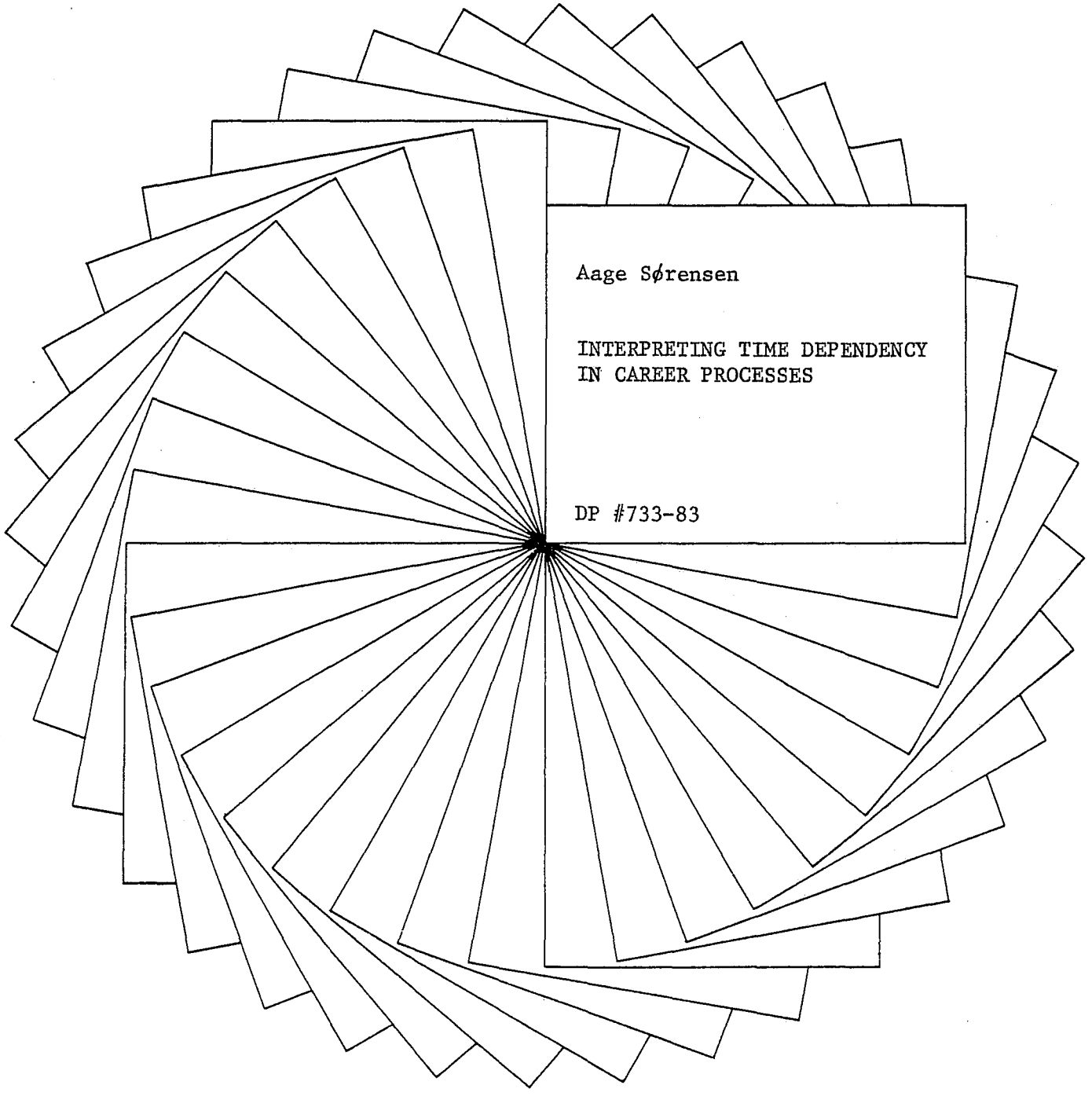

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INTERPRETING TIME DEPENDENCY
IN CAREER PROCESSES

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Interpreting Time Dependency in Career Processes

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ABSTRACT

This paper provides an analysis of rates of gains in socioeconomic attainment, emphasizing the effect and interpretation of labor force experience in the attainment process. The hypotheses that are tested are drawn from the vacancy competition theory of the process of socioeconomic attainment.

Interpreting Time Dependency in Career Processes

INTRODUCTION

Following the work of Blumen, Kogan, and McCarthy (1955), job mobility processes have been a favorite area for applying for stochastic process models in the social sciences. Most early attempts at applying stochastic process models to mobility processes tried to model aggregate mobility tables with simple (Markovian) models. The results often were empirically inadequate and conceptually unsatisfactory. Aggregate mobility tables make it difficult to adequately model individual differences in parameters governing mobility processes and time dependency, though both individual differences and time dependency usually are believed to exist in empirical mobility processes. Aggregate mobility data were, however, the only data available to sociologists for almost two decades.

The availability of rich and detailed data on job shifts and similar elementary acts of mobility has changed this situation quite dramatically. Retrospective life history and other event-history data on job moves permit the application of sophisticated statistical estimation techniques to continuous-time stochastic process models of mobility processes allowing both individual heterogeneity and time dependency. This approach, demonstrated first by Tuma (1976), has now given us a fair amount of knowledge about the basic properties of job mobility processes (Rosenfeld, 1981; Sandefur, 1981; Sørensen and Tuma, 1981; Andress, 1982; Caroll and Mayer, 1982; Felmlee, 1982; Tuma, forthcoming; Sørensen, forthcoming).

Sociologists have analyzed job mobility processes for the information they provide concerning career or socioeconomic attainment processes.

