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Larry S. Zudak

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L. S. Zudak

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THE ALLOCATION OF LABOR BY THE MAXIMIZATION
EXPECTED MILL-TIME EARNINGS*

It has been apparent for some time that the traditional explanation
of labor based on changes in work effort or horizontal mobility in response
to wage changes is inadequate in a modern industrial economy. Instead, a
theory of human capital has been developed to explain: earnings and pro-
ductivity, unemployment and turnover, on the job training, investment and
its return etc.¹ In many labor markets, these factors are institutionalized
in the concept of an occupation. Since the supply of labor in economic
theory is defined for the individual firm and worker, a theoretical hypo-
thesis is needed to consider the combined impact of these variables on the
individual worker's choice of occupations and thus the allocation of un-
skilled labor between competing occupations for a specific firm. The
problem of a new entrant in the labor pool of a steel mill department is
analogous to that of a new entrant in the general economy. He must choose
one occupation, sequence, from among those available. But the problem is
simplified because occupations, wages and promotional criteria are all
rigorously defined by the same contract, the United Steelworkers. In a
steel mill related jobs are organized hierarchically into sequences so
that each job serves as a training step for the next. Each job pays a
sufficient differential over the job below to insure that workers accept
promotion. Investment in the form of training for the job above occurs
automatically while working as part of a crew. The return on investment is

¹P. 13, Becker, G. Investment in Human Capital. National Bureau of

*This study benefitted greatly from the advice of Professor Ames, my
advisor, and Professors Ullman and Brown under Manpower Grant 91-16-68-35.

-1-
paid by promotion to a higher wage. In a rational firm the wage at each job level is determined by the contribution of that job to the joint productivity of the crew or department.

Sequences are organized so that each job provides training for the next. The supply of labor in any job can be increased (decreased) by promotion (demotion) based on continuous service in the sequence without hiring outside the sequence, eliminating the need for wage changes and undefined training lags since trained labor is a stock within the sequence. This has been established empirically by showing that horizontal mobility is insignificant and vertical nearly perfect.  

The analysis here will attempt to explain the supply of labor to entry level jobs in each sequence on the basis of individual worker choice. Since this choice is usually expected to be long term, often for life, the rational worker does not refer to the starting wage but to his lifetime earning prospects. This maximization of expected mill-time income by the worker allocates labor between competing sequences because the waiting period for an expanding sequence declines which increases its expected income. Relatively more workers choose the expanding sequence because its expected income has risen.

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\(^2\)See pp. 90-94, vertical mobility based on continuous service very high, horizontal mobility--out of twelve sequences tested none contained workers who had held skilled jobs in any other sequence; the expected value of semi-skilled labor transferring was less than 10% and even for unskilled workers did not exceed 20%. See pp. 90-91, "A Theoretical Analysis of the Supply and Demand for Labor in the Steel Industry," Volume I, CLFSTI, PB184069.
In order to discuss the maximization of mill-time income it is necessary to define the limits within which the maximization takes place. Just as the derivation of the consumer demand curve begins with the simplified case of a two good economy and then generalizes it to n goods, this analysis will define a function for calculating mill-time income and apply it first to choices within a department, then between departments and finally between firms. The effect of the business cycle and technology on this choice will also be considered. Although the real worker often only maximizes within a department after hiring because of inadequate information about sequence opportunities, it is still necessary to consider the generalized problem. The consumer only buys a few hundred from among the thousands of commodities available but it is still necessary to consider the general problem. Certain problems of generalized analysis are eliminated. The worker can set the value of any sequence or department equal to zero because he does not like heat or cannot hit a nail. For the worker this greatly reduces the actual difficulty of choosing an occupation. It is less difficult than it would be for efficiency experts. Further, the worker only has to choose for himself and the cost of knowledge is primarily paid by time invested in searching. The perfectly rational worker would stop seeking new information when its cost exceeded the gain in expected mill-time income.  

Derivation of Expected Mill-Time Earnings

In this section a function will be derived which assumes that skilled workers are necessary to production and that this requirement makes the worker's job choice a long term commitment. A function will be derived based on this assumption. The labor market being discussed in this paper, covers many separate steel producers which are close enough geographically to permit worker mobility. Many of these workers could fill equivalent jobs in other plants. However, the United Steelworkers' labor contract effectively eliminates their mobility by requiring that workers must enter a plant as laborers regardless of their previous experience. The specialization referred to by Reynolds, only functions to limit inter plant mobility in areas where only one steel plant is in operation. This specialization is rendered completely effective by the union and company formally limiting mobility by contract. The workers' desire for job security and the company's desire to recoup training costs and to have their trained labor stock available to expand output require the formal contract clauses discussed above. The need for a stock of trained labor is created by the uncertainty of the market.

Cartter states, "marginal analysis may apply in the long run". This is the period in which capital becomes variable. Steel output may expand 30% in a steel plant in three months but steel capacity and technology cannot be varied in three months. An expansion creates the need for additional highly trained workers who may take years to train. How does a firm or a department or a sequence, whose output is expanding even relatively succeed in obtaining additional unskilled workers? Its wages for entry level jobs do not change relative to the wages of other firms to allocate unskilled workers by traditional

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4 N.W. Indiana and South Chicago.

horizontal mobility. Yet, workers do go to the plant whose output is expanding. Plants are able to expand their output in three months or five months when capital is fixed, and need not wait for the "long run". A hypothesis is required which will serve to explain the allocation and motivation of unskilled labor when wages are fixed and horizontal mobility between competing markets for semi-skilled and skilled workers approaches zero.

In analyzing the allocation of workers by horizontal mobility, theoretical economics has largely ignored the difficulty and duration of training which requires a long term commitment of the worker. In traditional analysis the worker chooses a job by comparing current wages. The wage criterion is justified because the job choice could change immediately in response to a wage change, horizontal mobility and job choice are infinitely short. In the real world, workers chose occupations not jobs. Workers are not generally interested in horizontal mobility because they have invested years in training for their present sequence 6 and have no intention of starting over again at the bottom in a new sequence. They are interested in promotion, vertical mobility. The importance of promotion is exemplified by the notoriety given to it by those who do not have it. Policemen, high school teachers and social workers chronically complain about not having opportunity for upward mobility in their present line of work. Those listed have particular social importance because of the nature of their work. The remedy usually proposed is to provide periodic pay increases. These would provide a reasonable alternative to the promotions available elsewhere, and would therefore tend to keep experienced personnel in these occupations. Thus the remedy is to create an artificial sequence. Workers in general, and business school graduates in particular, avoid jobs without

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6 The average length of service of the employees of one steel company is over 11 years. It takes many 30- and 40-year men to make up for the new hirers.
"potential". The Department of Labor and a wide range of agencies realize the importance of long term earnings potential in career choice. In providing counselling information, they do not give the up-to-date hourly wages in various occupations. They give lifetime income figures and also indicate the formal investment in level of human capital necessary in the sequence in question. Table 4-1 contains examples of the investment and lifetime yield for several sequences.

