After some experimentation with lagged unemployment rates, we found that three lags were sufficient. The latter part of our sample included the initial OPEC shock. Thus, we ran equation (2) both with and without an OPEC dummy variable. The dummy variable was operative from 1974 to 1976. In both regressions, the coefficient of the difference in expected inflation rates is negative and significant at the ten-percent level. The effect of expectation errors is small. A difference in inflation expectations of one percent leads to a one-tenth percent change in the unemployment rate. The equation without the OPEC dummy variable yields a natural rate of unemployment of 4.59 percent. The equation with the OPEC dummy variable yields two natural unemployment rate estimates: 4.52 percent prior to the OPEC shock and 8.63 percent immediately after the OPEC shock.

V. Conclusion

This paper has covered a number of issues relating to inflationary expectations and the natural-rate hypothesis. First, the results indicate that for both the United Kingdom and the United States, workers are better forecasters of the inflation rate than employers. Second, our results tend to support the hypothesis that deviations of the unemployment rate from the natural rate is dependent upon the difference between workers' and employers' forecasts of the inflation rate. This latter point, however, needs further investigation.

References


The Work Decision of College Students

FREDERICK W. DERRICK

The objectives of this article are twofold. The first is to broaden the information concerning what determines whether an individual will work in the market while enrolled in an institute of higher education. Previous studies in the area [2, 4, 8] have been directed towards explaining the short run fluctuations. In contrast, this study employs a life cycle model that assumes no transitory elements and emphasizes the work decision over the lifetime of the individual. The second objective is to acquire two specific results which previously have not been found pertaining to the life cycle model. The two results are (1) estimates of the ratio of the production function parameters and (2) estimates of the production function parameters within the model. The latter will be obtained by combining the ratio results with a previous estimate of the sum of the production function parameters. Estimates of the production function parameters have not been found previously.

While with emphasis on the period of specialization in human capital production, i.e. full time schooling, this paper is in contrast to the usual application of life-cycle models. Ben-Porath [1] in the initial article in the field expresses major emphasis on the period following specialization and does not solve for the breakpoint between specialization and non-specialization in human capital production. Wallace and Innis [15] follow by deriving the optimal path for human capital accumulation while specializing under more restrictive loan assumptions. In each of these as well as in supporting works [5, 9, 10, 13], rental rates for human capital are fixed over the lifetime of the individual.

While the model applied herein is of similar vein to the previous life-cycle models, the model developed by Johnson [7] differs in two major aspects from previous life-cycle models. The first difference is that the individual receives a lump sum allowance while he is specializing. "Specialization is defined to mean that the total of earnings and allowance just equals the value of purchased inputs to the production of human capital ." [7, p. 3]. The second difference is that the individual receives a fixed wage, which does not change while he is specializing in the production of human capital.

The assumptions of Johnson's model provide a theoretical means of determining whether an individual will work or not work in the market while specializing in the production of human capital. The result of the model is that the individual will work if his allowance is less than the ratio of the coefficient of his own human capital, $\beta_1$, to the coefficient of purchased inputs, $\beta_2$, in a Cobb-Douglas production function for human capital times his fixed wage rate. Second, Johnson's life cycle model yields the theoretical result that the ratio of the production function parameters, $\beta_1/\beta_2$, is equal to the ratio of the foregone earnings to the reported earnings plus the allowance for those who worked.

The preceding results form the basis for the empirical study presented herein. The study of what determines whether an individual will work while specializing in the production of human capital is accomplished by using logi.
The income of an individual in this model differs in two respects from that of previous models. First, a wage, w, has been included which does not change while specialization is occurring. Hence, the amount of income which an individual specializing in human capital accumulation earns is w times the portion of effort devoted to the market. This income is independent of the amount of additional human capital accumulated after the decision was made to specialize in the production of human capital. The wage may vary between individuals because of differences in the stock of human capital accumulated before the decision was reached to specialize. The second difference, as noted above, is that the model includes a lump sum allowance per time period, A, while the individual is specializing. The individual may participate in two unique labor markets. The first is the labor market in which the individual participates while he is specializing in the production of human capital; and, the second labor market is the one where the individual is no longer specializing in the production of human capital. In the first market, the wage, w, is the maximum wage which the individual could earn if all of his effort was spent working at the same job which is available to him while he is specializing in the production of human capital. This wage is different from the maximum wage which he could receive if he were not specializing in the production of human capital. In the second labor market, the individual receives a rental rate for each unit of human capital which he sells in the market. The individual's objective is to maximize the present value of his income minus the cost of purchased inputs over the life cycle. The fraction of an individual's effort spent producing more human capital is denoted by \( k_i(t) \); and, the fraction of an individual's effort spent working in the market is denoted by \( k_a(t) \). The sum of \( k_i(t) \) and \( k_a(t) \) equals one. Thus, \( k_i(t) \) times the amount of human capital which the individual has is the amount of human capital used in producing more human capital, and the amount of human capital used in working, respectively.\(^1\)

\[ k_i - (w + A) \left( \frac{\beta_i}{\gamma_i + \beta_i} \right) \]  