Often the concern over career mobility processes is linked to a concern for the identification of different labor market structures. The rationale is that variation in career processes (of which job shifts are the elementary acts) reflect variation by industries and firms in opportunities and constraints on socioeconomic attainment processes (Spilerman, 1977). The study of labor market structures using analysis of job and career mobility is only one of the approaches taken by sociologists in research on the labor market. It is a particularly useful approach when the concern is for the identification of labor market structures where the mechanism of basic labor allocation is viewed as different from the competitive market structures assumed in standard economic theory about these matters. In particular, varieties of internal labor market theory (Doeringer and Piore, 1971; Williamson, 1975) and the related idea of vacancy competition structures (Sørensen, 1977) emphasize the analysis of career and promotion processes for identifying matching processes allocating people to jobs in internal labor markets or vacancy competition systems.

The vacancy competition theory for the socioeconomic attainment process examines the interaction of individual characteristics with stucturally created opportunities to produce career lines and socioeconomic attainment outcomes. The objective of the present paper is to test certain hypotheses about the effect of time in the labor force derived from the vacancy competition theory or model. Ideas about the nature of time dependency in rates of career gains will also be explored. Finally, the paper will analyze and compare certain models for career mobility inspired by human capital theory as developed in economics. This comparison is of interest because the allocation mechanism proposed in human

capital theory contrasts with the mechanism proposed in the vacancy competition model.

The use of job mobility to provide information on career trajectories is implied by a fundamental assumption of the vacancy competition theory. In vacancy competition theory, social and economic outcome variables are seen as characteristics of the positions people occupy in social structure, and outcomes are linked to characteristics of individuals through the process that matches people to jobs. A change in position is therefore the mechanism by which a change in socioeconomic attainment takes place. Information about such changes are given in data on job shifts. In contrast, standard market theory of the attainment process sees attainment as resulting primarily from characteristics of individuals, and change as coming about directly through changes in performance, skills, and efforts. Job shift data are less relevant for the analysis of the attainment process when this concept is applied. And indeed, economists tend to analyze job shift data with a quite different perspective from sociologists.

Not all job shifts produce changes in socioeconomic attainment, and if change is produced, decreases as well as increases may come about. Consequently, we analyzed three different outcomes of job mobility in Sørensen and Tuma (1981): shifts up in attainment, shifts producing no change, and shifts producing a loss in attainment. A different strategy is employed in this paper. The vacancy competition theory is a theory about how growth in socioeconomic attainment comes about. In the labor market structures where the theory is believed to apply, downward shifts are assumed to be the exception. Lateral shifts are noise. The focus on growth in attainment further implies that the event of interest is the event of a gain in attainment, one that improves the person's level of

attainment over his previous highest level. This means that not all upward shifts are of interest; those that only reestablish a level of attainment previously lost are ignored.

The theory deals with career events defined in this way. For this reason, the present analysis will in fact not analyze all job shifts performed by a sample of people.[1] Instead, only those shifts that increase a person's level of attainment over the previous highest level are defined to be events of interest. The waiting times for the events analyzed here are measured as time from when a person first enters a certain level of attainment (higher than any previously attained) until a job shift is performed that results in an increase in socioeconomic attainment. The first spell starts when a person enters the labor force and realizes attainment level y(0). Everyone has at least one spell, but it may be censored. Many have only one or two spells. The set of events defined in this way is heavily censored, more than is usually the case for job shift data obtained from retrospective life histories. Nevertheless, the approach offers conceptual as well as statistical advantages.

The conceptual advantages are that the approach permits estimation of models for the transition (hazard) rate or intensity, r(t), for events that represent growth in attainments. The analysis therefore may be seen as providing direct estimates of models that are proxies, but not solutions, to the differential equations defining career models. They are proxies because the size of the gain is not taken into account. In other words, the models estimated here may be seen as discrete state approximations to continuous state differential equations.

The statistical advantage is that the procedure produces better fit and simpler models than models for individual shifts. Elsewhere (Sørensen, forthcoming) I have presented a similar analysis focusing on all upward job shifts. The models that fit best there are more complicated than the ones presented here. They are of the form $r(d) = a_o + \exp(BX + \alpha d)$, with a_o being an intercept, BX being a set of independent variables, αd incorporating (negative) time dependency, and d measuring time in spell. The models estimated here are of the form $r(d) = \exp(BX + \alpha d)$ without the intercept. With identical variables, the models estimated here show more improvement in fit. The models incorporating additive intercepts are also computationally more expensive and not always estimable.

In this paper, socioeconomic attainment is measured as socioeconomic status in a metric (SAS) that forces an exponential distribution of the population distribution of attainment levels (as of 1970). The metric is presented and justified in Sørensen (1979). The distributional assumption is essential for the derivation of the vacancy competition model. Since conventional socioeconomic status scores have only ordinary metrics, nothing prevents performing an order preserving transformation that produces an exponential distribution of socioeconomic outcomes. The vacancy competition model also implies a conception of educational attainment, which ranks people rather than measures skill levels. For this reason, educational attaiment is measured in a metric (EDR) where educational distributions are standardized by year of entry into the labor force and the exponential distribution is imposed (Sørensen, 1979). Together with time in the labor force, measured as time since entry,

socioeconomic status and educational attainment are the only independent variables in most of the models to be presented.

In general, models of the following sort will be estimated

$$r(d) = f(\lambda(d), BX) \qquad (1)$$

where $\lambda(d)$ captures time-in-spell or duration dependence, while BX represents the effect of a set of exogenous variables. Most models will be estimated using RATE (Tuma, Hannan, and Groeneveld, 1979), where $\lambda(d)$ is assumed to be exponentially dependent on d and the functional form of the relation between r(d) and BX also is exponential. One other specification of $\lambda(d)$ will be estimated using GLIM.