Table 4-1

<table>
<thead>
<tr>
<th>Estimated Average Lifetime Earnings of Elementary and High School Male Graduates, Selected Occupations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lifetime earnings from age 18 to 64</td>
</tr>
<tr>
<td>-------------------------------------</td>
</tr>
<tr>
<td>Crafting, Foremen and kindred worker</td>
</tr>
<tr>
<td>Average</td>
</tr>
<tr>
<td>Brickmasons, stonemasons and tile setters</td>
</tr>
<tr>
<td>Carpenters</td>
</tr>
<tr>
<td>Composers and typesetters</td>
</tr>
<tr>
<td>Electricians</td>
</tr>
<tr>
<td>Linemen and Servicemen, telegraph-phoners</td>
</tr>
<tr>
<td>Machinists</td>
</tr>
<tr>
<td>Mechanics and repairmen</td>
</tr>
<tr>
<td>Painters, construction and maintenance</td>
</tr>
<tr>
<td>Plasterers</td>
</tr>
<tr>
<td>Plumbers and pipefitters</td>
</tr>
<tr>
<td>Toolmakers, diemakers and setters</td>
</tr>
<tr>
<td>Operatives and kindred workers</td>
</tr>
<tr>
<td>Average</td>
</tr>
<tr>
<td>Busdrivers</td>
</tr>
<tr>
<td>Mine operatives and laborers</td>
</tr>
<tr>
<td>Truck and tractor drivers</td>
</tr>
<tr>
<td>Operative and kindred workers</td>
</tr>
<tr>
<td>Service workers, including private household</td>
</tr>
<tr>
<td>Average</td>
</tr>
<tr>
<td>Barbers</td>
</tr>
<tr>
<td>Firemen, fire protection</td>
</tr>
<tr>
<td>Policemen and detectives</td>
</tr>
</tbody>
</table>

In selecting between competing sequences the worker must like the traditional worker consider:

(1) working conditions: hazards, etc.;
(2) physical and mental effort

but because of the long term nature of his commitment he must consider two additional factors suggested by Reynolds:

(3) length and difficulty of training;
(4) vulnerability to the business cycle (and technology), long run.

Factors (1) and (2) can be assumed equalized between competing sequences because to the extent possible, industrial engineers objectively classify jobs and set wages in each sequence so as to effectively equalize with respect to these two factors. Within any sequence a worker obtains wage increases by promotion to higher jobs in his occupation rather than by horizontal mobility to competing markets paying a higher wage. Because training is associated with tenure, promotion is dependent on length of service in the occupation. The fact that promotion and thus higher wages are associated with tenure severely reduces horizontal mobility. Although wages are equal between horizontally equivalent jobs, they are not equal between sequences, occupations. Thus the worker chooses a sequence by comparing sequences on the basis of wages offered in each job in the sequence over the projected finite length of the worker's commitment.

Any sequence consists of a series of jobs requiring increasing skill and training and paying increasingly higher wages, \( w_{ij} \) for the wage of the job \( j \) in sequence \( i \). In calculating the current expected mill-time earnings of sequence \( i \), the worker must not only consider the wage that he will receive at each level, \( w_{ij} \), but the total amount of time that he expects to spend earning it, \( E(t_{ij}) \), and subjectively discount, \( d_{ij} \), each \( w_{ij} \) for the length of time before it is attained. Since the wage ratios between various sequences are not permitted to change, the

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8 For a discussion of the job classification by engineers, see page 114 to 115, ibid. footnote 2.
worker can assume that \( w_{ij} \) will represent the same relative return in the future when he actually attains it as it does now. The variables needed to calculate mill-time income are \( w_{ij}, E(t_{ij}) \) and \( d_{ij} \), they will be defined below and then combined to derive the expected mill-time income for any sequence \( i \).

The wage rate paid for each job \( j \) in a sequence \( i \) is \( w_{ij} \). For simplification the analysis will use \( w_j \), the base wage of job class \( j \). A job in any sequence which was classified by industrial engineers as job class \( j \) will carry wage \( w_j \). The table on the following page shows that for all jobs in all sequences in the steel industry:

\[
\begin{align*}
  j &= \text{job class} \\
  1 &\leq j \leq 35
\end{align*}
\]

\( w_j \) is the base wage paid for same job class \( j \) in Table 2, is the same for all sequences, where for any sequence \( i \), \( w_{ij} = w_j \). Very few if any sequences contain all job classes, therefore no sequence will contain all \( w_j \). Every sequence includes \( w_1 \) which equals \$2.35, the labor pool wage rate. The first \( w_j \) for which \( j > 1 \) will be assumed to be the first job in the sequence. In some cases in the real world the entry level wage equals the wage of the first job in the sequence. Any sequence can be viewed as the sum of the wages which it contains. This can be viewed as its expected value. However, in comparing the expected values of sequences a discount must be placed on each current wage rate for how far in the future it will be attained in order to obtain for purposes of comparison, the present value of these sums.

For the \( j \)th job in \( i \)th sequence, the discount will be:

\[
\begin{align*}
  d_{ij} \\
  0 \leq d_{ij} \leq 1
\end{align*}
\]

In general \( d_{ij} \) in any sequence will be larger for higher level jobs than for lower. The relative differential in the discount for higher level jobs is determined by the worker's utility and need for current income versus future
Table 2.  
Contract Wages

In the steel industry the base wage rates, hourly, are set forth in the following list:

**WAGE SCALE - SICK BENEFITS - LIFE INSURANCE**

<table>
<thead>
<tr>
<th>Job Class No.</th>
<th>Hourly Rate</th>
<th>Day Rate</th>
<th>Sick Benefits based on your August 1, 1967 Classification</th>
<th>Life Insurance: Prior to Retired</th>
<th>Life Insurance: After Retired</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 &amp; 2</td>
<td>$2.4945</td>
<td>$19.56</td>
<td>$75.00</td>
<td>$4500</td>
<td>$1800</td>
</tr>
<tr>
<td>3</td>
<td>2.520</td>
<td>20.16</td>
<td>70.00</td>
<td>4500</td>
<td>1800</td>
</tr>
<tr>
<td>4</td>
<td>2.595</td>
<td>20.76</td>
<td>76.00</td>
<td>5000</td>
<td>1850</td>
</tr>
<tr>
<td>5</td>
<td>2.670</td>
<td>21.36</td>
<td>76.00</td>
<td>5000</td>
<td>1850</td>
</tr>
<tr>
<td>6</td>
<td>2.745</td>
<td>21.96</td>
<td>76.00</td>
<td>5000</td>
<td>1850</td>
</tr>
<tr>
<td>7</td>
<td>2.820</td>
<td>22.56</td>
<td>76.00</td>
<td>5000</td>
<td>1850</td>
</tr>
<tr>
<td>8</td>
<td>2.895</td>
<td>23.16</td>
<td>76.00</td>
<td>5000</td>
<td>1850</td>
</tr>
<tr>
<td>9</td>
<td>2.970</td>
<td>23.76</td>
<td>76.00</td>
<td>5000</td>
<td>1850</td>
</tr>
<tr>
<td>10</td>
<td>3.045</td>
<td>24.36</td>
<td>83.00</td>
<td>5500</td>
<td>1900</td>
</tr>
<tr>
<td>11</td>
<td>3.120</td>
<td>24.96</td>
<td>83.00</td>
<td>5500</td>
<td>1900</td>
</tr>
<tr>
<td>12</td>
<td>3.195</td>
<td>25.56</td>
<td>83.00</td>
<td>5500</td>
<td>1900</td>
</tr>
<tr>
<td>13</td>
<td>3.270</td>
<td>26.16</td>
<td>83.00</td>
<td>5500</td>
<td>1900</td>
</tr>
<tr>
<td>14</td>
<td>3.345</td>
<td>26.76</td>
<td>83.00</td>
<td>5500</td>
<td>1900</td>
</tr>
<tr>
<td>15</td>
<td>3.420</td>
<td>27.36</td>
<td>83.00</td>
<td>5500</td>
<td>1900</td>
</tr>
<tr>
<td>16</td>
<td>3.495</td>
<td>27.96</td>
<td>89.00</td>
<td>6000</td>
<td>1950</td>
</tr>
<tr>
<td>17</td>
<td>3.570</td>
<td>28.56</td>
<td>89.00</td>
<td>6000</td>
<td>1950</td>
</tr>
<tr>
<td>18</td>
<td>3.645</td>
<td>29.16</td>
<td>89.00</td>
<td>6000</td>
<td>1950</td>
</tr>
<tr>
<td>19</td>
<td>3.720</td>
<td>29.76</td>
<td>89.00</td>
<td>6000</td>
<td>1950</td>
</tr>
<tr>
<td>20</td>
<td>3.795</td>
<td>30.36</td>
<td>89.00</td>
<td>6000</td>
<td>1950</td>
</tr>
<tr>
<td>21</td>
<td>3.870</td>
<td>30.96</td>
<td>89.00</td>
<td>6000</td>
<td>1950</td>
</tr>
<tr>
<td>22</td>
<td>3.945</td>
<td>31.56</td>
<td>89.00</td>
<td>6000</td>
<td>1950</td>
</tr>
<tr>
<td>23</td>
<td>4.020</td>
<td>32.16</td>
<td>96.00</td>
<td>6500</td>
<td>2000</td>
</tr>
<tr>
<td>24</td>
<td>4.095</td>
<td>32.76</td>
<td>96.00</td>
<td>6500</td>
<td>2000</td>
</tr>
<tr>
<td>25</td>
<td>4.170</td>
<td>33.36</td>
<td>96.00</td>
<td>6500</td>
<td>2000</td>
</tr>
<tr>
<td>26</td>
<td>4.245</td>
<td>33.96</td>
<td>96.00</td>
<td>6500</td>
<td>2000</td>
</tr>
<tr>
<td>27</td>
<td>4.320</td>
<td>34.56</td>
<td>96.00</td>
<td>6500</td>
<td>2000</td>
</tr>
<tr>
<td>28</td>
<td>4.395</td>
<td>35.16</td>
<td>96.00</td>
<td>6500</td>
<td>2000</td>
</tr>
<tr>
<td>29</td>
<td>4.470</td>
<td>35.76</td>
<td>102.00</td>
<td>7000</td>
<td>2050</td>
</tr>
<tr>
<td>30</td>
<td>4.545</td>
<td>36.36</td>
<td>102.00</td>
<td>7000</td>
<td>2050</td>
</tr>
<tr>
<td>31</td>
<td>4.620</td>
<td>36.96</td>
<td>102.00</td>
<td>7000</td>
<td>2050</td>
</tr>
<tr>
<td>32</td>
<td>4.695</td>
<td>37.56</td>
<td>102.00</td>
<td>7000</td>
<td>2050</td>
</tr>
</tbody>
</table>

Effective August 1, 1967 Hospital Confinement:

* Less than (10 years) Service 365 Days
* More than (10 years) Service 730 Days

* Weekly Sick Benefits Less than (2 yrs.) 26 wks.
* Weekly Sick Benefits More than (2 yrs.) 52 wks.

Financial Secretary-L.U. #1066
income. Obviously both utility and need will be largely a function of the current economic status of his family. Background also determines whether or not the worker is even aware of sequence opportunity before hiring into a department. Since many workers are not aware of the need to choose a sequence until they are already in a steel mill, the discount in this case has important applications. In the special case where the worker is already in the department:

$$d_{i,1} = 1,$$

because $$j = 1$$ is the entry level job in the department and the plant. Thus the current value of the sum of wages in any sequence $$i$$ is the sum of each wage $$w_j$$ multiplied by $$d_{ij}$$ its discount. However, this interpretation implicitly assumes that the worker spends an equal amount of time on each job in the sequence. This is of course a gross oversimplification. It is obvious that the worker may not have the ability to attain some jobs and may spend different amounts of time waiting for each promotion.

When a worker enters a steel mill he expects to spend a certain amount of time employed there, $$T$$. In many cases $$T$$ is equivalent to his working life, in others it could be equal to his summer vacation. Any sequence which the worker considers as a possible choice subdivides time $$T$$. The worker would absolutely maximize his mill-time earnings by being employed for time $$T$$ at the maximum possible wage, $$w_{35} = 4.85$$, i.e., max mill earnings = $$T \cdot w_{35}$$. Unfortunately the contract states that the worker must begin in the labor pool. Part of $$T$$ must be spent working at wages $$w_1$$. The worker's expectation as to how long he must work at $$w_1$$ in order to gain entry into sequence $$i$$ will be $$E(t_{i,1})$$. The worker's investment in human capital is primarily based on the amount of time he spends at $$w_1$$ waiting for an opening in sequence, $$i$$, while he could instead be earning $$w_j > 1$$ in another sequence. Obviously the worker prefers to spend as little time as possible at $$w_1$$. He will attempt, ceteris paribus, to choose the sequence with the shortest $$E(t_{i,1})$$. Since no sequence goes directly from $$w_1$$ to $$w_{35}$$, $$T$$ will be broken down into several $$E(t_{ij})$$ where $$E(t_{i,j})$$ is defined as the time expected to be spent
working on the \( j \)th job in sequence \( i \), \( T = \sum_{j=1}^{35} E(t_{ij}) \). \( E(t_{ij}) \) is directly dependent on two promotional variables completely ignored by traditional theory. 

A. \( E(t_{ij}) \) is based on the worker's assessment of his own ability to reach the job in question, job \( j \). The results of personnel tests, management opinions and the advice of senior workers provide the objective basis for this subjective evaluation. For any job \( j \) in sequence which the worker believes himself incapable of attaining, \( E(t_{ij}) = 0 \).

B. The worker will assess the promotional opportunities in the sequence. Lists are published showing the entry date of all workers in the sequence and their positions.\(^9\) If many of the workers holding top jobs in the sequence are approaching retirement, they will set a larger \( E(t_{ij}) \) on the higher level jobs than for sequences with young workers. Similarly the longer term the worker, the more time he expects to spend in any sequence and the larger the \( E(t_{ij}) \) he will set for higher level jobs.

