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ABSTRACT

This paper outlines four existing theories dealing with income distribution and labor market allocation. Predictions on the proper specification of wage equations are derived and testing procedures are proposed. Since theories dealing with allocation under imperfect information are found unsatisfactory, a new model is proposed, incorporating the assumption that improved information comes along with experience, and testable predictions are also made in this situation. Some hints at the relevant empirical literature are given.

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1. INTRODUCTION

The debate on the functioning of labor markets has received new stimulus from the challenge of such theories as the dual market hypothesis, the job competition model, and the radical theory---all questioning the appropriateness of the neoclassical view of the world. The latter view was the basis for many U.S. policies aimed at improving the distribution of jobs and earnings through schooling and training programs, and as some of these policies did not readily produce what was hoped for, existing theories were questioned. This paper will focus on the key element in the competing theories, the nature of market adjustments: How are people allocated to jobs, which signals convey market information, or conversely, what do wage rates reflect?

The paper begins by briefly outlining four different approaches to the problem in a setting of perfect information and by condensing these theories to a few testable hypotheses. Next, the situation with imperfect information is studied and since existing theories are found defective, a new model is presented to obtain some understanding of this case. The paper takes a brief look at existing empirical evidence and indicates how further testing can be accomplished.

Clearly, the present paper is related to Cain's (1976) survey, which provides a kaleidoscopic picture of the challenges offered by "segmented labor market theories." This paper focuses more explicitly on market allocation and the hypotheses dealing with it, as well as on the empirical evidence bearing on it.

2. THEORY: PERFECT INFORMATION

The Neoclassical Model

The neoclassical model is such a standard that it barely needs elaboration. Essential to it are the assumption of a homogeneous commodity and a perfect market. These assumptions imply a unique market clearing price; the usual dynamic assumption specifies a positive wage response to the emergence of excess demand. The model envisages markets organized by skills: In each market, a supply of workers with given skills is confronted with demand for workers of that particular skill. Factors that can be upgraded (e.g., from unskilled to skilled worker) have an equilibrium price ratio that is determined by the marginal cost of grading up. The price ratio is essentially supply determined, although demand may have an impact if the marginal cost is not constant and if the input factors are less than perfect substitutes in production. If grading up is not possible (as with pure noncompeting groups), there is no such supply-determined equilibrium price ratio and relative supply and relative demand in the different markets determine the relative price. The predictions are straightforward and seem easily testable.

However, the condition of homogeneity is not so easily met in reality, perhaps only in such narrowly defined job-worker relations as on an assembly line, with fixed speed and negligible scope for quality variation. This means that actual predictions always will deal with average wage rates for certain categories and that variation about the mean, due to some irreducible heterogeneity has to be tolerated. Such variation is important however, for a theory of earnings distribution.

In its strictest form, the neoclassical model predicts instantaneous wage adjustments to maintain market clearing at any time. Yet, there are some good reasons, within a neoclassical framework of profit/utility maximizing agents, to expect some resistance to quick price adjustments. In general, the arguments to be given here relate to the fact that long-run considerations may be brought in before the decision on changing prices is made. In the absence of a (Walrasian) auctioneer who calls the prices, some agents (usually the employers) have to quote the price for a particular labor type. The employer will be reluctant to make instantaneous price adjustments for the following reasons:

(1) Price adjustments are costly. The change in prices will not only apply to new hires but also to identical workers already under contract and may trigger adjustments in wages for related workers (see below). These adjustments have administrative costs that employers will try to avoid by aiming at a price level that can be maintained for a longer period of time. Price instability also carries cost of information. If prices change frequently and if the changes come about at different rates for different employers (which may well be the case in a transition to a new equilibrium--cf. search theory), agents have to invest in obtaining information. The effect of such cost also is to prefer a situation with stable prices to a situation with fluctuating prices, even though the average price level may be the same.

(2) There are the constraints of a wage structure. Agents will be aware of a wage structure and their perception of it will set constraints on wage adjustments in a single compartment. Adjustment in one

compartment will necessitate adjustment in other compartments (related skill classes, different experience categories) and this is not without cost; hence, single compartment adjustments will be postponed until their long-run inevitability becomes clear and will be bounded by the limits of the wage structure.[1]

Taken together, these factors have a dampening effect on wage movements in response to changing market conditions, in particular in the shorter run. But they do not wash out the general prediction of the neoclassical model that in the longer run wage rates will respond to changes in supply and demand and will maintain an equilibrium price ratio for factors that can be upgraded.

Neoclassical reasoning has also been brought to bear on the problem of unemployment. Unemployment is obviously relevant for understanding labor market allocation, since it may identify failings in the process. In particular, the differential incidence of unemployment on different workers is relevant here. Stressing the cost of recruitment and placement as well as the impact of on-the-job, firm-specific training, Oi (1962) predicts a higher incidence of unemployment at lower skill levels. The neoclassical model can now be summarized in the following predictions:

1. Wage rates for given skill classes respond to changes in supply and demand: Excess demand will be eliminated by wage increase.

2. In long-run equilibrium, wage differentials for factors that can be upgraded equal the marginal cost of upgrading.

3. Wage rates for individuals with identical skills are equal.

4. The incidence of unemployment is inversely related to the level of skill.

The Job Competition Model

Thurow (1975) presents his job competition model in sharp contrast with the neoclassical wage-competition model. The model can be outlined with three basic postulates:

1. There is a frequency distribution of job opportunities: Jobs are indicated by their wage rates, so essentially this is an income distribution, available at the demand side of the labor market.

2. Wages are paid based on the characteristics of the job (Thurow, 1975, p. 76); essentially, wages are exogenous to the model and sociologically determined (workers impose their preferences about relative wages--apparently not conflicting between different classes--by their control over marginal productivity through manipulation of efforts on the job). Wage competition is suppressed to promote on-the-job training among workers (a worker would not be willing to train someone who subsequently will compete his wage down).

3. For each job, there is a queue of potentially qualified workers; each job requires on-the-job training and in the job queue, workers are ranked according to increasing (expected) training costs--the costs of turning the applicants into reliable, adequately performing workers. Expected training costs are inferred from "background characteristics (education, innate abilities, age, sex, personal habits, psychological test scores, etc.)" [Thurow, 1975, p. 86]. Hiring for each job is according to the sequence in the job queue (best workers first, etc.) and will continue until the marginal productivity of that job

is driven down to the level given by the exogenous wage; thus marginal productivity becomes a theory of employment.[2] The impact of training costs on hiring is not made very clear, and inconsistent statements are made.[3] A neoclassical argument, equating present value of marginal productivities and marginal cost, including training cost and allowing for turnover effects would seem to fit in quite well.