As noted, the main interest is in the role of t, time in the labor force, as an element of the vector X of (1). The main concerns are predictions of the size of the coefficient to t and the interpretation of t. It is to the formulation of these predictions and interpretations that I now turn. I will then discuss the role of $\lambda(d)$ in models of this sort.

CONCEPTS OF THE EFFECTS OF TIME IN THE LABOR FORCE ON SOCIOECONOMIC ATTAINMENT

This section will argue that the role and interpretation of time in the labor force in the vacancy competition model is very different from that in the human capital model, which may be seen as an alternative to the vacancy competition model. There are a variety of specifications of the human capital model. I shall primarily focus on the much-used specification proposed by Mincer (1974). I shall first consider the vacancy competition model, which is a one-man art.

Vacancy Competition

The derivation of the vacancy competition model is presented in Sørensen (1977), but a brief summary is necessary here to develop the arguments of the present paper. The model conceives of the socioeconomic attainment process as being generated by vacancy chains, which are chains of opportunities in a hierarchical structure of positions. Vacancy chains are set in motion by people leaving the labor force and new positions being added. Empty positions, created in this way, will be filled by new entrants into the labor force and by people moving up from lower attainment levels into the vacant positions. As people move up, additional new vacancies are created, and chains of vacancies are formed. The observed attainment of individuals reflects their ability to obtain access to vacant positions. The attainment process therefore will reflect the number and distribution of vacant positions by attainment levels and the qualifications of individuals which determine their ability to obtain access to vacancies.

If positions are assumed to be exponentially distributed, a simple mobility regime can be shown to characterize the system. The exponential distribution is characterized by a parameter β, so that $p(y > y') = \exp(\beta y')$, $\beta < 0$. The size of β determines the number of positions above a certain level, so that the smaller β is in absolute magnitude, the more positions will be above any given attainment level. New vacancies not filled by new entrants are assumed to occur at a constant rate, h. These new vacancies will set in motion vacancy chains that will arrive at a certain rate at the various attainment levels in the system and provide opportunities for individuals to gain attainment at these levels.

The rate at which vacancies arrive at a certain level of attainment can be shown to be a function of h and β. Denote the number of jobs at levely y by n(y), the number of vacancies arriving at level y in a period by m(y), and the total number of jobs in the system by N. It can be shown (Sørensen, 1977: 970-71) that

$$m(y) = h \int_{y}^{\infty} n(u)du, \qquad (2)$$

that is, the number of vacancies arriving at y is the sum of new vacancies created at higher levels. Denote the rate at which opportunities for better jobs will arrive at y by q(y): then $q(y) = m(y)/n(y)$. But $n(y) = Nf(y)$ where f(y) is the density of the exponential distribution assumed to describe the distribution of attainments. Carrying out the integration in equation (2) gives $m(y) = hN\exp(\beta y)$. Hence

$$q(y) = \frac{hN\exp(\beta y)}{N(-\beta \exp(\beta y)}$$

$$= -\frac{h}{\beta}.$$

Thuq q is independent of y and opportunities are a function of the rate at which new vacancies are created, h, and of the shape of the distribution of attainments, β. This seems appropriate.

That opportunities for gains occur at a constant rate q does not mean that everyone at a certain attainment level will be equally likely to take advantage of these opportunities. People have a certain set of characteristics, or resources, that determine their ability to obtain access to a better position when it is vacant. Given the opportunity structure,

there will be a level of attainment that will be the best a person can hope to achieve, denoted y(m). Further assume that the level of resources, denoted z, does not change over a person's career. With this in mind it follows that people whose current level of attainment, y(t), is below y(m) may be in a position to take advantage of opportunities. The greater the discrepancy between y(m) and y(t), the more likely it will be that they move up. Since y(m) is determined by z in a particular opportunity structure, the rate of movement upward is determined by the discrepancy between resources and current attainments.

Assume now, further, that downward moves are the exception. It then should be the case that those who have just entered the labor force will be most likely to undertake a move. Every move will reduce the discrepancy between resources and current attainments. Hence the rate of move should be negatively related to the amount of time in the labor force; assuming that the opportunity structure and the people do not change.

To be more specific, if one arrays the incumbents of a given attainment level by the time they have spent in the labor force, this will provide an ordering of their ability to take advantage of the opportunities for moving up that are presented by vacancies at the next higher level. The overall rate is q. The rate for an individual with t years in the labor force is r(t). Across all individuals at the given level of attainment, the individual rates should sum to the overall rate. Hence

$$\int_0^\infty r(t) = q = -\frac{h}{\beta}$$

should hold. An expression that is monotonic and simple for r(t), satisfying this integral equation, is

$$r(t) = \exp(bt),\ b = \beta/h < 0. \tag{3}$$

The exponential decline for r(t) is not the only conceivable formulation that will satisfy the integral equation, but it is the simplest and corresponds well to what is observed (Sørensen, 1975). Formulation (3) will receive major attention in the empirical analysis of this paper.

The number of shifts a person has undertaken by time t is $v(t) = \int_0^t r(t)$, and the gains per shift are on the average $y(m) - y(0)/v(\infty)$. For $z = -by(m)$, it is easy to derive that the career trajectory will be

$$y(t) = \exp(bt)y(0) + z/b\ [\exp(bt)-1]. \tag{4}$$

Differentiating gives

$$\frac{dy(t)}{dt} = z + by(t), \tag{5}$$

and r(t) should be proportional to dy(t)/dt, so that estimates of r(t) provide direct information on (5).