A worker saving for college who intends to work a few months or even two years will select the sequence which yields the largest discounted income for this short period. His choice would be different if he were choosing a sequence for life. This difference in expected mill-time concentrates long term workers in the sequences with the best long term prospects, and the biggest training costs. The short term employee sets \( E(t_{ij}) \) on the higher level jobs equal to zero because they cannot be attained during his intended stay in the mill. Long term workers will tend to attach positive \( E(t_{ij}) \) to the higher level jobs. Sequences which include a large \( w_j \) at the top will be given a lower evaluation by a short term employee than a long term because each worker is solving a different problem. Similarly, rational workers with less ability or ambition will give

\(^9\) These list the entry date of each worker and the job he holds and the job to which his seniority entitles him. p. 72. The Contract Agreement between United Steelworkers of America and X Steel Company, September 1, 1965.
a lower rating to the sequences with the highest job classes than a more able or ambitious worker. Since higher job classes represent a greater contribution to joint productivity, the more able ambitious and long term employees will be allocated to the sequences which are the most difficult and require the most skill and training. This should produce a better than random pairing of worker abilities and sequences and better than random returns on investment in human capital for both the firm and the worker.

A final factor affecting $E(t_{ij})$ is technological change. Since the worker's job choice is long term, his expectation of time spent on any job in the sequence must consider the possibility of a sequence being eliminated by technological advance. Engineers and others through trade journals, etc. are aware of such possibilities and they communicate this knowledge to the workers by a variety of means, including personal contacts and rumors. This information forms an "objective" basis for the worker's subjective evaluation of $E(t_{ij})$ for any sequence $i$ on the basis of its vulnerability to technological change. The worker's vulnerability to technological change is partly eliminated by the contract as will be shown in the next section.

All of the factors discussed above are expressible in the form of three variables: $W_j$, the wage of job $j$, $E(t_{ij})$, the amount of time the worker expects to spend on job $j$ in sequence $i$, and $d_{ij}$, a discount for the $j^{th}$ job in the $i^{th}$ sequence. Thus for the purpose of comparing sequences in occupations, each sequence can be characterized as an expected income function $E(\phi_i)$:

$$E(\phi_i) = f(W_j, E(t_{ij}), d_{ij})$$

$E(\phi_i)$ can be defined as:

$$E(\phi_i) = W_1E(t_{i1})d_{i1} + W_2E(t_{i2})d_{i2} + W_3E(t_{i3})d_{i3} + \ldots + W_nE(t_{in})d_{in}$$

$$E(\phi_i) = \sum_{j=1}^{n} W_j d_{ij} E(t_{ij})d_{i,j}$$
Thus $W_j E(t_{ij})d_{ij}$ is the present value to the worker of the income he expects to earn in sequence $i$, job $j$, and $E(\phi_i) = \sum_{j=1}^{35} W_j E(t_{ij})d_{ij}$ is the present value to the worker of his lifetime earnings in sequence $i$.

The Maximization of Mill-Time Income within a Department

If his current choice of a job represents a long term or even lifetime commitment, the worker seeks to: Max $E(\phi_i)$. It is necessary to define a limit on the choice of sequences open to the worker. The simplest and most typical case is where a worker is already in a department. The second case is that of a worker already with the firm choosing a department. The most general case occurs when the worker is free to choose from among all the departments in all the firms in the area. Within the limits on worker choice above, several sets of market conditions will be considered. Initially, the normal micro economic assumption of no unemployment, business cycle or obsolescent will be assumed. These assumptions will then be dropped because a worker is committed to the job he selects, often for life. During that time unemployment, the business cycle and technology will affect his job earnings and expectation of promotion.

The Allocation Between Sequences

The simplest situation in applying max $E(\phi_i)$ is that of a worker choosing from among the sequences in a department where he is already working, $i = 1$ to $M$, where $M =$ total number of sequences in the department. Assume that the worker is currently in the departmental labor pool, he belongs to no sequence. The

---

$^{10}$ Actually he seeks to maximize $U(E(\phi_i), L_i)$ where $L_i$ is the amount of lifetime on-the-job leisure. Here $U$ is simplified to make it $U(E(\phi_i))$; for each $i$, $U$ is calculated, and max, i.e., set of sequences, $U(E(\phi_i))$ exists, since the set of sequences is finite. A weaker union or contract could render the expectations less certain making $E(\phi_i)$ less determinate.
worker maximizes his expected mill-time income by calculating \( E(\phi_i) \) for each sequence. He then compares these values and rejects the smaller amount of money. Since the number of sequences in a department, \( i \) goes from 1 to \( M \), is relatively small, he will by comparison arrive at an \( E(\phi_i) \) which is greater than any other \( E(\phi_i), E(\phi_K) \), i.e.: 

\[
E(\phi_K) > E(\phi_i) \quad i = 1 \text{ to } K-1
\]

If there is no unemployment, the expected time \( E(t_{ij}) \) is equal to zero for all \( i, 1 \leq i \leq M \), because the worker can enter any sequence immediately with no need to wait at labor pool wages, \( w_j \). Since sequence \( K \) is immediately available, the worker will begin working in the preferred sequence, and his expected lifetime return, i.e., his wages in traditional theory, will equal \( E(\phi_K) \). He will have chosen that sequence with the highest mill-time return. The full employment assumption is a useful simplification but even traditionalists admit that as a practical matter, there is unemployment.

The existence of unemployment and under-employment is statistically easy to support but is ignored in the usual theoretical model. In the analysis below, the problem of allocating labor between competing sequences will consider the possibility of more workers choosing a sequence than available positions, hence unemployment.

The accessibility of a sequence \( i \), in conjunction with its other characteristics, affects the worker's expectation with respect to the amount of time to be spent on higher level jobs, since total \( E(t_{ij}) \) is finite. Also the lower the accessibility of the sequence, the larger \( E(t_{ij}) \) and the greater

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the discount, $d_{ij}$, that must be applied to all wages in sequence $i$ which further lowers its expected value. The worker's expectations as to the time spent at various wage levels including the labor pool and their discount will affect the relative attractiveness of one sequence versus another.

If the preferred sequence, $K$, is not immediately available then the expected time to be spent in the labor pool awaiting an opening in sequence $K$ is greater than zero, $E(t_{K,1}) > 0$. There is excess supply at existing wages. Since the worker is already in the labor pool the discount on the labor pool wage is one, $(d_{K,1}) = 1$.