(1)

For \( k_i \) to be less than one as is required for a case 2 individual, \( A < w(\beta_i/\gamma_i) \) as can be seen from the preceding equation. Thus, an individual will be a case 1 individual and will not work in the market if \( A = w(\beta_i/\gamma_i) \) and will be a case 2 individual and will work in the market if \( A < w(\beta_i/\gamma_i) \).

With its distinction between case 1 and case 2 individuals during specialization in the production of human capital, the theoretical life cycle model and its assumptions yields three results which can be used to determine whether an individual will work or not while enrolled in higher education. The first point is that the individual faces a dichotomous choice. The individual will either be in the market working as a case 2 individual, or will not be in the market, and hence will be a case 1 individual. Thus, the question is not how much will be working, but if he will be working. This question is partially answered by the second result yielded by the theoretical model, which is that the decision to work in the market is based only on the variables \( A \) and \( w \) and the parameters \( \beta_i \) and \( \beta_a \) as noted above. The relationship between \( A \) and \( w \) in the two equations is linear as can be seen by rewriting \( A = w(\beta_i/\gamma_i) \) and \( A \geq w(\beta_i/\gamma_i) \) as \( \beta_i A - \beta_i w > 0 \) and \( \beta_i A - \beta_i w < 0 \). The decision to work or not to work is based solely on this linear relationship between \( A \) and \( w \). Thus, the study is directed to the linear relationship between the allowance and the wage. The third result yielded by the model concerns the relationship between \( k_i \) and allowance, and between \( k_i \) and the wage. If partial derivatives are taken of \( k_i \) in Phase I, with respect to \( A \) and \( w \), the results are:

\[ \frac{dk_i}{dA} = \frac{1}{\gamma_i + \beta_i} \left( \frac{\beta_i}{\gamma_i + \beta_i} \right) \]  

(2)

\[ \frac{dk_i}{dw} = \frac{A}{\gamma_i + \beta_i} \]

With the assumption in the model that \( \beta_i, \beta_a, w \) and \( A \) are positive numbers, the results state that there is a positive relationship between \( A \) and \( k_i \), and a negative relationship between \( w \) and \( k_i \).

The theoretical model also yields a means of estimating the ratio of \( \beta_i \) to \( \beta_a \) for individuals who are working in the market while specializing in human capital production. By solving \( k_i = 1 - k_a \) for a case 2 individual, for the ratio of \( \beta_i \) to \( \beta_a \), the following result is obtained:

\[ \frac{\beta_i}{\beta_a} = \frac{w(1 - k_a)}{A + w} \]  

(3)

Therefore, the model yields the result that the ratio of the production function parameters is a relationship between \( w, k_a \), and \( A \). This relationship will be used in reaching the second objective.

Logit Model

In the study of what determines whether an individual will work while specializing in human capital production, the dependent

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\(^1\)For a more rigorous presentation of the model see Johnston (7).
variable, the work of the individual, is dichotomous (i.e., yes or no). With a dependent variable of this type, a means of estimation is conditional logit analysis. Using this approach, the probability of an individual working while specializing in the production of human capital is equal to

\[ 1 \quad (4) \]

This formulation of \( v \) is based on the implications that the work decision is based on the allowance and the wage given \( \beta_1 \) and \( \beta_2 \), and that the work decision is based on a linear relationship between allowance and wage.\(^3\)

The coefficients can be calculated by maximum likelihood estimation [11, p. 108]. The variables used in the estimation of \( \alpha \) either describe the attributes of the alternatives or the attributes of the individual.

A test of whether the coefficient of a variable is significant is accomplished by calculating the maximum likelihood estimators under the constraints imposed by the null hypothesis, and by calculating the maximum likelihood estimators under no constraints. Next, the log-likelihood of the unconstrained likelihood function is subtracted from the log-likelihood of the constrained likelihood function. Twice this difference is used as the test statistic, and it is approximately distributed as a chi-squared distribution with the degrees of freedom equal to the number of constraints [11, pp. 120–121].