Equation (3) has been estimated in Sørensen (1979) and support for the interpretation of parameters obtained. Here the main emphasis is on estimating equation (3) and the proxy estimation of (5) using r(t) with the observation scheme described earlier. Two questions are important. The parameter b is a measure of the opportunity structure: the larger the absolute magnitude of b, the fewer opportunities for gains should be available. If, for example, blacks are believed to have more unfavorable opportunities than whites, then we should expect that $b_b < b_w$ $(b < 0)$, where b_b and b_w are estimates of b for blacks and whites respectively.

Second, t is an indicator of the discrepancy between resources and current attainments in the argument that lead to (3). Introducing actual measures of resources and current attainments into models for r(t) should therefore at least reduce the net effect of t, if not eliminate it, as t does not enter explicitly into equation (5). These are the main implications to be tested below.

Human Capital Formulations

In Mincer's (1974) formulation of the human capital model, time in the labor force, or labor force experience, is a dominant variable. In fact, it explains much more variation in earnings than does education. The original Mincerian model is cross-sectional, with cross-sectional data, and time in the labor force is conceived of as a proxy measure for accumulated human capital obtained from investments in general on-the-job training. The level of attainment is directly tied to the amount of human capital as measured by years of schooling and labor force experience. The experience-earnings profile has the typical shape, with attainments increasing rapidly in the early years and then leveling off. It is argued that the leveling off is due to a leveling off in training that occurs for a number of good reasons, including the finite time left in the labor force, the increasing costs of financing new training as earn-ings levels increase, and perhaps also a certain atrophy in ability to learn.

The vacancy competition model and the cross-sectional human capital model predict the same basic career curve. This should surprise no one, since the basic shape is what is observed both for earnings (Mincer, 1974) and for socioeconomic status (Sørensen, 1975). However, the

interpretation of time in the labor force is very different in the two models. In the human capital model, time in the labor force is a causal variable measuring an attribute of individuals (post-school training) that has an effect in the cross-section that presumably is structurally genuine. In the vacancy competition model, in contrast, time is just a domain variable. The parameters of (3) are not identifiable in the cross-section, and t is not a causal variable in the manner suggested by human capital models, where it would be a resource variable. If $t \to \infty$ in equation (4), one obtains an expression for y(m) that can be made a linear function of a resource variable if z is decomposed into an additive function of measured variables. Time would not be assumed to be among these variables. A more sophisticated version would argue that people learn a lot of specific skills as time passes, but are getting promoted in order to be kept motivated to use these skills. This version still will not include time as a resource variable. A model for y(m) should only be estimated on a cross-sectional sample where everyone has reached their peak attainments. Mincer's earnings model is estimated for everyone.

Very different mechanisms for change are conceived of in the two theories. One sees change as brought about by people utilizing opportunities for gains without any necessary change in their performance and skills. The other sees change as brought about by changes in performance and skills alone. The different interpretations of the time dependency of the process reflect these different conceptions of how change is brought about.

The observation scheme and the variables used in the present analysis are not very suitable for a convincing test of human capital models. It

is an earnings theory and not a status theory, and while a status theory should follow upon the earnings theory when status is conceived of as primarily reflecting "goodness" of jobs (Goldthorpe and Hope, 1972), the following suggestions may be somewhat unsatisfactory.

The Mincerian model is cross-sectional. The present analysis will focus on rates of gains in attainments. Two interpretations can be given for what such analysis will show in relation to human capital theory. One is that the focus is upon rates of new additions to human capital. These increases are very quickly translated into higher attainments, and we observe discrete jumps in these attainments in our analysis. The other interpretation is that the process is in disequilibrium and what is observed is the rate at which the appropriate level of attainment is brought about for a given stock of human capital.

The investment interpretation suggests that estimation of equation (3), in a human capital interpretation, would show that time in the labor force reduces the rate of new training because of the finite amount of time people spend in the labor force. This suggests the same prediction about the coefficient to time--that it should be negative. However, it is not clear what this would suggest about black-white differences. If it is argued that blacks enter earlier and therefore spend longer total time in the labor force, then a given time in the labor force is associated with more time left for blacks than for whites. It should follow that $b_b > b_w$ ($b < 0$), the opposite of the prediction from the vacancy competition model. However, it may not be true that blacks spend more time in the labor force, overall, than whites. Mincer (1974) suggests that schooling differentials in entry into the labor force are compensated for by differentials in retirement ages.

It is generally argued that people of higher ability and education (if one learns to learn in schools) have lower training costs and therefore higher rates of new training. This suggests augmenting estimates of equation (3) in the human capital formulation with measures of ability and education and predicts positive signs for both these variables. It can further be argued that with higher levels of attainments, new training will be more costly. One should therefore include attainment levels in the model. These modifications would make the model identical to the vacancy competition model in terms of variables (except for a different metric for education). Contrary to the vacancy competition model, time in the labor force does have a legitimate role in predicting rates of gains seen as measuring rates of new training. Unfortunately, models with identifiable effects of both resources and current attainments do not suggest that the process is in equilibrium. Hence the training interpretation becomes more ambiguous.

Something can be done about the ambiguity of the training interpretation in a model including measures of both resources and current attainment if one relies on interactions with duration dependence. The rationale for this will be suggested in the next section.