The contract allows an applicant to apply for three different sequences if he is not already working in a sequence. The choice of additional sequences is constrained by the requirement that the worker must accept a vacancy offered in any sequence for which he has made application. Why should a worker put in applications for less preferred sequences? The two next preferred sequences, $e$ and $m$, which are inferior to $K$ when none of them are available might be preferred to it if an opening occurred in $e$ or $m$ while sequence $K$ remained unavailable. If $e$ or $m$ is currently available and is still inferior to $K$ then the only way it could become preferred is if an opening developed in $e$ or $m$ above the entry level.\[12]

Consider the first possibility where for

\[ E(\emptyset_K), E(t_{K,1}) = r_{K,1} > 0 \]

\[ d_{K,1} = 1 \]

The other two sequences are $e$ and $m$:

\[ \text{12} \] It is possible $m$ already had an opening above the entry level in this case a higher opening will make $m$ preferred to $K$.\[12\]
\[ E(t_e, 1) = t_e, 1 > 0 \]
\[ d_{e, 1} = 1 \]

and
\[ E(t_m, 1) = t_m, 1 > 0 \]
\[ d_{e, 1} = 1 \]

since:
\[ E(\emptyset_K) > E(\emptyset_i) \quad K+1 \text{ to } n \quad \text{i = 1 to } K-1 \]
\[ t_{K, 1} > 0 \]
\[ d_{i, 1} = 1 \]
\[ t_{i, 1} > 0 \]
\[ d_{i, 1} = 1 \]

If for some \( i = e \) when \( t_{e, 1} = 0 \) with \( d_{e, 1} = 1 \):

(I) \[ E(\emptyset_e) t_{e, o} = 0 \geq E(\emptyset_K) t_{K, 1} > 0 \]
\[ d_{e, o} = 1 \]
\[ d_{K, 1} = 1 \]

then the worker will put in a second application for sequence \( e \). Similarly, he will file a third application for some sequence \( m \) if:

(II) \[ E(\emptyset_m) t_{m, 1} = 0 \geq E(\emptyset_K) t_{K, 1} > 0 \]
\[ d_{m, 1} = 1 \]
\[ d_{K, 1} = 1 \]

If both above conditions I and II hold, then the worker will file three applications, \( K, e, m \). Further if an opening occurs in previously rejected sequence \( i \) and:

\[ E(\emptyset_i) t_{i, 1} = 0 \geq E(\emptyset_K) t_{K, 1} > 0 \]
\[ d_{i, 1} = 1 \]
\[ d_{K, 1} = 1 \]

then the worker will accept the job in sequence \( i \). If an opening occurs in any of the chosen sequences as the result of a change in output or supply, the worker will accept it and thus be allocated to the area where he is most needed.
This allocation is subject to the fact that the worker maximizes his mill-time opportunities with fixed wages and nearly zero horizontal mobility above the entry level. The firm minimizes its training cost by not training a man now who will later waste the training by changing occupations.

The second possibility is that:

\[ E(\emptyset_K) > E(\emptyset_m) > E(\emptyset_e) \]

where \( E(t_{K,1}) > 0 \)

even when \( E(t_{m,1}) = 0 \)

\( E(t_{e,i}) = 0 \)

\( d_{i,1} = 1 \) where \( i = K, e, m \).

The worker would not enter one of these sequences unless an opening become available at a higher than entry level position. \( E(t_{m,j}) \) or \( E(t_{e,j}) \) must be equal to zero for some \( j > 1 \). Since jobs up to Class 6 are ranked as unskilled, management can assign laborers to work on the jobs up to job Class 6, \( 1 \leq j \leq 6 \).

Therefore a sequence may develop openings above the entry level. Thus the worker may be allocated to sequence \( e \) or \( m \) because if that sequence fails to attract labor, \( E(t_{e,j>1}) \) or \( E(t_{m,j>1}) \) will equal zero for \( j \leq 6 \). If:

\[ E(\emptyset_m)_{t_{m,j=1}} = 0 \geq E(\emptyset_k)_{t_{K,1} > 0} \]

\( d_{m,1} = 1 \)

\( d_{K,1} = 1 \)

or

\[ E(\emptyset_e)_{t_{e,j=1}} = 0 \geq E(\emptyset_k)_{t_{K,1} > 0} \]

\( d_{e,1} = 1 \)

\( d_{K,1} = 1 \)

he will apply for \( e \) or \( m \). If an opening occurs above the entry level in a sequence, \( i \), other than those for which he has applied, than if for some \( \emptyset_i \):

\[ (\emptyset_i)_{d_{i,j} = 1} \geq (\emptyset_k)_{d_{K,1} = 1} \]

\( t_{i,j} > 1=0 \)

\( t_{K,1} > 0 \)

He will take the new job sequence since the expected mill-time income of some
sequence i, without the necessity to spend part of his mill-time in the sequence's lowest jobs, is greater than that in the best sequence for which he has applied.

Although the process of maximizing with respect to one sequence or even three seems plausible, why should the worker treat an opening as a lifetime commitment. It has already been shown statistically that workers do not move horizontally.\textsuperscript{13} Still, the behavioral question remains, why will not a worker accept any job which pays a higher wage than labor, $W_1$, and wait there until the sequence with the maximum $E(\phi_i^t)$ appears. He must of course give up one of his applications, say m. Suppose that the worker follows this procedure, it does not invalidate the analysis. If this worker is not required in the preferred sequence for two years, he has too much time invested in the temporary sequence and cannot afford to return to the lowest level job in sequence $K$ or $e$. In a sense, his behavior has created the case just discussed above in which the worker has access to a job above the entry level. In this worker's case, if

$$E(\phi_{e_{t, j}})_{t, j > 1} = 0 \quad \quad \quad E(\phi_{K_{t, j}})_{t, j > 0}$$

$$d_{i, j} = 1 \quad \quad \quad d_{i, j} = 1$$

The fact that he has two or three years of seniority will raise the $d_{i, j}$ for the current sequence over its former level since there is less risk of being laid off.\textsuperscript{14} This increase in $d_{i, j}$ tends to trap the worker in his temporary sequence. This is the reason workers regard any sequence opening as a potential mill-time commitment. There are other factors which discourage the worker from taking a job in one sequence while waiting for another.

\textsuperscript{13}See Figures 2-4, 2-5, 2-6.

\textsuperscript{14}Layoff is based first on seniority. Ibid, "Seniority," The Contract Footnote 11.
The contract says that new men will be accepted into the sequence on the basis of the same criterion as they are promoted, seniority. Seniority is defined as:

1. continuous service
2. ability
3. physical fitness.

For workers in the sequence, it is the sole criterion. However, if the worker accepts a job in sequence i, he must be available as a laborer to be substituted into bottom level jobs in sequences K, e or m. Vacancies develop due to sickness, vacation, expansion, etc. The worker must accept a five or more day vacancy in a job for which he has an application or nullify his application. If a five or more day temporary vacancy develops in sequences R, m or e, he must leave his own sequence to take it with no guarantee that it will lead to a job in K, m or e.

As the worker climbs the ladder in i, it becomes an increasing financial burden to take a temporary or full time job in another sequence. Also, if some other facility in the department discontinues operations, men with more seniority than the hypothetical man will be released into the labor pool. If the worker has not established priority by working five consecutive days in the sequences where he has applications, then these "older" men's applications for any sequence would take precedence over the younger man's. This decreases the $d_{ij}$ value of the $E(\phi_K) > 0$ function. Thus the statistics show that there is little transfer from any sequence above job Class 6. The max of $E(\phi_i)$ as the variables $t_{i,j}$ and $d_{i,j}$ change allocates new labor from where it is not needed to where it is.

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15 Tables 4-5 and 4-6.

It has been shown that the firm can expand its supply of skilled labor without wage or quality changes by promoting some of its presently underutilized stock. The allocation of unskilled labor between competing sequences without wage changes is similarly based on the stock of applicants exceeding sequence vacancies. The supply of labor to a sequence can be increased by reducing the age of the application required to enter the sequence. This reduces the waiting period for this sequence for one or more workers and makes it relatively more attractive. If sufficient entry vacancies do not produce sufficient labor vacancies will occur above the entry level.\textsuperscript{17} The allocation of new labor to sequences on basis of waiting time is not neutral with respect to a worker's socio-economic status. This problem will be discussed further in the final section, after considering the effect of technology and the business cycle on \( \max E(\Phi_1) \).