Thurow is very specific about worker allocation at the microeconomic level of the individual firm (a theory of worker selection, actually) but is not explicit about the macroeconomic process of allocation. The following picture might be drawn, however. As mentioned, there is a given frequency distribution of jobs according to wage rates ("job opportunities"). Also, there is a job queue, which, in case of collapsing background characteristics to one indicator of training costs, gives a national ranking of workers from least preferred to most preferred; since many workers can obtain the same rank, a frequency distribution by rank emerges. One can now interpret this situation so that workers will be allocated to job opportunities according to this preference ranking. Starting at the top, the best job (highest wage) is given to the worker with the lowest training cost, and so on down the line. Hence, supply and demand are equated by rationing supply along the available openings. In Thurow's words, "The only overall constraint on the job distributions is that the total number of filled jobs cannot exceed the total number of workers available in the labor queue. There can, of course, be unfilled job openings" [Thurow, 1975, p. 99]. The latter addition is somewhat troublesome. In the above interpretation, unfilled openings could only occur at the bottom of the distribution of job opportunities. However, in more complicated (and realistic) multibackground, multipreference rankings Thurow concedes that for some job opportunities training costs would be so high as to prohibit hiring. But nowhere does he indicate how these unfilled openings may remain, and where.

In summary, the frequency distribution of job opportunities is given (to a large extent by technology, and thereby exogenous; but wage rates and training costs are also relevant), and individuals are consecutively assigned to that distribution. The observed frequency distribution of wages may differ from the distribution of gross wages[4] in so far as training costs are borne by the employee (lowering his observed earnings). If the sharing of training costs between employer and employee varies with the wage level, the observed wage distribution may differ in shape from the distribution of job opportunities (i.e., it will be twisted).

Using training costs (in a broad sense) as the criterion to rank individuals according to their abilities in a particular occupation is an attractive specification. It provides in fact a cardinal measure of ability, unidimensional but allowing for differences among jobs. The focus on the demand side of the labor market and the stress on the ranking of individuals in potential performance is appealing and reminds us of Roy (1951); witness the following quotations. "It will be shown here that whatever the rates of remuneration which either rational choice or irrational prejudice allocate to the units of output in different occupations, such scales of rewards exercise no more than a superficial distorting effect upon a basic pattern. . . It depends . . . upon the varying relative effectiveness of human abilities when faced with different kinds of productive problems and can be altered only by changes in the technique of production in the various activities in which the human race engages" [Roy, 1951, p. 136]. The conclusion points to the same direction as Thurow's, emphasizing the structure of demand.

Although Thurow's model has interesting and challenging elements, it is not without some shortcomings. In particular, it lacks a rigorous, formal presentation and this creates some fuzziness. The essential concept of the labor queue is not clearly defined.[5] For singular jobs this may cause no problems, but this is different for the national labor queue. If the labor queue is based on expected training costs only and yields varying rankings across occupations, how does the "national labor queue" emerge? And how does the labor queue relate to the distribution of job opportunities in such a case? As mentioned above, the relation between marginal productivity, wage rate, and training costs is not made clear. Moreover, training costs are not given any dimension of time or experience in the job; hence the deviation between the distribution of gross and net earnings is seemingly given a static status, while obviously it is dynamic.

Still, the popularity of the theory and the nature of the predictions are sufficient reason for including it in a testing program. The job competition model will thus be represented by the following predictions.

1. Wages are independent of the conditions of supply and demand; wages do not clear markets.[6]

2. Wage differentials do not vary systematically over the business cycle, but demanded background characteristics (hiring standards) do.

3. ". . . if there are an inadequate number of jobs, those at the bottom of the labor queue will be left unemployed" [Thurow, 1975, p. 95].

It should be pointed out that Thurow does not claim general validity to the entire economy for this model, but contends that the U.S. is somewhere between job competition and wage competition. For testing purposes, the extreme position of general validity will be assumed.

The Supply-and-Demand Model

The model put forward by Tinbergen, which he refers to as a "supply-and-demand theory," is a very special blend of neoclassical and disequilibrium elements. It is neoclassical in its reliance on allocation through prices, disequilibrium in its allowance of individuals ending up in jobs for which they are either under- or over-qualified. The model essentially dates back to 1956 (Tinbergen, 1956), but later publications sometimes have different emphases. The idea is to account for labor heterogeneity by a set of characteristics and to distinguish a joint frequency distribution of characteristics supplied (available "intensities", or levels, for each characteristic) and a joint frequency distribution of characteristics demanded (required "intensities"). The former distribution specifies the available jobs, the latter the available workers. Overall equilibrium allocation is established if in each and every interval the frequencies of supply and demand are equal. This has to be brought about by a price function, specifying the equilibrium price (wage) pertaining to each interval of the labor market. In the original 1956 paper, the wage function was defined on required intensities, with the coefficient reflecting supply, but later work stresses that both required and available intensities should be explicitly included (Tinbergen, 1977; Berkouwer, Hartog, and Tinbergen, 1978).

The approach can be illustrated with a discrete example (Tinbergen, 1975). Suppose there are three levels of education. At any given time, the total supply of workers with any of these levels is fixed. Demand for each level is derived from a production function, marginal productivity equals the wage rate. Now, the production function includes as a separate input, labor with education level i performing a job requiring level j ($i \neq j$). Suppliers with a given educational level have preferences regarding jobs requiring different levels of education; they are willing to accept a divergence between actual and required level of education in exchange for a wage increase. Equilibrium has to be established by a proper set of relative wages, such that all available labor is allocated over the available jobs. Free competition will lead to a situation where individuals with education level i are indifferent among jobs requiring different levels of education j: Wage rates will compensate for the loss in utility that occurs if $j \neq i$. Conditional on the assumptions made, a wage structure arises with higher wages for higher education levels and with wages for workers performing above their educational level ($j > i$), surpassing the wages of those performing at a job exactly matching their education level ($j = i$).