The disequilibrium interpretation of what is estimated in human capital models for rates of gains assumes that the level of human capital is formed at the start of the spell and that the spell concerns finding the attainment level that gives the appropriate rewards for it. Nielsen and Rosenfeld (1981) have proposed such a partial adjustment model for gains in attainments. The defining differential equation would be (with the present notation):

$$\frac{dy(t)}{dt} = -b[y(e) - y(t)]$$

where y(e) is the equilibrium level of attainments, not the maximum, since y(e) will change as the stock of human capital changes--the latter changes are not modeled. This can evidently be brought on the same form as equation (4). However, Nielson and Rosenfeld argue that the interpretation of b is quite different from what the vacancy competition model suggests. They see b as a measure of speed of adjustment and argue that the more speed, the more opportunity. Hence for black-white differences, b_w is predicted to be larger in absolute magnitude than b_b, or $b_b > b_w$ ($b < 0$), contrary to the prediction of the vacancy competition model.

In estimating the partial adjustment model, y(e) may be written as a linear function of resource variables. Among those, according to the human capital formulation, should be time in the labor force with a positive sign.

INTERPRETATIONS OF DURATION DEPENDENCE

The vacancy competition model predicts no duration dependence in observed rates provided that resources and current attainments are accurately measured. Opportunities arrive at a constant rate at each attainment level. Given the discrepancy between resources and current attainments for a person, the rate of move up should be a constant over the spell. Hence $\lambda(d) = \lambda$ and the simple Poisson process are assumed to govern events.

Even when there is no true duration dependence as assumed in the vacancy competition model, such dependence may be observed in empirical

analysis. Negative duration dependence will be produced by unmeasured heterogeneity among individuals as a result of fallible measures or omitted variables. Net of the measured variables, rates will appear to decline with duration in the state because the unmeasured heterogeneity makes those with high rates leave first, leaving behind those with low rates. Of course, negative duration dependence may also be genuine, if the concept of the vacancy competition model is erroneous or too narrow. Thus, specific on-the-job training tying a person to a particular firm and job should produce negative duration dependence.

It is possible to use search theory to argue for positive time dependence in rates. Suppose people have a certain level of aspiration that determines which of the opportunities that they encounter they will be willing to make use of. If this aspirational level remains constant, no duration dependence should follow. If, on the other hand, people lower their aspirational level as time goes by without bringing the initially desired promotion, positive duration dependence should come about. The aspirational level need not in fact be that of the individual, but could be that of the candidate's employer. There appears to be no empirical documentation for positive duration dependence created by this mechanism. It is likely that unmeasured heterogeneity overwhelms positive time dependence caused by search.

There is a statistical source of positive duration dependency that appears to have been ignored so far in the literature on event-history analysis. It may be quite important in certain processes. The nature of the phenomenon was discovered in an analysis of rates of first marriages (Sørensen and Sørensen, 1983), where strong positive duration dependence was observed. Inspection of the survival curves and plots of the rates

show that in fact the duration dependence is nonmonotonic, inversely u-shaped. This could be due to a falling aspiration mechanism combined with heterogeneity, but a simpler explanation is that it reflects unmeasured variation in the times of origin of the spells. In other words, people enter the state of being at risk of marrying at different times. Since we do not know when people start looking, or when someone starts looking for them, the starting date for the spell was fixed in our analysis at age 18 for everyone. Positive duration dependence then will be obvserved in the first part of the process as people move from having rates that are zero when in school or not yet rich enough for a spouse (the analysis is of a sample of men). Some empirical support for this interpretation of nonmonotonic time dependency has been obtained (Sørensen and Sørensen, 1983) by interacting the duration dependency with schooling. A similar phenomenon could take place in analyzing rates of gains in attainment from retrospective life history data, if people misremember starting dates for spells, or forget about events. This hypothesis will be explored below.

RESULTS

The first set of results I shall report are apparently quite discouraging for the vacancy competition model. They pertain to estimates of the effect of time in the labor force on rates of attainment gains, using a slightly generalized version of equation (3):

$$r(d) = \exp(b_0 + b_1 t + b_2 d)$$

Three hypotheses are derived from the vacancy competition model. First, it should be the case that $b_1 < 0$. Second, $b_2 = 0$ in the unlikely

situation of no unmeasured heterogeneity. This would mean that t is a perfect indicator of the size of the unmeasured discrepancy between resources and current attainments because t provides a perfect ordering of individuals with respect to the size of this discrepancy. Finally, and most important, we should find that $b_{1b} < b_{1w}$, reflecting more unfavorable opportunities for blacks than for whites.

These first set of results is presented in Table 1.

It is the case that $b_1 < 0$ for both groups. There is negative duration dependence presumably reflecting unmeasured heterogeneity. It appears that t is a fallible indicator of the discrepancy between resources and current attainments. This negative heterogeneity is not all that important. The results of models assuming the duration dependence to be zero are quite close to those allowing for duration dependence. Strangely, however, the negative duration dependence is less for blacks than for whites. Blacks are often believed to have more chaotic careers, so that t should be a poorer indicator of the discrepancy between resources and current attainments for them. The opposite seems to be the case.

The main problem with the results shown in Table 1 is the failure of the prediction from the vacancy competition model regarding the outcome of the comparison of blacks to whites used to validate the interpretation of b as a measure of opportunities. Instead, the comparison seems to suggest the Nielsen-Rosenfeld interpretation, or a human capital interpretation of the model showing the effect of amount of time left in the labor force on training investments.