Technology and the Business Cycle

The foregoing analysis assumes that a worker is able to discount the possibility of technological change eliminating one or more of the sequences under consideration. The contract further protects the worker against the effects of unforeseen technological change. Displaced workers have first claim on the process which directly or indirectly replaced the one upon which they were formerly employed. This clause not only protects the long term worker whose projections of \( E(\Phi_1) \) are negated by technology, but also ensures that labor will be allocated from where it is no longer needed to where it is needed. The clause specifies that those who are displaced will be allocated to the new facility with the same ordering within the new sequence as they had in the old. In keeping

\textsuperscript{17} In the relatively rare case that this is not sufficient, the firm may apply to union to raise wages or change job contents, etc.
with the range of the present discussion, assume that the new facility is in
the same department as the workers who are being displaced by it. The decision
criteria here will be the same as for the special case of a worker in the labor
pool who is offered a job above the entry level.

If \( E(\theta_u) \) is the expected earnings in the new sequence, the displaced worker
will go to work in that sequence if:

\[
E(\theta_u)_{d_u,j > l} \geq \begin{cases} 
E(\theta_i) \quad & i = 1 \text{ to } u - 1 \\
E(\theta_i)_{t_u,j > l} & i = u + 1 \text{ to } n
\end{cases}
\]

Only here the \( E(t_{ij}) \) equals the remainder of the worker's time in the mill. Thus,
the application of our principle again leads to an optimal allocation of labor
from old to new facilities.

The likelihood that a worker will attain a job as expected and the correct
projection of that attainment into the future depends on a historical factor which
is usually assumed away by traditional theory. The business cycle is ignored
because of the full employment assumption and the transitory nature of the worker's
commitment to the job he chooses. This cycle is of great concern to the steel
worker because of his extreme vulnerability to it. Traditional macro theory
recognizes that economic down turns had disproportionate effects on primary goods
industries via the accelerator. The vulnerability of a sequence to the cycle
is reflected in the \( E(t_{ij}) \) valuation that the worker places on it and the \( d_{ij} \).

When demand declines each worker faces three possibilities based on
his continuous service; he remains on his job, he is demoted but remains
employed or he is demoted to unemployment with or without S.U.B.

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\[18\] For example, workers chose non bonus craft type jobs to higher paying
bonus jobs because they are less vulnerable to the business cycle. But in
the sustained upswing of the sixties craft workers in U.S.W. and U.A.W. revolted
and they now have veto in the U.A.W.
benefits. It is obvious that a worker may hold the same job with the same \( w_j \) more than once during the contract and many times during his mill-time. \( E(t_{ij}) \) is not a single number but a set of numbers. Similarly \( d_{ij} \) is a set of numbers. The worker knows that he may occupy the mobile crane job for three months and then be promoted for six months. A post-strike downswing may return him to the mobile crane for another six months. Obviously, \( E(t_{ij}) \) is different during the three month period than for the six month period. Similarly, a different discount, \( d_{ij} \), must be applied to the first period \( W_j \) than to the second period \( W_j \).

Assume that the business cycle is a sine curve and that it makes one complete cycle during the two year period that the contract is in effect.

![Figure 4-1 Sine Curve Business Cycle](image)

Also assume that the peaks and troughs are equal and that the area under the historical trend line is normally distributed about the trough and equal to the area above the trend line which is also normally distributed. The sine curve is continuous and the number of crews on any machine is discrete. Assume for simplicity that levels of output above 125 require four crews worked 4 or 5 or 6 or 7 days per week. For levels between the trend line and 125, only three crews are worked. For levels of output from the trend line to 75, two crews
are worked and from 75 to 50, one crew is worked. During the first two year period the worker is working in the entry level job in sequence i. For the first three months \(E(t_{i1}) = 3\) months, \(d_{ij} = 1\). The worker is then unemployed for the next eighteen months and receives supplementary unemployment benefits. The last three months of the contract period the worker returns to work \(E(t_{i1}) = 3\) months and \(d_{ij}\) must be discounted for eighteen months. Thus any \(t_{ij} = \gamma_{j1} + \gamma_{j2} + \gamma_{j3} \ldots\). In this simplified example, the worker will attain a position in the sequence where it is no longer possible for him to be reduced to job j. A worker in the top job in a sequence cannot be returned to the bottom under the business cycle assumed. In the real world the probability of being returned to any job from any higher job remains positive in the event of severe depression. A similar analysis can be made for \(d_{ij}\). Therefore, \(d_{ij}\) is equal to \(\partial_{j1} + \partial_{j2} + \partial_{j3} \ldots\). The foregoing discussion makes it obvious that another step must be added to the sequence. When the worker is unemployed \(w_o = S.U.B., d_{i1} = \gamma_{i1}\) is the discount and \(E(t_{i1})\) is the expected amount of time expected to be spent unemployed if the worker chooses sequence i. In the discussion that follows \(t_{ij}\) and \(d_{ij}\) are sums and \(t_{i1}\) and \(d_{i1}\) refer to \(\gamma_{i1}\) and \(\partial_{i1}\); the original expected time spent in the labor pool waiting for sequence i:

\[
\begin{align*}
  d_{ij} &= \sum_{s=1}^{n} \partial_{js} \\
  t_{ij} &= \sum_{s=1}^{n} \gamma_{js}
\end{align*}
\]

Where \(S = \) the level of operations associated with each stage of the business cycle.

The above example is of course extreme but it illustrates the reason for the relatively high unemployment rate among younger workers.

The analysis above has incorporated into the worker's decision function two major macro economic phenomena. A further possibility exists, the technological obsolescence of the industry. It will be assumed that a rational worker takes
this factor into account in choosing an occupation when the allocation of labor between departments and firms is discussed in the next section. Certain demographic factors, death, accident, and illness, interfere with the worker's actually earning the expected lifetime income which he has projected. Since the system protects the worker from the business cycle and internal technological change, it also protects him from these demographic risks. The insurance provided at each wage rate in Table 2 protects the worker's investment return from demographic interference just as the sequence and supplemental unemployment benefits protect him from the business cycle.

In the foregoing analysis, the worker chooses a sequence by maximizing expected lifetime income in terms of $w_j, d_{ij}$ and $E(t_{ij})$. If a shortage of labor develops in a sequence $i$ or demand increases, it tends to reduce $E(t_{ij})$ or $E(t_{i,j>1})$ and decrease $d_{ij}$ making $E(\phi_i)$ increase relative to other sequences and more workers are allocated to it. Because of the long term nature of the average worker's choice, a sequence vulnerability to technology and the business cycle is reflected in its $E(t_{ij})$ and $d_{ij}$. Thus $E(\phi_i)$ is a function of the opportunity for promotion in the sequence and it explains not only the supply of labor but how labor is trained for the specialized jobs in various sequences. Having shown how this variable operates to allocate labor between competing markets within a department, it is still necessary to expand the analysis to include allocation between departments and between firms. It will be assumed in those discussion that it is possible for the worker to choose the optimal sequence $K$ in each department by the method developed in this part.