Note that in this model marginal productivity neither resides in the job nor in the individual, but results from the interaction of the two. By consequence, wage rates should be related both to required <u>and</u> supplied intensities (e.g., years of education). Elsewhere (Tinbergen, 1977) it is argued that the required intensities should have a positive sign and the supplied intensities a negative sign, on the following grounds. Suppose in a unidimensional specification (only one aspect relevant), the frequency distributions of demanded intensities and of supplied intensities are specified as inverted parabolas, while the demand frequency for jobs requiring intensity j is also assumed to respond negatively to the wage w_{ij} to be paid for labor endowed with some given intensity of the aspect[7] i and performing the job requiring intensity j. Then, equilibrium requires equality of the frequencies in each "intensity-compartment" and the indicated wage function results. The outcome is similar to a one-commodity, reduced-form equation, where the equilibrium price also depends positively on demand variables and negatively on supply variables. The analogy is immediate from substituting quantity in the one-commodity model for frequency, and supply and demand variables for intensities of the aspects.

The model works fine for excess demands for higher educated workers, but in the case of excess supply has some unusual implications. Suppose the supply of college educated workers becomes so large that their marginal productivity in college jobs will fall below that of high school educated workers performing in high school jobs. Then, college educated workers can seek jobs that require high school education (and even increase the marginal productivity gap, since they are more productive than the high school educated) and obtain a higher wage than in college jobs, presumably compensating them for the divergence between their actual and required education. Even in the short run, such compensation for underutilization seems unlikely; one might expect this to be competed down by other college workers pouring into high school jobs. The implication follows from Tinbergen's utility function, which is symmetric in over- and underutilization. Empirical evidence should settle the matter.

The supply-and-demand model can be represented by the following predictions.

1. Wage rates respond to changes in supply and demand: Excess demand in any labor market compartment will be eliminated by wage increase.

2. For workers with given characteristic i, working in jobs requiring j, wages w_{ij} are ranked by $w_{ii} \leq w_{ij}$, all j.

3. Wage rates are positively related to required intensity of relevant aspects, negatively to available intensity.

The Multicapability Model

The multicapability theory, developed in Hartog (1978a, summarized in 1978b) builds on the same basis as the supply-and-demand theory, but employs different specifications. Key variables are capabilities: those characteristics of an individual that determine his productive potential. Individuals are endowed with stocks of capabilities, jobs require a certain level of each capability. Strong assumptions are made on the nature of these capabilities: measurable on a ratio scale, perfectly divisible and separable. This definition permits the use of the standard price-theoretic framework for further analysis: Capabilities can analytically be considered as commodities in the sense of economic theory for which a market clearing unit price can be established.

Allocation of individuals to jobs is along neoclassical lines. On the demand side, jobs can be performed with different combinations of capabilities (i.e., substitution between amounts of the capabilities is allowed for) and requirements will be specified as the least-cost capability combination. Individuals decide on their labor market behavior through the choice of capability supply, maximizing a utility function that includes consumption and the extent to which capabilities are employed in a chosen job (reflecting efforts). Hence, job choice comes down to the choice of a supplied combination of capabilities.

Due to the assumption of a perfect labor market (and of separability and divisibility of capabilities), the shape of the observed income distribution is mainly supply determined. It is a transformation of the frequency distribution of available capabilities, transformed by capability prices and individual supply behavior (the extent to which individuals choose to employ their capabilities). For example, if the market value of individuals' total capability endowment is normally distributed, and if preference for effort (the extent of capability utilization) is also normally distributed, the observed income distribution is positively skewed (unless there is strong negative correlation between individual market value of capability endowment and effort preference). (See Hartog, 1977a, p. 114; 1978b.)

The theory stresses the distinction between individuals' available capability stocks and the actual use of capabilities, or the levels required in the job. Wage rates are related to required capability levels, not to actual available levels. Note that the theory can also deal with a phenomenon like "skill stripping", a concept used in dual and radical labor market theory (see Sørensen and Kalleberg, 1977). Skill stripping involves downgrading of labor, from reorganization of jobs in order to break them up into simple, routine components. The multicapability theory predicts reorganization of jobs if the price of a particular capability increases: Substitution will reduce its use.

A key question is whether jobs are decomposable or nondecomposable capability bundles. Assuming that jobs are divisible and that capabilities are homogeneous and separable leads to the prediction of a wage function that is linear in the (required) capabilities. This is a major contrast to standard hedonic models (Lucas, 1977; Rosen, 1974). The difference arises from the scope for arbitrage, which is effectively ruled out in these standard models, but not in the present one. The possibility of arbitrage can be envisaged as follows. Suppose each capability can be associated uniquely with a particular set of activities or tasks, and that jobs constitute different mixes of these tasks, i.e., job requirements can be specified as the number of each type of task that have to be performed in a standard period. Let individual capability stocks relate directly and proportionately to the number of tasks of the associated type that the individual can perform in a standard period of time (cf. Sattinger, 1975). If the tasks to be performed in a job can be done independently by different individuals and in any combination of part-time workers, without loss in productivity, then, obviously, a perfect market will establish unit prices for the different tasks and hence for capabilities. Clearly, linearity of the wage function is an important target for empirical testing.

In summing up, the multicapability model brings the following hypotheses to test.

1. Wage rates respond to changes in supply and demand: Excess demand will be eliminated by wage increase.

2. Wage rates are related to required capabilities rather than available capabilities.

3. The wage function is linear in required capabilities.

4. An increase in the price of a capability will lead to the redesigning of jobs so that the use of that capability is reduced.

<u>A Synopsis</u>

In reviewing the four theories described above, some common elements turn up which may lead to a condensed testing program. The foremost question is that on wage rigidity as opposed to wage flexibility. Wage rigidity singles out the job competition model from the other three models. Hence, wage responsiveness to changes in supply and demand conditions comes out as a prime hypothesis worth testing.

Neoclassical theory is unique in its assumption that equally endowed individuals will obtain equal pay. The other three theories stress that equal individuals may end up in different jobs with different pay. In the job competition model, the employer's selectivity and job rationing takes care of it; in the supply-and-demand theory as well as in the multicapability theory, individual choice creates the gap. The three models differ in the specification of the earnings function, however: The multicapability theory prescribes required intensities, the supply-and-demand theory prescribes required and supplied intensities, the job competition model defies earnings equations. Hence, the proper specification of the earnings equation is another battleground for testing.