It is often argued that blacks have more chaotic careers, reflecting the secondary labor market structures in which they are employed. This would imply that the comparison of blacks to whites fails to support the

Table 1

Estimates of Vacancy Competition Models for Effect of Time in the Labor Force on Rates of Gains in Socioeconomic Attainments (Total sample of spells for blacks and whites)

Model: 1.1 $r(d) = \exp[b_0 + b_1 LFB]$

1.2 $r(d) = \exp[b_0 + b_1 LFB + b_2 d]$

	Whites		Blacks	
Parameter	1.1	1.2	1.1	1.2
b_0	-4.405 (.03683)	-3.771 (.04799)	-4.681 (.04216)	-4.268 (.005803)
b_1(LFB)	-.01117 (.0009188)	-.01187 (.0008992)	-.007564 (.0009237)	-.008522 (.0009164)
b_2(d)		-.01193 (.0007588)		-.006352 (.0007154)
Chi square	189.79	500.83	81.24	170.42
Degrees of freedom	1	2	1	2
N	1942		1553	
Censored	768		668	

Note: LFB is time in labor force, t, measured to beginning of spell; d is time in spell. Spells are time to gains in attainment over previous highest level. See text for description of observation scheme.

theory because blacks are not employed in the vacancy competition structures assumed in the theory. Chaotic careers imply less orderly gains as well as losses, so that time in the labor force accounts for these gains less well for blacks. The models presented in Table 1 provide less of an improvement in fit over the constant rate model for blacks than for whites, according to the chi squares. This supports the suggestion of more chaos and less orderly careers for blacks than for whites.

The existence of more disorderly careers for blacks suggests abandoning reliance on predictions about time in the labor force from equation (3) to test the vacancy competition theory and instead to use more elaborate models. Before this is done it is useful to consider one other possible source of failure of the predictions tested in Table 1. That source is errors of recall. Such errors may be more serious for blacks than for whites because blacks in these data on the average entered the labor force earlier than whites.

Errors of recall could affect the results in several ways. One suggestion is that errors of recall lead to positive duration dependence in the early part of the career. As noted above, this would result from failure to remember early gains so that the lengths of spells analyzed are misrepresented, creating unmeasured variation in the actual time of entry into the spell. This positive duration dependence would, later in the career, be replaced by negative duration dependence because of unmeasured heterogeneity. The resulting nonmonotonic duration dependence cannot be captured by the models estimable in RATE that only allows for monotonic duration dependence. The misspecification of the models presented in Table 1 might have produced the failure of the predictions, as the models of Table 1 would be more misspecified for blacks than for whites.

On the basis of an idea of Aitkin and Clayton (1980), Bennett and Whitehead (1981) have shown how it is possible to use GLIM to obtain estimates of rate models that assume a log-logistic distribution of waiting times and hence nonmonotonic duration dependence. This might provide one solution to the failure-of-recall problem. Another solution is to use partial likelihood models for the relation between rates of gains and time in the labor force, since duration dependence then can be left unspecified. Such a partial likelihood model can be estimated with RATE. The results of the use of the log-logistic and the partial likelihood models are shown in Table 2.

The shape parameter in the log-logistic models provides evidence for nonmonotonic duration dependence if $p > 1$. Using this criterion, there is some, apparently weak, evidence for nonmonotonic duration dependence for blacks consistent with the failure-of-recall hypothesis. However, modeling this time dependence does not provide estimates of the effect of time in the labor force that supports the theory's prediction regarding black-white differences. Neither do the partial likelihood estimates.

The problem with this exercise is that if there are recall problems, then there are problems also with the recall of the time-in-the-labor-force variable. A straightforward solution to this problem, though a somewhat uneconomical use of the data, is to estimate the models only for the more recent events. The Hopkins Life History Study covers events from the mid-1940s to 1969. I first selected events where the original state was entered into during 1956-69 and estimated the model of Table 1 on these spells. These results are presented in Panel A of Table 3.

In the more recent sample of events the point estimates of b come out as predicted, indicating more unfavorable opportunities for blacks than

Table 2

Estimates of Models for Effect of Time in Labor Force on Rates of Gains Using Log-Logistic and Partial Likelihood Models

Log-Logistic $\lambda(d) = \frac{\lambda p(\lambda d)^{p-1}}{1 + \lambda d^{p}}$

Parameter	Whites	Blacks
b_0	-3.478 (.05416)	-4.460 (.06182)
b_1	-.01549 (.001133)	-.01105 (.001147)
p	.956	1.092

Partial Likelihood

Parameter	Whites	Blacks
b_1	-.008699 (.0007218)	-.006880 (.0008082)

Table 3

Estimates of Vacancy Competition Models for Effect of Time in the Labor Force on Rates of Gains in Socioeconomic Attainment (Spells are 1956-1969, and 1960-1969)

A. Period 1956-1969. Model is 1.2

Parameter	Whites	Blacks
b_0	-4.138	-4.406
	(.0995)	(.1176)
b_1(LFB)	-.008065	-.008123
	(.001162)	(.001224)
b_2(d)	-.01308	-.004187
	(.001658)	(.001688)
Chi square	112.20	52.31
Degrees of freedom	2	2
N	27	745
	(560)	(450)

B. Period 1960-1969. Model is 1.2

Parameter	Whites	Blacks
b_0	-5.011	-4.731
	(.2338)	(.2756)
b_1(LFB)	-.001579	-.005453
	(.001719)	(.002013)
b_2(d)	-.007785	-.004645
	(.003834)	(.004516)
Chi square	4.60	7.38
Degrees of freedom	2	2
N	459	392
	(349)	(308)

for whites. The difference is small and the confidence intervals for these estimates clearly overlap. It is of course possible to restrict the recency of events even further. This is done for Panel B of Table 3 where spells entered 1960-69 are analyzed. Now the difference is substantial and the confidence intervals do not overlap--in fact, the estimate of b for whites is not significantly different from zero.

Note that the estimates for the most recent events are closer to zero for both races. This reflects a period effect towards more favorable opportunities for all.