The results from the conditional logit pro-

cedure can be used in three ways. First, the empirical results provide a means of testing the results from the life cycle model. One result obtained from the life cycle model is that \( A \) and \( w \) play a significant part in the individual’s decision to work or not to work while specializing in the production of human capital. Another result from the theoretical model which is based on equation (2) is that the coefficient of \( A \) and the coefficient of \( w \) in should be negative and positive, respectively. Second, the estimated coefficients can be used in equation (4) to predict whether an individual will work while specializing in the production of human capital. Third, the ratio of the estimated coefficients of allowance to the estimated coefficient of wage is an estimate of \( \beta_1 / \beta_2 \). Another estimate of the ratio of \( \beta_1 \) to \( \beta_2 \) is obtained by taking the ratio of foregone earnings, (the difference between maximum earnings and reported earnings), to total income. Total income equals the sum of the allowance and the reported earnings. This estimate applies only to those individuals who report their earnings while specializing in the production of human capital and is based on equation (3).

Estimation of \( \beta_1 \) and \( \beta_2 \)

Estimates of the production function parameters, \( \beta_1 \) and \( \beta_2 \), are obtained by solving the simultaneous equation system consisting of the estimate of the ratio of the production function parameters from this study and the estimate of the sum of the production function parameters from Hall and Hays [5].

In Hays’ study, it is shown that the estimate of the production function parameter in his paper is also an estimate of the sum of the production function parameters used in this paper. An apparent difficulty is that the two

models make different assumptions and use different definitions for the period of specialization. This difficulty is eliminated if the production function for an individual is assumed fixed over the lifetime of the individual.

Definitions

In the application of the theoretical results, definitions are necessary for the terms: specialization, working, the maximum wage, and the allowance.

(1) An individual is said to be specializing if he was a full-time student during the fall of 1972.

(2) An individual is said to be working if he used part of his savings, summer earnings, or earnings while taking courses to finance part of his first year of college. The survey did not distinguish between summer earnings and personal savings.

(3) The fixed maximum wage facing the individual during specialization is estimated in one of two methods. The first method which applies to those who reported their earnings is to transform reported earnings into a yearly maximum wage. The second method applies only to those individuals who did not report their earnings. In order to establish a wage for those individuals, a wage generating equation is estimated based on the characteristics of those who reported their earnings [3]. The estimated wage generating equation is then used to estimate the missing wages.\(^4\)

(4) The allowance is estimated by finding the sum of the support which the student received directly and which does not require any financial obligation. These items are listed under individual support, scholarships, grants, and other aid in Table 1. Consideration is given to augmenting this basic definition of the allowance with the amount of loans received for higher education. It is not possible to consider the effect of indirect subsidies as part of the allowance due to limitations in the data source.

Results from the Class of 1972

The data set of 1559 individuals is from the "National Longitudinal Study of the High School Class of 1972." The set is restricted to those who attended the same four-year public college or university for the fall of 1972 and
TABLE II. Variable Definitions and Codings for the Class of 1972

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALLOW</td>
<td>The aid in dollars received directly by the student which does not require repayment.</td>
</tr>
<tr>
<td>C1, C2, C3</td>
<td>The size of the city where the individual attended college. C1 will be 1 if the city size is less than 50,000; C2 will be 1 if the city size is between 50,000 and 100,000; C3 will be 1 if the city size is greater than 500,000.</td>
</tr>
<tr>
<td>LOANS</td>
<td>The sum in dollars of the loans which the individual received for financing his higher education.</td>
</tr>
<tr>
<td>MARR</td>
<td>The marital status of the individual. 1 if single or separated; 0 if otherwise.</td>
</tr>
<tr>
<td>RACE</td>
<td>The race of the individual. 1 if white; 0 if otherwise.</td>
</tr>
<tr>
<td>SEX</td>
<td>The sex of the individual. 1 if male; 0 if female.</td>
</tr>
<tr>
<td>SES1, SES2, SES3</td>
<td>The socioeconomic status of the individual. SES1 will be 1 if the individual's status is in the upper quartile; SES2 will be 1 if the individual's status is in the middle two quartiles; SES3 will be 1 if the individual's status is in the lower quartile.</td>
</tr>
<tr>
<td>WK</td>
<td>The work choice of the individual. 1 if summer earnings, savings, or earnings from working during the school year were used to finance his education; 0 if otherwise.</td>
</tr>
</tbody>
</table>

The socioeconomic status variables are calculated in the "National Longitudinal Study of the High School Class of 1972." For a description of the procedure used, see U.S. Department of Health, Education, and Welfare [2, p. 34].