Note that both the job competition model and the multicapability model relate wages to job characteristics rather than personal characteristics, but for different reasons. In the multicapability model, individuals' preferences, at given prices, drive a wedge between available and supplied levels of variables. Market constraints have no effect on this. By contrast, these constraints are essential in the job competition model: Job rationing will generally prevent the exact matching of available and required levels.

Approaching the issue from the other side, observed deviations between available and required levels may have two causes: individual preferences and market restrictions, each with quite different implications from a welfare perspective. How can they be disentangled? It would seem that the nature of the variable concerned is important. If the discrepancy relates to a variable where higher levels are usually obtained through efforts of some sort and aim primarily at labor market utilization, a gap cannot be expected to arise from well-informed, free individual choice. Such a gap usually entails a welfare loss. With nonaugmentable variables, or variables where levels may be increased for other reasons than labor market activities (i.e., consumption), the two causes are not so easily separated. Although the first category is conceptually clear, examples may be harder to find. Perhaps a good example is strictly vocational education (as contrasted with education of a more general nature, which may serve other purposes).

The incidence of unemployment on different job-worker categories seems a very interesting and relevant topic, but the predictions are not sufficiently discriminating. Both neoclassical theory and the job competition would explain the inverse relation of unemployment to level of skill, while the other two theories have (as yet) no predictions on that. The topic should therefore be set aside for the time being.

3. EVIDENCE

Introduction

In section 2, particularly in the synopsis, it became clear that the conflict in theories revolves around two basic problems which will be dealt with separately: One is wage flexibility, the other is the nature of the earnings function. Existing evidence is scanty. Using the neoclassical model of wage competition, there have been ex post explanations of observed phenomena such as the movement of skill differentials, but deliberate tests where the data determine the tenability of a hypothesis are rare. Reder (1960) provides support for the neoclassical model mainly by applying it to interindustry differentials.[8] Keat (1960) supports the human capital approach to wage differentials. In his tentative but careful calculations, the drop in apprenticeship durations and the increase in apprentice wages (both reducing training costs) yield changes in skill differentials between 1903 and 1956 that match the observed changes quite well.

Work on the proper specification of the earnings function as outlined here is even scarcer. Some first attempts are given in Berkouwer, Hartog and Tinbergen (1978) with mixed results. Demanded intensities yielded slightly better explanations than available intensities; introduction of both available and required intensities produced expected signs in many cases, though not in all. Thurow and Lucas (1972) included "years overeducated" and "years undereducated" in their regressions. The former got positive coefficients supporting the supply-and-demand model, the latter negative coefficients (rejecting its symmetry).

Wage Flexibility

An ideal test of wage flexibility would begin from knowledge of supply and demand curves, shifts in these curves over time, and confrontation of the predicted change in wage rates with the actual change. Usually, the knowledge of supply and demand curves is not available from observations independent of wage-and-employment figures. Even independent knowledge of exogenous shifts in the curves is not readily available.

In the absence of the above mentioned knowledge, other methods have to be used. An obvious first step is to see whether there is any change at all in the wage structure over time, hence calculate the correlation between wage rates at different points in time (both the Pearson product-moment and the Spearmen rank correlation coefficient can be calculated). But the test comes closer to the target if employment data are used as well. The neoclassical model generally predicts an association between wage rate changes and employment changes, coming about through exogenous shifts in the curves. Although the model cannot predict the relation between the two variables without further information, it does imply a binary prediction: either wages and employment change, or neither changes (i.e., if employment does not change, the curves have not shifted and hence, the wage rate should be unchanged). The prediction implicitly rules out three situations:

1. perfectly elastic or perfectly inelastic relative supply,
2. perfectly elastic or perfectly inelastic relative demand,
3. a coincidental shift in supply and demand curves such as to trace out a straight line of successive equilibrium points.

Ruling out these situations as generally applicable seems reasonable,[9] and hence, a test can be performed by selecting an appropriate criterion level for "no change" (e.g., < 5%) and calculating a bivariate contingency table from data on earnings and employment for many occupations at different points in time. Census data for 1940, 1950, and 1960 allow such a test and work on it is now underway.

The Earnings Equation

Proper tests of the earnings equation require data about both supplied and required levels of relevant variables. Attempts to collect data have just begun.[10] The proposed procedure is to match job requirements from the *Dictionary of Occupational Titles* with available levels of variables from individual micro-data sets that contain job information in the Census classification scheme. With such data, the alternative specifications outlined in section 2 can be tested.

4. ALLOCATION UNDER IMPERFECT INFORMATION

Introduction

The theories discussed so far deal with allocation in a situation where individuals' abilities and their accompanying marginal productivities in different jobs are known with certainty, without any cost.[11] This is obviously a deviation from the real world and an attempt will now be made to get closer to reality.

In the existing literature on allocation under uncertainty, Spence's signaling model assumes a prominent position (Spence, 1973, 1974), together with some related models on screening such as Arrow (1973). In these models, individual abilities and/or marginal productivities are not known, but background provides information on the probability distribution of marginal productivities. In a signaling equilibrium, employers' beliefs about these probability distributions are confirmed, because individuals' investment in acquiring signals ("background" variables such as education) is consistent with these beliefs and with employers' selection of individuals for different jobs. The model serves as an alternative to the skill-augmenting view of education in the human capital approach and also has been used extensively to explain discrimination in the labor market (see Aigner and Cain [1977] for references and critique).

A basic flaw of these models is the lack of learning about individuals' abilities. It seems reasonable to assume that marginal productivity in a given job differs for individuals of different ability. Hence, ability will be revealed from observed marginal productivity. The assumption clearly does not hold if either marginal productivity is entirely a characteristic of the job, with no scope whatsoever for individual variation, or if marginal productivity cannot be observed at all. The former situation may occasionally occur in very specific jobs, but is certainly not a general feature of the labor market. It also seems unrealistic to claim that marginal productivity can never be observed, but even so, any measure of performance used instead of marginal productivity will lead to essentially the same results and performance is certainly an observable variable.

If abilities are revealed in the process of production, the uncertainties will be reduced over time: Information builds up and decisions can be made more accurately. This means that the analysis should be expanded to cover such improved information over time and this section will do just that. First, a simple one-period model will be developed to set the stage and next, a two-period model will be studied, with imperfect information applying only to the first period. It will be demonstrated that shapes of age-earnings profiles can be linked to the process of accumulating information and the ensuing allocation adjustments. It will also appear that there is only limited scope for market signaling: It will be confined to the first period only.