The Allocation Between Departments

The analysis of the last section was based on the assumption that the worker was already employed in a firm and that he could only choose from among the sequences in the department in which he was already employed. This assumption
is not necessarily an oversimplification. Nevertheless, transfer is possible in the industry and its analysis will help to validate the simplification alluded to. Having derived the maximization of mill-time income as an equivalent for the traditional wage in a simplified case, it will be easy to extend it to more general cases. First, the case where the worker is already in the firm but has a choice among departments. Second, the more general case where the worker is choosing a firm and a department in the steel industry will be considered. Finally, an attempt will be made to suggest a generalization of the sequence concept to labor markets other than steel.

A new laborer is hired into the labor pool of some department of a firm. The firm offers the job to the candidate on the basis of his scores on tests and departmental needs. It is unlikely that there is more than a 50-50 chance that workers will go to the department where they would be most efficient. This allocation by the company will however, send the new workers where they are most needed. The contract states that after two years, the workers may apply for any production or maintenance department that they choose.

The men thus have two choices under the contract:

(1) Choose a job from among those in the department to which the company sent them on the basis of its needs.

(2) Apply for transfer to another department when an opening there appears.

Very often the worker will choose (1). If the department is short-handed, the chances of getting into a sequence and beginning to accumulate continuous service and thus security and promotional opportunity are likely to require the minimal time, six weeks. The worker may have to wait two years

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19 Since workers must change sequences to change departments, footnote 2 also shows the maximum horizontal mobility from one department to another.
before he has enough service in order to qualify for a transfer. If the worker attempts to transfer to a department where a reduction in output is in process, he may have to wait many additional months in that department before obtaining a job in the selected sequence. Waiting time explains the allocation between departments and replaces the wage in traditional theory. If the worker is sent by management to the only department that is expanding, he will have a greater tendency to stay in that department because relatively more sequences will have immediate openings than other departments which are not expanding or are even contracting, i.e., more labor is allocated to the expanding market. If the worker remains in the department to which management first sent him then the analysis is identical to that in the last section where it was assumed that the worker would only choose a sequence within the single department.

Suppose that a worker decides not to remain in a department after the completion of his two year probationary period. He can apply for a job in almost any department in the plant if he is willing to wait until he is the senior man in line for transfer to the new department. The worker must then in the new department's labor pool, until an opening occurs. The worker who fails to select a sequence from among those in the department to which he has been assigned, attempts to maximize his expected mill-time earnings by comparing $E(\emptyset, j)$ among all the sequences in all the departments in the plant.

In discussing inter-departmental mobility, the contract breaks the labor force down into two categories. (1) Workers who have been directly or indirectly displaced by a new facility in an existing plant, having the same transfer rights to the new facility in a different department as already discussed for a new facility located in their present department. (2) Employees who simply wish to transfer, and who must have two years of service in their

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20 See Seniority, the Contract, Ibid. Chapter 2, pp. 73 and 75. Footnote 11.
present department, and sequence. After two years the willingness of workers in the second group to leave the sequence drops sharply reflecting the increase in the cost of leaving the sequence. Since a transfer between departments always involves changing sequences, horizontal mobility between departments can be no greater than that between sequences described above. The two year requirement reduces inter departmental mobility protecting the company's investment in training and their original placement decision. Some companies strictly adhere to the contract and effectively require two years for transfer. Others are more flexible on this point. For either group the transferring worker must transfer to the other department's labor pool rather than to a specific sequence.

Since the worker who simply wishes to transfer is not assured of obtaining any single sequence on a transfer to another department, he must rate each department on the basis of all its sequences. The contract requires that the worker be able to qualify for the transfer in terms of his own ability. He must then set $d_{ij}$ for each sequence in the department to which he is considering transferring. He must discount each job in each sequence, i.e., the chance of obtaining it, in the new department. Discounts will tend to be greater than they would have been had he been in the new department to begin with.

Since $d_{ij}$ for $j=1$ will be a discount for obtaining a department, it will have the same value for all the sequences in the department. Except for the department where he is currently employed, $0 \leq d_{i,1} \leq 1$ for all departments. The expected value of department $P$ is:

$$E(\emptyset_i)_P = \left[ \sum_{j=1}^{n} d_{ij}E(t_{i,j}) W_j \right]^{X}_{P=1} = E(F_p).$$

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21 Ibid., footnote 2.

22 The contract: Intra-plant transfers. Ibid. Footnote 11, p. 73, Chapter 2.
In order to maximize expected mill-time earnings among departments, the worker must use a process of elimination similar to that employed for choosing the best sequence. The expected mill-time value of each sequence in each department can be determined by the formula on page 12. The sum of the $E(\emptyset_i)$ in each department can be compared with that of each other department. If in this process of comparison, the lower value is rejected, the worker will by using elimination find the department, K, with the highest expected value, i.e.:

$$E(\emptyset_i)_K \geq E(\emptyset_i)_{P=1}^{K-1}.$$ 

If the department chosen by this process, department K, equals his present department, as is generally the case, then the worker will remain where he is and go through the maximization procedure described in the first part of this section for the worker already in a department. If $E(F_K)$ is such that its expected value, even discounted for waiting exceeds his present one, plus all others, he will make application for transfer. The expected value, $E(F_p)$, of each department is the sum of opportunities of interest to the worker, some or even all of the sequences may be set equal to zero, $E(\emptyset_i) = 0$. The worker then seeks to maximize the sum of the mill-time earnings in each sequence for which $\emptyset_i \neq 0$ in each department since he does not know which sequence he will get.

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The worker may have two applications on file. He may choose a second department by the same method as described above. Only he must choose a second department H such that:

\[ E(\phi_i)_{d_{i,1}=1}^K \leq E(\phi_i)_{d_{i,1}=1}^H \]

\[ t_{i,1} > 0 \quad t_{i,1} = 0 . \]

If he cannot find one then he will only maintain one transfer application on file.

The third category consists of cases where a job opens in:

(a) a previously rejected sequence of another department.

(b) a new facility in another department.

The analysis of this third case will be the same as the previous analysis except that \( E(\phi_i)_{K} \) replaces \( E(\phi_i) \) in the analysis and \( d_{ij} \neq 1 \) except in the sequence in which the worker is currently employed.

The Allocation Between Firms

Extending the above analysis to all the steel firms is relatively simple. A prospective worker is offered a job in a department of the firm, not in the firm at large. If a worker is from a family with steel mill experience, he will tend to evaluate the various departments from family knowledge. Another source of information is the plant personnel office which may also know something about sequence opportunities in the various departments available and may inform the worker. A worker may accept a job in a department in that plant. He may accept a vacancy in one plant in order to await a vacancy in another. But after a year or two of employment, a worker will seldom leave one firm to go to another just for a slightly better job.

\[ ^{24} \text{Ibid, footnote 2.} \]
In general then, the worker must choose the department with the highest expected value from among those offered by the various steel firms in the area. Suppose $E(\phi)$ is designated the expected value to the worker of the $i$th sequence in the $p$th department in firm $R$.