It is a bit ambiguous that when the difference between the races becomes significant and in the right direction, the estimates for one of the groups show no effect of labor force experience at all. Less ambiguous results can be obtained testing the prediction of the vacancy competition model regarding the parameter b as a measure of opportunities when b is estimated as the coefficient to attainment in equation (4). This would also allow for a test of the prediction that time in the labor force is an indicator of the discrepancy between resources and current attainments. Results are presented in Table 4.

The coefficient to SAS clearly differs in the predicted direction between the races. Current attainment constrains gains in attainment more for blacks than for whites. There is no longer any significant duration dependence in the models for blacks. Recall problems may still bias the estimates, or resources and current attainments are better measured with the two variables for blacks than for whites. It can be shown that with more comprehensive measures of resources and current attainments, the duration effect also disappears for whites in analysis of rates of upward job shifts (Sørensen and Tuma, 1981).

Table 4

Estimates of Vacancy Competition Models for Effects of Education and Current Attainment on Rates of Gains (Period is 1956-1969)

Model: 4.1 $r(d) = \exp[b_0 + b_1 SAS + b_2 EDR + b_3 d]$

4.2 $r(d) = \exp[b_0 + b_1 SAS + b_2 EDR + b_3 d + b_4 LFB]$

Parameter	Whites		Blacks	
Model	4.1	4.2	4.1	4.2
b_0	-4.099 (.1106)	-3.800 (.1347)	-4.471 (.1242)	-4.092 (.1543)
b_1(SAS)	-1.282 (.09006)	-1.196 (.09134)	-1.659 (.1662)	-1.505 (.1642)
b_2(EDR)	.5290 (.05614)	.4435 (.06243)	.4305 (.07318)	.3331 (.08252)
b_3(d)	-.008624 (.001635)	-.009386 (.001639)	.0008814 (.001670)	-.002129 (.001678)
b_4(LFB)		-.004394 (.001232)		-.005369 (.001232)
Chi square	50.11	63.65	60.94	81.74
Degrees of freedom	3	4	3	4
N	27 (560)		745 (450)	

Note: SAS is socioeconomic status measured to provide exponential distributions of attainments in the population. EDR is education measured to provide exponential distribution and standardized to account for growth in educational attainments (see Sørensen, 1979, for procedures).

Adding time in the labor force to the models provides some improvement in fit. However, the coefficient to time in the labor force is less than half its size in Panel A of Table 3. Current attainments and resources are not perfectly measured with our two variables, leaving some variation to be accounted for from time in the labor force. Also, there is noise in the empirical system, so that time in the labor force does not provide a perfect ordering of people according to career stage. Of course, a human capital interpretation may also be suggested. I shall return to this below.

Racial differences do not unambiguously reflect "structural" differences. There are always omitted variables and measurement problems with the variables that are included. Alternative explanations can be provided for the flatter career curves of blacks. If one could directly identify labor market structures that vary in opportunities for gains, more persuasive evidence for the vacancy competition interpretation would result. A popular classification in the sociology of labor markets divides industries into core-monopoly and periphery-competitive sectors. This classification is usually presented in an elaborate dual economy frame-work, but it is not clear what it represents other than a proxy measure of industries with larger firms. Larger firms should have more elaborate internal labor markets and therefore longer promotion ladders. Hence it should be the case that core positions should provide more opportunities for gains than periphery positions. I have used the classification proposed by Beck, Horan, and Tolbert (1978). There are extensive discussions about the best way to do this. I have no reason to defend the present one. Better classifications informed by the theory are yet to be implemented. Estimates of the models in each sector are presented in Table 5.

Table 5

Estimates of Vacancy Competition Models for Effects of Education, Time in Labor Force, and Current Attainment on Rates of Gains, for Core and Periphery Sector of Industry (Period is 1956-1969; models estimated are 1.2 and 4.2--notation as in 4.2)

A. Core Sector

	Whites		Blacks	
Model	1.2	4.2	1.2	4.2
Parameter				
b_0	-4.287 (.1222)	-3.775 (.1616)	-4.702 (.1661)	-4.293 (.2045)
b_1(SAS)		-1.130 (.1008)		-1.494 (.1984)
b_2(EDR)		.3937 (.07268)		.3849 (.0927)
b_3(d)	-.01220 (.001995)	-.008586 (.001971)	-.002845 (.002253)	.0004851 (.002256)
b_4(LFB)	-.007196 (.001407)	-.004223 (.001483)	-.006576 (.001602)	-.004095 (.001588)
Chi square	63.04	247.26	18.80	104.49
Degrees of freedom	2	4	2	4
N	652 (405)		469 (309)	

(table continues)

Table 5 (cont.)

Estimates of Vacancy Competition Models for Effects of Education, Time in Labor Force, and Current Attainment on Rates of Gains, for Core and Periphery Sector of Industry (Period is 1956-1969; models estimated are 1.2 and 4.2--notation as in 4.2)

B. Periphery

	Whites		Blacks	
Model	1.2	4.2	1.2	4.2
Parameter				
b_0	-3.790 (.1712)	-3.815 (.2555)	-4.069 (.1667)	-3.810 (.2241)
b_1(SAS)		-1.559 (.2266)		-1.525 (.3275)
b_2(EDR)		.5669 (.1273)		.1665 (.1723)
b_3(d)	-.01475 (.002977)	-.01062 (.002949)	-.005066 (.002564)	-.003825 (.002530)
b_4(LFB)	-.1026 (.002090)	-.003782 (.002268)	-.009901 (.001917)	-.007243 (.002014)
Chi square	52.80	119.24	34.17	68.44
Degrees of freedom	2	4	2	4
N	273 (153)		275 (141)	

Note: For classification of core and periphery, see Beck, Horan, and Tolbert (1978).