A Single-Period Model

Consider first a model where time is not broken up in periods and where conditions do not change. Let potential employees be distinguished into two background categories, b_1 and b_2. Any useful variable can be employed to define these categories, such as education, training, family background, race, and sex.[12] The level of capability of an individual is also dichotomized, into k_1 and k_2, where k_1 will be denoted as the higher capability level.[13] Also, there are two job types, j_1 and j_2. The following assumptions will be made.

Assumption 1.1 Background can be observed without error and without cost.

Assumption 1.2 Capabilities cannot be observed, but there is a known probability p_1 that an individual with background b_1 has capability level k_1 and a known probability p_2 that an individual with background b_2 has capability level k_1. In matrix form

		background	
		b_1	b_2
capability	k_1	p_1	p_2
	k_2	$1-p_1$	$1-p_2$

It will be assumed that $p_1 > p_2$.

Assumption 1.3 The relation between marginal productivity and capability is known with certainty. Let mp_{ij} indicate the marginal productivity in job i of individuals with capability level j.

Again in matrix form

		job	
		j_1	j_2
capability	k_1	mp_{11}	mp_{21}
	k_2	mp_{12}	mp_{22}

It will be assumed that $mp_{11} > mp_{12}$ and that $mp_{21} > mp_{22}$: k_1 individuals are better at both jobs.

Assumption 1.4 Wages are given in the market and determined by background class, and will be indicated as $w(b_i)$ for background b_i.

The model thus has a built-in association of background b_1 with the higher capability level k_1 $(p_1 > p_2)$; higher capability manifests itself in higher marginal productivity $(mp_{i1} > mp_{i2}, i = 1, 2)$. How will labor be allocated in this model? Will background serve as the variable through which individuals are assigned to different jobs?

An employer, considering whether to hire b_1 or b_2 for j_1 will be assumed to decide according to the highest expected net return. Hence, in j_1, he will hire b_1 if the net return from hiring b_1 is greater than the net return from hiring b_2:

$$p_1\, mp_{11} + (1 - p_1)mp_{12} - w(b_1) > p_2\, mp_{11} + (1 - p_2)mp_{12} - w(b_2) \tag{1}$$

or

$$p_1 > p_2 + \frac{w(b_1) - w(b_2)}{mp_{11} - mp_{12}}\,. \tag{2}$$

Thus, b_1 is hired for j_1 if the probability of obtaining the higher marginal product is sufficiently high to make up for the differential in wages. Similarly, he will hire b_2 for j_2 if

$$p_2\, mp_{21} + (1 - p_2)mp_{22} - w(b_2) > p_1\, mp_{21} + (1 - p_1)mp_{22} - w(b_1) \tag{3}$$

or

$$p_1 < p_2 + \frac{w(b_1) - w(b_2)}{mp_{21} - mp_{22}}\,. \tag{4}$$

Background effectively distinguishes the labor force according to the job that employers will prefer them for (i.e., b_1 to j_1 and b_2 to j_2, a "$\{b_i, j_i\}$ allocation") if conditions (1) and (3) hold simultaneously. The joint condition can be written as a condition on wage rates:

$$w(b_2) + (p_1 - p_2)(mp_{21} - mp_{22}) < w(b_1) < w(b_2) + (p_1 - p_2)(mp_{11} - mp_{12}). \quad (5)$$

Assumptions (1.2) and (1.3) imply that all bracketed terms are positive, and this implies

$$w(b_2) < w(b_1). \quad (6)$$

Alternatively, the joint occurrence of conditions (1) and (3) can be written as a restriction on p_i

$$p_2 + \frac{w(b_1) - w(b_2)}{mp_{11} - mp_{12}} < p_1 < p_2 + \frac{w(b_1) - w(b_2)}{mp_{21} - mp_{22}} . \quad (7)$$

Since $w(b_1) > w(b_2)$, a necessary condition for (7) is

$$mp_{11} - mp_{12} > mp_{21} - mp_{22} . \quad (8)$$

This is an interesting and appealing condition. It states that the productivity gap of k_1 over k_2 should be greater in j_1 than in j_2. Condition (8) will be referred to as <u>comparative advantage</u>. The condition reminds us of comparative advantage as used by Sattinger (1975) to explain positive skewness in the distribution of earnings but is not identical to it.[14] Comparative advantage seems a condition that is easily met in reality: At "higher-level" jobs, the scope for differences in marginal productivity and even for disasters from assigning low capability individuals to them, is undoubtedly larger than at low levels. Stated otherwise, at low levels, the productivity gain of employing high-ability workers is far less than at high-level jobs.

Clearly then, in this model it is possible to have an outcome where b_1 is allocated to j_1 and b_2 to j_2, with $w(b_1) > w(b_2)$, provided the probability of capability level k_1 in background class b_1 is in some well-defined interval; for this interval to be nonempty, k_1's productivity advantage at j_1 should be greater than at j_2 ("comparative advantage"). Inequalities (5) and (7) reflect necessary and sufficient conditions for the (b_i, j_i) allocation, while comparative advantage (8) is only a necessary condition. Note that a necessary condition for b_1 and b_2 to be hired at all in j_1, resp. j_2 is non-negative net return, i.e.,

$$w(b_1) \leq p_1 \, mp_{11} + (1 - p_1)mp_{12}, \tag{9}$$

$$w(b_2) \leq p_2 \, mp_{21} + (1 - p_2)mp_{22}. \tag{10}$$

Writing out conditions similar to (1) and (3) for different allocations is straightforward. Such conditions yield,

$$\text{in } j_1,\ b_1 \text{ is preferred if } p_1 > p_2 + \frac{w(b_1) - w(b_2)}{mp_{11} - mp_{12}}, \tag{11}$$

$$b_2 \text{ is preferred if } p_1 < p_2 + \frac{w(b_1) - w(b_2)}{mp_{11} - mp_{12}}. \tag{12}$$

$$\text{In } j_2,\ b_1 \text{ is preferred if } p_1 > p_2 + \frac{w(b_1) - w(b_2)}{mp_{21} - mp_{22}}, \tag{13}$$

$$b_2 \text{ is preferred if } p_1 < p_2 + \frac{w(b_1) - w(b_2)}{mp_{21} - mp_{22}}. \tag{14}$$

The situation where b_1 is preferred in j_1 and b_2 is preferred in j_2 was already encountered. In both j_1 and j_2, b_1 will be preferred if the most binding of conditions (11) and (13) applies, and assuming comparative advantage this is (13). Similarly, for b_2 to be preferred in j_1 and j_2, the most binding of conditions (12) and (14) should apply, and this is (12). Taken together, these results imply that three situations can be distinguished.