It has already been shown that the worker chooses the best sequence $K$ in the best department $K$ within a firm. All that remains is to show how this maximizing procedure allocates him between the departments of $Q$ competing firms. The maximizing worker seeks to:

$$\max_{i, p, q} E(\phi_i)^Z_{p, q}$$

This means that he seeks a department such that:

$$E(\phi_{K, S + 1}^{\text{to} Z})_{K, S} \geq E(\phi_{i, p}^{\text{to} Q = 1 \text{ to } S-1})_{i, p}$$

for all sequences $i$, departments $p$ and firms $q$ currently having jobs available. In general the analysis of situations (a) and (b) above will be the same here except that the expected value of the department must also carry the index of the firm offering this value.

It should also be apparent that the expected value of a large department with fifty sequences is not necessarily greater than that of another with six. The worker may set the expected value of all the sequences but two equal to zero in the large department because he does not like the working conditions etc. If he sets positive expected values on all six of the sequences in the smaller department, it may be preferred to the larger department. This eliminates the costly process of having efficiency experts test the worker on all the jobs in the forty-eight sequences in which he is not interested. It also eliminates the costly mistake of assigning him to one of these jobs or sequences, investing training in him and then having him quit. The system may not be optimal and the lack of perfect information on both sides makes it less
so, but given that constraint it produces a tolerable level of efficiency for both worker and management.

If there are non steel firms in the area with formal departments and sequences such as the public utility company cited in Chapter 2, then it will simply be one of the values of Q. Each of this firm's departments will be one of the values of P. If the analysis were extended to include craft sequences, then the firm designation would be irrelevant but each of the locals of each building trade craft, such as carpenters, could be viewed as departments since the labor pool exists within the hiring hall. Each craft local would contain one sequence such as carpenters. In order to compare the expected values of industrial departments with a single sequence craft, it would be necessary to define a probability distribution over the expected value of each sequence in the department in which the worker was interested. The sum of the probabilities would add to one. This procedure would make it possible to compare the expected value of a department with a craft department where the probability of obtaining a given craft sequence is equal to one, since there is only one.

Policy Implications

In the analysis above it was possible to take explicit economic phenomena such as unemployment, technology and the business cycle into explicit account in formulating the worker's job choice. It is also possible to use the analysis to discuss the effect of such socio economic problems as poverty on the allocation of labor. Unlike traditional theory where identical labor inputs respond to identical information, the allocation of labor between competing sequences on the basis of waiting time is not socio economically neutral. The worker from a socio economically deprived background will tend to make poorer departmental

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25 Ibid. footnote 2.
choices because he will lack prior information. Once in a department his evaluation of $E(θ_1)$ will be influenced by low job expectations, ambition, and high preference, or need, for current income. Although no one can argue that a worker who sets high value on current income versus future is not optimizing, he will nevertheless have a lower expected lifetime income, and may be working at a lower level than his ability warrants. For example, new migrants from the South often start careers in steel with the assumption that they will soon return. The result is they actually try to maximize current income to provide enough savings to realize their goal. Five years later they are often still working on the same job or are at the top job in a sequence which didn't go very high. Their contemporaries in the mill are earning the same current wages or more and still have the opportunity for further advancement. The individual worker caught in such a situation is likely to ascribe the situation to a variety of non-economic factors. Actually the system is organized to optimize the return for those workers who will fill the skilled, high sequence jobs which make modern production possible. Workers from industrial families who fill this need are more likely to have prior knowledge or at least be able to understand and rationally respond to the system once they are in it. Since the worker's environment largely determines his knowledge of the system and response to it, environment becomes an important determinant of the relative efficiency of labor allocation, rewards (wages) and production. It also affects these variables indirectly through the educational choice system.

At the level at which the analysis is being conducted, high school graduates, or less educated workers brought in during a boom, the rationality of a
specific worker's discounting can not be questioned. However, the only reasons that these workers were hired at all is because at age six they "decided" to go to grade school and at fourteen they "decided" to go to high school. In fact, educational choices are made on the basis of environment. Parents and the state discount for the worker the relative desirability of the sequences requiring high school versus those which do not. The same conditions apply with somewhat less force to the college decision. In an optimally efficient economy, it would have to be assumed that the most able students would go to high school and college. If intelligence quotient is accepted as a measure of ability, then it has shown that this criterion is not satisfied in the real economy. Father's occupation, class, was so strong among Boston High School students as to make college expectation inversely related to ability. This occurs for two reasons. Both discounting, $d_{ij}$, and the expectation of achieving a given job level $E(t_{ij})$ are functions of environment. The child assumes he will attain the level of his father. Further environment may deprive the individual of the finances needed to make an optimal investment. This provides a rigorous theoretical justification, in terms of improved labor allocation, for programs like Head Start and argues for better career counseling at all levels especially within the plant by union officers.

CONCLUSIONS

A worker choosing an occupation, sequence, usually expects the choice to last for the duration of his employment, life. If the labor market were purely competitive and if all workers evaluated factors (1) and (2) and on the job leisure alike then mill-time income could be based solely on the return on human capital but without these initial conditions it must be based on total

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27 Ibid Reynolds, as above.

28 See Becker, college investment still pays a positive return.
wages. The worker chooses the sequence that offers the maximum mill-time income discounted for time and its vulnerability to the business cycle and technology.

A. The maximization of lifetime income variable has been shown to be capable of allocating unskilled labor on the basis of horizontal mobility between competing sequences in the contract period which assumes restrictions. (1), (2), that wages are fixed by contract and horizontal mobility is insignificant for all but unskilled labor. When demand expands in one sequence, i, relative to others, it reduces the waiting period, \(E(t_{i,1})=0\) or offers openings above the entry level, \(E(t_{i,j+1})=0\). This raises the relative mill-time income of sequence i, relative to other sequences by increasing \(E(t_{i,j})\) for \(j>1\), and by reducing the discount rate for \(j>1\). Relatively more workers discover by comparing the expected incomes of various sequences that:

\[\text{Max} E(\theta_1) = E(\theta_1).\]

B. The analysis in this chapter not only fits observable data in the steel industry it also provides an explanation for other observable economic phenomena. Unemployment among young workers is relatively higher than other age groups. The failure of unemployed workers, cyclic or technological, to accept jobs with other firms is impossible in a world of short term interchangeable wage maximizers. Structural unemployment is caused by the existence of specifically skilled workers and both are impossible in the traditional theoretical model.

C. The complex choice required of the maximizing worker works against underprivileged workers. Currently basic education is being offered within the mill by the Manpower Administration but adequate counselling should also be provided. As the proportion of college students from non college families rises counselling in the choice of college "sequences" is also required, both in high school and on campus.

D. The long term, nature of the worker's job choice, makes it possible to organize and train workers for the right jobs and makes the specialization of labor possible. The worker is able to make a long term investment in skill and training because of the sequence system which provides increased protection as the worker's commitment increases. Expansion and contraction in the supply of trained labor can be explained by the allocation of the stock of labor thus created between competing jobs within a sequence on the basis of vertical mobility. Thus, the maximization of mill-time income with respect to a sequence provides the company with a flexible supply of specifically trained labor and rationalizes the firm's investment in human capital.