The results are quite pleasing. For both races, the periphery sector provides fewer opportunities then does the core sector. This comes about by measuring opportunities with the coefficient to labor force experience, using the application of equation (2), and with the coefficient to attainment, using the application of equation (4). The industry classification does not eliminate the black-white differences in this case. Blacks are still exposed to more unfavorable opportunities in the core sector than are whites. It is likely that this only reflects the crudeness of industry classifications to capture labor market structures. However, even if structures containing elaborate internal labor markets could be better identified, it is likely that the present data would not assign a great many blacks to these structures.

Finally, I present estimates of models attempting to provide some evidence for human capital theory interpretations of what is taking place.

There are, as mentioned, two possible interpretations of what could be estimated in models for rates of gains using the human capital framework. One is that what is modeled are rates of acquiring new skills, assuming the process is in equilibrium and that we are observing discrete jumps in the attainment increases produced by these new skills. The model corresponding to this interpretation is presented in Panel A of Table 6. Here, time in the labor force has a significant negative effect, as hypothesized. Education and ability have has no significant effect. It was expected that they should positively affect the rate of new training because of lower training cost. The training interpretation is not supported.

The second interpretation is that the level of human capital is formed at the outset of the spell and the spell concerns finding the

equilibrium attainment level for this stock of human capital. The models corresponding to this interpretation are presented in Panel B of Table 6. The results are very similar to those obtained for the similar vacancy competition model shown in Table 4. In the human capital interpretation, time in the labor force should be a resource and have a positive effect in the partial adjustment interpretation of the model. This is not the case: the effect is negative. One could argue that the partial adjustment process is confounded with a training process, but it is not possible to separate these various mechanisms.

Ability, which is likely to be poorly measured in this study, has a modest effect only for blacks.

Overall, the results seem quite supportive of the vacancy competition interpretation of this model. It is of interest, for this evaluation of the model, that the chi square for whites is 351.16 for 5 degrees of freedom in Panel B of Table 6. The corresponding model of Table 4 has a chi square of 363.65, with 4 degrees of freedom. The difference of degrees of freedom reflects the inclusion of ability in the model of Table 6. It has no effect for whites. The better fit of the model of Table 4 must be due to the difference in the metric for education between the two models. When education is measured in the metric (EDR), inspired by the vacancy competition model, the model fits better. A similar result does not come through for blacks but here ability does have an effect.

CONCLUSION

This paper has tested certain implications of the vacancy competition theory for the effect of time in the labor force on rates of gains in

Table 6

Estimates of "Human Capital Theory" Interpretations of Models for Rates of Gains in Attainment (Period is 1956-1969)

A. Model: 6.1 $r(d) = \exp[c_0 + c_1 LFB + c_2 EDY + c_3 ABIL + c_4 d]$

	Whites	Blacks
Parameter	6.1	6.1
c_0	-3.629 (.1941)	-4.166 (.2094)
c_1(LFB)	-.009555 (.001238)	-.008994 (.001293)
c_2(EDY)	-.1039 (.03521)	-.09186 (.04076)
c_3(ABIL)	-.003925 (.02853)	.01834 (.02874)
c_4(d)	-.01330 (.001654)	-.004368 (.001686)
Chi square	125.13	49.93
Degrees of freedom	4	4

(table continues)

Table 6 (cont.)

Estimates of "Human Capital Theory" Interpretations
of Models for Rates of Gains in Attainment
(Period is 1956-1969)

B. Model: 6.2 $r(d) = \exp[c_0 + c_1 LFB + c_2 EDY + c_3 SAS + c_4 ABIL + c_5 d]$

Parameter	Whites	Blacks
c_0	-4.151 (.2109)	-4.508 (.2227)
c_1(LFB)	-.004323 (.001271)	-.004714 (.001271)
c_2(EDY)	.1962 (.04200)	.1241 (.04480)
c_3(SAS)	-1.128 (.08982)	-1.535 (.1686)
c_4(ABIL)	.02318 (.03094)	.06390 (.03137)
c_5(d)	-.009727 (.001640)	-.001973 (.001684)
Chi square	351.16	182.42
Degrees of freedom	5	5
N	930 (560)	745 (450)

Note: ABIL is verbal ability measured at time of interview. EDY is education measured in years of schooling.

attainment. These implications contrast with those that may be drawn from human capital theory or the partial adjustment model related to that theory. The paper employed an observation scheme in which only events were recorded that represent gains in attainment over the person's previously highest level. With this observation scheme, it has been shown that recall errors appeared to invalidate the prediction from the vacancy competition theory when the full sample of events was analyzed.

Restricting the sample to the more recent events provided findings that support the theory. Particularly strong support was found by testing the predictions regarding the effect of past attainment on rates of gains in attainment and regarding the impact of economic sector on rates of gains. The human capital interpretation of the process did not receive much support. It could be argued, however, that the test of the human capital interpretation is not completely convincing, since the focus was on socioeconomic status gains rather than on level of earnings.

NOTES

[1]The data used in the present analysis are retrospective life history data obtained from the Hopkins Life History Study initiated by James S. Coleman and Peter H. Rossi. It dealt with occupational, educational, and residential experiences of respondents from age 14 to the time of interview in 1968. The universe is the total population of men aged 30-39 residing in the United States in 1968. The total number of completed interviews was 1589: 738 blacks and 851 whites. The job histories have a total of about 13,000 events. Events occurring before completion of full-time education were excluded from the present analysis. Military service occurring after entry into the labor force was subtracted from the duration of spells. Entry into the labor force is defined as first full-time employment over a period of at least 18 months.

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