1. b_2 is hired only

$$0 < p_1 < p_2 + \frac{w(b_1) - w(b_2)}{mp_{11} - mp_{12}}. \tag{15}$$

In this case, p_1 is so low that b_2 is preferred in both jobs. Rewriting as a wage condition yields

$$w(b_2) + (p_1 - p_2)(mp_{11} - mp_{12}) < w(b_1). \tag{16}$$

For b_2 to be hired at all it should be that at least expected net return is non-negative in the most productive job:

$$w(b_2) \leq \max\{(p_2\ mp_{11} + (1 - p_2)mp_{12}),\ (p_2\ mp_{21} + (1 - p_2)mp_{22})\}. \tag{17}$$

Then b_2 would be hired in this most productive job only.

2. (b_i, j_i) allocation

$$p_2 + \frac{w(b_1) - w(b_2)}{mp_{11} - mp_{12}} < p_1 < p_2 + \frac{w(b_1) - w(b_2)}{mp_{21} - mp_{22}} . \tag{18}$$

This is the case already encountered: b_1 to j_1 and b_2 to j_2. The wage conditions are

$$w(b_2) + (p_1 - p_2)(mp_{21} - mp_{22}) < w(b_1) < w(b_2) + (p_1 - p_2)(mp_{11} - mp_{12}), \tag{19}$$

$$w(b_1) \leq p_1 mp_{11} + (1 - p_1)mp_{12}, \tag{20}$$

$$w(b_2) \leq p_2 mp_{21} + (1 - p_2)mp_{22}. \tag{21}$$

3. b_1 is hired only

$$p_2 + \frac{w(b_1) - w(b_2)}{mp_{21} - mp_{22}} < p_1. \tag{22}$$

In this case, p_1 is so high that b_1 is preferred in j_1 and j_2; the wage conditions are

$$w(b_1) < w(b_2) + (p_1 - p_2)(mp_{21} - mp_{22}), \tag{23}$$

$$w(b_1) \leq \max\{(p_1 mp_{11} + (1 - p_1)mp_{12}), (p_1 mp_{21} + (1 - p_1)mp_{22})\}. \tag{24}$$

Denoting $w(b_1) - w(b_2)$ in case i by Δ_i the result implies (from (16), (17), (23) and Assumptions 1.2 and 1.3):

$$\Delta_1 > \Delta_2 > \Delta_3 \tag{25}$$

Also, cases (1) and (2) imply $w(b_1) > w(b_2)$, from (16), (19) and Assumption 1.2, while case (3) does not. The situations can be summarized as follows. In a situation where p_1, the probability of capability level k_1 in background class 1 is low, and the wage differential $w(b_1) - w(b_2)$ is large, b_2 will be preferred both in j_1 and j_2. In a situation where p_2 is large and the wage differential $w(b_1) - w(b_2)$ is small, b_1 is preferred in j_1 as well as in j_2. In a situation with intermediate values of p_1 and the wage differential, background will be used to discriminate individuals between the two jobs.

It is worthwhile to bring out one particular implication of the present model. Suppose, wage rates were equal, i.e.,

$$w(b_1) = w(b_2). \tag{26}$$

Then, it is clear from the three cases just distinguished, and from the asssumption $p_1 > p_2$, that case 3 applies: b_1 is preferred in j_1 as well as in j_2 and b_2 will not be hired at all. In other words, for b_2 to be hired at all $w(b_1) = w(b_2)$ should be ruled out and, in fact, $w(b_1) > w(b_2)$ is a necessary condition (condition 22 should not hold): If different backgrounds have different expected marginal productivities, wage rates should differ in the same direction, otherwise only the most productive background class will be hired.

A Two-Period Model

As observed in the introduction, it is unrealistic to assume that information on the workers' actual abilities and/or marginal productivities will never be obtained. Therefore, the model presented in this section will investigate consequences of learning about individuals' productivity while they are engaged in the production process. The following assumptions will be made.

<u>Assumption 2.1</u> As before, background b_i is observed without cost, without error. The relation between capability, background and marginal productivity is also unchanged:

	Probability		Marginal Productivity	
	b_1	b_2	j_1	j_2
k_1	p_1	p_2	mp_{11}	mp_{21}
k_2	$1-p_1$	$1-p_2$	mp_{12}	mp_{22}

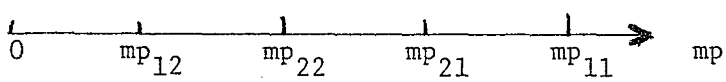
<u>Assumption 2.2</u> It will be assumed that $p_1 > p_2$.

<u>Assumption 2.3</u> It will be assumed that $mp_{i1} > mp_{i2}$, $i = 1, 2$

$$mp_{11} > mp_{21}$$

$$mp_{12} < mp_{22}.$$

This means that the ranking of marginal productivities can be displayed as follows:



These assumptions are easily acceptable, with the possible exception of the last one. This expresses that allocating k_2 to j_1 would be very detrimental to output: k_2 would be unable to turn j_1 into a more productive job than j_2, as k_1 would do. The condition seems quite adequate for significant differences between k_1 and k_2 as well as between j_1 and j_2, but may be inadequate for neighboring positions on a fine scale (recall also the comments on (8), absolute advantage). As examples, one may think of incompetent managers doing more harm than good, or of an incompetent mechanic ruining a client's car.

<u>Assumption 2.4</u> In contrast to the previous model, it will now be assumed that there are two time periods. A time period is defined on the length of experience of an individual. If individuals enter the firm, only their background is certain, their marginal productivities are not. However, at the end of the first period their marginal productivities are supposed to be known, with certainty, and hence their capabilities are unveiled. Relocation of individuals can take place and it will be assumed that this is costless.

The model thus starts out with the same uncertainties as the simple model, but at the end of the period they are eliminated: Information is a joint product along with the commodity output. The situation in the second period is easiest to analyze. Since relocation is costless, period 2 can be studied independently of period 1. The optimum allocation will be k_1 in j_1 and k_2 in j_2 on the following grounds. Marginal productivities are known and wages will be paid accordingly (assuming the individuals can always leave the firm and get their worth elsewhere).[15] This means that k_1 will prefer j_1 to j_2, since $mp_{11} > mp_{21}$; similarly, k_2 will prefer j_2, since $mp_{12} < mp_{22}$: Earnings maximization will drive individuals to their best option.