The following is a summary of the principal findings of the logit analysis.

1. The allowance was predicted to have a negative relationship with the probability that an individual will work. This was found to be the case when allowance was defined to include all the direct aid received by the student which did not require repayment.

2. The maximum wage, which a full-time student could earn if all his efforts were spent working at a job he could obtain while a college student was predicted to be in the life cycle.
The marital status of the individual was found to have an insignificant effect on the probability that the student would work. Perhaps this result was due to the small percentage of married students in the sample. The socioeconomic status of the individual was found to have an insignificant effect on the probability that the individual would work.

(4) A measure of the city size where the student attends college was included in the logit analysis as a proxy for the size of the labor market. It was hypothesized that there would be a positive relationship between the city size and the probability that the individual would work while a full-time student. This relationship was not found. The failure to find this expected relationship may be a result of the city size being a reasonable proxy for the labor market during the academic year, but not during the calendar year, since summer work is not necessarily limited to the city where the student attends college.

(5) When the estimated coefficients from the logit analysis were used to estimate the probability that a full-time student would work (Table IV), it was found that the logit model fit the data well. The predictions were correct in over 60 percent of the cases where the estimated probabilities fell in the interval from .40 to .60. For the predicted probabilities below .40 or above .60, over 70 percent of the predictions were correct. The predictions from a separate data set from 1971 [12] were also not good. For the individuals in this data set with estimated probabilities greater than .70, 77 percent of the predictions were correct.

Thus, in the logit analysis, it was found that the maximum wage and the direct aid received by the student had a significant effect on the full-time student's work decision. The individual's sex and race were found to be shifters which have a significant effect on the probability that the individual will work.

Estimates of \( \beta_i/\beta_2 \)

The individual estimates of the ratio of \( \beta_i/\beta_2 \) are obtained by taking the ratio of the individual's forgone earnings to the sum of his allowance and his actual earnings. These individual estimates are then averaged to estimate the population ratio of \( \beta_i/\beta_2 \). The data set for this estimation consists of the 1,032 individuals who reported that they worked. The other students in the main data set of 1,559 individuals did not work for pay, and hence cannot be used in this estimation.

When the basic definition of allowance is used, the estimates of the ratio (reported in Table V) have a mean of 4.40 and a standard deviation of 2.167. The smallest estimate is -0.29 and the largest is 704.47. The negative estimate of the ratio is a result of the estimated maximum wage being smaller than the reported earnings. The mean estimate is significantly different from one which implies that \( \beta_i \) and \( \beta_2 \) are not equal.

Alternatively, the ratio of \( \beta_i/\beta_2 \) was estimated by taking the negative of the ratio of the coefficient of allowance to the coefficient of wage from the logit analysis. This estimate was based on the result in the lifetime model that an individual will not work if \( x = (\beta_i/\beta_2)w \), where allowance is defined to include the direct aid which the student receives which does not have to be repaid. The estimates of the ratio of \( \beta_i/\beta_2 \) using this method for the Class of 1972 were between 2.97 and 8.71.

The results from the direct estimate of the ratio of \( \beta_i/\beta_2 \) and from the logit analysis were comparable, and there was no statistical reason for preferring one over the other. From a cost point of view and from a viewpoint of ease in calculation, a method using direct estimates is preferable in future computations of the ratio of \( \beta_i/\beta_2 \).

---

### TABLE IV. Distribution of Estimated Probabilities for the Class of 1972

<table>
<thead>
<tr>
<th>Estimated Probabilities of Working</th>
<th>Total No. of Observations</th>
<th>No. that Actually Worked</th>
<th>No. that did not Work</th>
<th>Percent Correct Predictions</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00-0.10</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>&gt;0.10-0.20</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>&gt;0.20-0.30</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>50</td>
</tr>
<tr>
<td>&gt;0.30-0.40</td>
<td>28</td>
<td>6</td>
<td>22</td>
<td>79</td>
</tr>
<tr>
<td>&gt;0.40-0.50</td>
<td>64</td>
<td>65</td>
<td>99</td>
<td>60</td>
</tr>
<tr>
<td>&gt;0.50-0.60</td>
<td>596</td>
<td>160</td>
<td>236</td>
<td>62</td>
</tr>
<tr>
<td>&gt;0.60-0.70</td>
<td>655</td>
<td>479</td>
<td>156</td>
<td>75</td>
</tr>
<tr>
<td>&gt;0.70-0.80</td>
<td>126</td>
<td>118</td>
<td>11</td>
<td>92</td>
</tr>
<tr>
<td>&gt;0.80-0.90</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>&gt;0.90-1.00</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