Note that this model drastically reduces the scope for statistical discrimination. If productivities can be inferred during some initial production period, since abler individuals will be more productive at any job,[16] optimal allocation (and concomitant pay) according to ability can be accomplished later. Similarly, the potential role of signaling is diminished. At best, it has some relevance for the initial period, when abilities are not yet known, but if this period is sufficiently short, and the cost of obtaining signals sufficiently high, the investment will not pay off.

What happens in the first period depends crucially on the wage rate, as before. Suppose that wages would only differ by job and that wages for first-period workers would equal those for second-period workers. Thus, with $w_j\ (b_i)$ for the wage in job j for individuals with background b_i, this means

$$w_j(b_i) = mp_{jj}. \tag{27}$$

Wages do not differ by background, and the results of the first model reappear, as is easily shown. Let R_{ij} indicate the net return from allocating b_j individuals to j_i (marginal productivity minus wage rate). Then

$$R_{11} = (1 - p_1)(mp_{12} - mp_{11}) < 0, \tag{28}$$

$$R_{21} = p_1(mp_{21} - mp_{22}) > 0, \tag{29}$$

$$R_{12} = (1 - p_2)(mp_{12} - mp_{11}) < 0, \text{ and} \tag{30}$$

$$R_{22} = p_2(mp_{21} - mp_{22}) > 0. \tag{31}$$

Then, obviously neither b_1 nor b_2 individuals will be allocated to j_1: In j_1 both will yield negative returns to the firm, while in j_2 they will yield a positive return. Comparing (29) and (31) reveals that the firm does not want to hire any b_2 at all: since $p_1 > p_2$ and $mp_{21} > mp_{22}$,

$$R_{21} > R_{22}. \tag{32}$$

This means that if wage rates in a job were equal for "experienced" and "inexperienced" workers, b_2 individuals would not be given the opportunity to reveal their capability. Individuals from less favorable backgrounds would not be able to enter the labor force.

Suppose, wages do differ by experience and in fact, let the differential $\{(b_i, j_i), i=1, 2\}$ allocation of the first model apply in the first period. Then, dynamic implications can be studied from comparing the first period results to the second period results. Recall the wage condition, (19)

$$w(b_2) + (p_1 - p_2)(mp_{21} - mp_{22}) < w(b_1) < w(b_2) + (p_1 - p_2)(mp_{11} - mp_{12}). \quad (19)$$

Individuals' wages can now be compared over time, keeping in mind that in period 2, k_1 will be allocated to j_1, earning mp_{11} and k_2 to j_2, earning mp_{22}. Thus

	Wage in period 1	Wage in period 2
k_1 in b_1	$w(b_1)$	mp_{11}
k_1 in b_2	$w(b_2)$	mp_{11}
k_2 in b_1	$w(b_1)$	mp_{22}
k_2 in b_2	$w(b_2)$	mp_{22}

Now, recall the necessary conditions of case 2 in the one-period model

$$w(b_1) \leq p_1 mp_{11} + (1 - p_1)mp_{12}, \quad (20)$$

and $$w(b_2) \leq p_2 mp_{21} + (1 - p_2)mp_{22}. \quad (21)$$

It is now clear from (19) and (20) that

$$w(b_2) < w(b_1) < mp_{11}.$$

Thus, k_1 will always increase his wage from period 1 to period 2, but for k_2 the outcome is uncertain: It may go up or down, depending on his first period wage. If (20) and (21) hold as equalities, k_2 in b_2 will certainly experience a drop in income, while this may also apply to k_2 in b_1 if mp_{12} is not too low. Note that this model immediately has the following important implications:[17]

1. In period 1, wages are determined by background variables, in period 2 by capabilities,
2. Individuals of higher capability will always increase their income over time,
3. The income gain for individuals of higher capability will be larger for those from less favorable background,
4. Within a given background class, the income increase of individuals of higher capability will always surpass that of individuals of lower capability.

Implications

It would seem that two implications of the model are of foremost importance. One is the impact of information on shaping careers and age-income profiles. Early in the labor force attachment of individuals, abilities are known far less accurately than later, when output has been observed. This can lead to a situation where initially many different individuals are treated equally, but where the differences are brought out as experience accumulates. The model presented here formally demonstrated such a situation but other motives may reinforce the effects. For example, risk aversion may lead to a situation where employers prefer "underassignment" to "overassignment" in the initial period and then promote the better individuals rather than downgrade the lesser ones.

Another important implication deals with the selection of variables in an earnings equation. In the model given here wages were initially determined by background, by capabilities later. This can be interpreted in various ways. First, it implies that background variables will become less important in earnings equations as experience accumulates: They should ultimately become statistically insignificant in an equation that also contains true capability measures.[18] Conversely, if a variable's explanatory power dwindles with experience this may be taken as evidence that it serves as a screening variable initially, but looses out against the true capability variables later. There is yet another way of reaching the conclusion: Within any background class, the variance of income will <u>increase</u> over time, within a capability class the variance will <u>reduce</u> over time, as earnings become more closely related to capabilities.

5. CONCLUDING REMARKS

This paper has outlined some alternative models of the labor market and the income distribution it generates. It appeared possible to extract some predictions that discriminate between the theories, although the distinctions are certainly not yet sufficient for final choices (if ever). Further work is needed to carve out these sharper distinctions. In the meantime, the predictions that can be tested provide enough stimulus for some relevant empirical work.

Appendix to Section 4: The Perfect Competition Situation

The One-Period Situation

In the main text, it is assumed that wages are given in the market and that employers decide on the allocation of workers. Suppose now that the market would drive wages down to expected marginal product in any occupation that individuals would bid for, and thus would differ both by background and job in the first period, i.e.,

$$w_j(b_i) = p_i \, mp_{j1} + (1 - p_i) mp_{j2}. \tag{a1}$$

Then, employers would be indifferent among all possible allocations, since marginal net revenue would be zero in all cases. Allocation is then determined by individual choice. Assuming individuals maximize earnings, b_1 will prefer j_1 if

$$p_1 \, mp_{11} + (1 - p_1) \, mp_{12} > p_1 \, mp_{21} + (1 - p_1) \, mp_{22}, \tag{a2}$$

and b_2 will prefer j_2 if

$$p_2 \, mp_{11} + (1 - p_2) \, mp_{12} < p_2 \, mp_{21} + (1 - p_2) \, mp_{22}. \tag{a3}$$

Taking (a2) and (a3) together and rewriting yields

$$p_2\{(mp_{11} - mp_{12}) - (mp_{21} - mp_{22})\} < mp_{22} - mp_{12} < p_1\{(mp_{11} - mp_{12}) - (mp_{21} - mp_{22})\} \tag{a4}$$

The peripheral elements in (a4) are recognized as the extent of comparative advantage (cf. equation 8), weighted by the probability of k_1 in each background class. Assuming comparative advantage to exist, (a4) implies

$$0 < mp_{22} - mp_{12}. \tag{a5}$$

Hence, if comparative advantage exists, a (b_i, j_i) allocation now requires that individuals of capability k_2 are more productive at j_2 than at j_1. In fact, defining A as the extent of comparative advantage,

$$A \equiv (mp_{11} - mp_{12}) - (mp_{21} - mp_{22}), \tag{a6}$$

the required condition for a (b_i, j_i) allocation can be written as

$$p_2 < \frac{mp_{22} - mp_{12}}{A} < p_1. \tag{a7}$$

In other words, k_2's productivity differential at the two jobs, relative to the extent of comparative advantage should be in the interval bounded by p_2 and p_1.

The Two-Period Situation

Assume, the (b_i, j_i) allocation of the previous section applies to the first period. Then

$$w_1(b_1) = p_1\ mp_{11} + (1 - p_1)\ mp_{12} < mp_{11}, \tag{a8}$$

$$w_2(b_2) = p_2\ mp_{21} + (1 - p_2)\ mp_{22} < mp_{22}. \tag{a9}$$

In the second period, there will be a (k_i, j_i) allocation and the wage sequences are as follows

	wage in period 1	wage in period 2
k_1 in b_1	$w_1(b_1)$	mp_{11}
k_1 in b_2	$w_2(b_2)$	mp_{11}
k_2 in b_1	$w_1(b_1)$	mp_{22}
k_2 in b_2	$w_2(b_2)$	mp_{22}

Assumption 2.3 ($mp_{11} > mp_{21} \geq mp_{22}$) implies

$$mp_{22} < mp_{11}. \qquad \text{(a10)}$$

Then, 3 out of 4 conclusions of this section on the two-period situation hold again:

1. In period 1, wages are determined by background, in period 2 by capabilities.
2. k_1 individuals will always increase their income over time, since $mp_{11} > w_1(b_1)$ by (a8) and $mp_{11} > mp_{22} > w_2(b_2)$ by (a9) and (a10).
3. Within background classes, k_1 individuals always have larger income gains than k_2 individuals, since the former rise to mp_{11} and the latter to mp_{22} (where $mp_{11} > mp_{22}$), either from $w_1(b_1)$ or from $w_2(b_2)$.

Larger income gains for k_1 individuals from less favorable background cannot be proven, since $w_1(b_1) > w_2(b_2)$ cannot be established.

NOTES

[1]The wage structure may entail wage differences of only a few percentages, leaving little scope for single compartment adjustments.

[2]Note that marginal productivity resides in the job, not in the man.

[3]According to Thurow (1975) "In job competition, wage differentials are fixed and the employer searches for workers with quality differentials that match or exceed the existing wage differentials. Ideally, he would like to find employees whose training costs are less than the existing gap between a job's marginal product and its wage" [p. 90]. "...However, within each job category employers hire workers until the marginal productivity of that job is driven down to the level given by the exogenous wage. Each job is paid in accordance with its marginal product" [p. 100]. The first statement permits a gap with which training costs can be matched, the second does not.

[4]The difference between net (observed) wages and gross wages is the worker's share of training costs.

[5]Thurow's (1975) statement above chart 3, page 93 comes closest.

[6]Since wages are exogenous, they cannot be "explained." Thurow gives no guidance to those who would like to run regressions of wages on explanatory variables. "Wages are paid based on the characteristics of the job . . ." [p.76]. But it is unknown which these characteristics are, apart from some tentative pointing to "costs" (effort, hardship, etc.) (p. 109). Generally, it is not easy to derive straightforward,

testable predictions, since many outcomes are made conditional. For example (p. 123), "A more equal labor queue may or may not lead to a more equal distribution of earnings."

[7]Positive response of supply to the wage rate produces the same result.

[8]His application to narrowing skill differentials over time is very indirect, just referring to the observed increase in average level of schooling.

[9]Alternatively, one might call it suspect if wage flexibility can only be maintained by refuge to any of these three conditions as a general situation.

[10]This is a joint project with Michael Olneck of the Institute for Research on Poverty.

[11]Imperfect knowledge is implicit in Thurow's theory, but the particular consequences are not investigated. Uncertainty is acknowledged by building the labor queue from expected training costs and the model reminds us somewhat of Spence's signaling approach (Spence, 1973, 1974), but the formation of expectations, possible feedback, the conditions of equilibrium, etc., are not explicitly dealt with.

[12]As to subscripts: whenever relevant, 1 denotes a "higher" level than 2 and in case of two subscripts the first one will refer to the job.

[13]k_i measures the capability level the individual is willing to supply and not necessarily his total available level (cf. the multicapability model, p. 12). Capabilities are defined as in the multicapability theory. Examples are intellectual, manual, social and executive capabilities.

[14]Comparative advantage as defined by Sattinger requires $mp_{11} / mp_{12} > mp_{21} / mp_{22}$; his definition implies comparative advantage as in (8) if $mp_{12} \leq mp_{22}$ (sufficient, not necessary condition).

[15]It also assumes that the individual can use the information on performance in his previous job; this seems to be more common than employers withholding the information. The issue was raised at a presentation of the model at the Institute.

[16]Note the implicit restriction here: in the real world, it may be that a particular job can only reveal capabilities relevant to a limited set of other jobs, not for all. The point was made by Glen Cain.

[17]The Appendix demonstrates that the essential conclusions also obtain under perfect competition, where the wage rate in each job would always equal expected marginal productivity for those selected into that job.

[18]Examples of such measures are used in Hartog (1978 a,b,c) and Berkouwer et.al. (1978); see also note 13. More work is needed however, on the operational specification of such "true capability measures." The present model suggests that the information that comes along with experience should be incorporated.

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