---

### TABLE V. Distribution of the Individual Estimates of the Ratio of \( \beta_i/\beta_2 \) for the Class of 1972

<table>
<thead>
<tr>
<th>Range of Estimated ( \beta_i/\beta_2 )</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 0</td>
<td>1</td>
</tr>
<tr>
<td>0-1</td>
<td>45</td>
</tr>
<tr>
<td>1-2</td>
<td>576</td>
</tr>
<tr>
<td>2-3</td>
<td>325</td>
</tr>
<tr>
<td>3-5</td>
<td>90</td>
</tr>
<tr>
<td>5-7</td>
<td>9</td>
</tr>
<tr>
<td>7-10</td>
<td>43</td>
</tr>
<tr>
<td>10-20</td>
<td>11</td>
</tr>
<tr>
<td>20-40</td>
<td>1</td>
</tr>
<tr>
<td>40-60</td>
<td>0</td>
</tr>
<tr>
<td>60-80</td>
<td>0</td>
</tr>
<tr>
<td>80-100</td>
<td>0</td>
</tr>
<tr>
<td>&gt;100</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>1,052</td>
</tr>
</tbody>
</table>

---

### TABLE VI. Estimates of \( \beta_i \) and \( \beta_2 \) for the Class of 1972

<table>
<thead>
<tr>
<th>Estimate of ( \beta_i/\beta_2 )</th>
<th>Estimate of ( \beta_i )</th>
<th>Estimate of ( \beta_2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;0.29</td>
<td>0.492</td>
<td>1.112</td>
</tr>
<tr>
<td>Total</td>
<td>0.492</td>
<td>1.112</td>
</tr>
</tbody>
</table>

The estimates of \( \beta_i \) and \( \beta_2 \) are in Table VI and these estimates are calculated by using the estimates of the sum of \( \beta_i \) and \( \beta_2 \) which were found by Haley. The table includes the results obtained by using the logit model and the ratio model. When the logit results are used, the estimates of \( \beta_i \) and \( \beta_2 \) are of the expected sign. The mean estimates of \( \beta_i \) range from 0.452 to 0.542, and the mean estimates of \( \beta_2 \) range from 0.062 to 0.152. The results obtained by combining the direct estimates of \( \beta_i/\beta_2 \) with Haley's results are that the mean of \( \beta_i \) is 0.492 and the mean of \( \beta_2 \) is 0.112.

**Summary**

The work decision of college students was significantly influenced by the allowance (i.e., direct aid) and the maximum wage. Thus with attempts by the Federal administration to reduce grants to students and to raise the minimum wage, it should be expected that the percentage of students working would increase and that the portion of effort spent on human capital production would decrease. It is difficult in this paper to precisely identify the impact that reductions in federal support will have on the work decision of students since the allowance used in this paper is a combination of support from individuals, from local scholarships, and from federal support.
However, under the assumption that federal support will be reduced sufficiently such that there will be a ten percent reduction in the allowance, the percentage of students working will increase by approximately one percent at the point of means (59.6% to 60.5%). Similarly, a net reduction in the allowance of twenty-five percent will lead to an increase of approximately four percent. The change in the minimum wage legislation would also change the quantity demanded and thus may influence the probability that the student would be able to find work.

Loans were not found to influence the part-time work decision. This may be a result of the availability of loans having an influence on the decision to attend college or on the conditional decision of how many hours to work given that the decision is to work. An additional question which was not directly approached but would be of future interest is the influence of work study arrangements versus work versus loans. Based on this study which does not make a distinction between work the student finds and work the college finds, one would expect that the larger the hourly wage (or alternatively the larger the maximum wage) the greater the probability of working.

The results for the demographic variables were mixed, with sex, and race having significant influences and with marital status, socio-economic status, and the city size (as a proxy for the size of the labor market) being found to have insignificant influences on the probability of working. Males and whites were found to have significantly higher probabilities of working than females and non-whites.

The expected positive relationship between the city size and the probability of working while a full-time student was not confirmed. This failure may be a result of the city size being a reasonable proxy for the labor market during the academic year but not during the entire calendar year, since summer work is not necessarily confined to the city where the student attends classes. Alternatively, it could be argued that most students work at or near the college and consequently the relevant market size is not the city size.

The results from the direct estimates of the ratio of β1 to β2 and from the logit analysis were comparable with no statistical reason for preferring one over the other. Estimates of the coefficients for human capital were in the range from 0.45 to 0.54, and were in the range from 0.062 to 0.152 for the coefficient of purchased inputs.

References