Center for the Study of Welfare Policy

STANFORD RESEARCH INSTITUTE

Research Memorandum 48
March 1977

CHANGES IN RATES OF ENTERING AND LEAVING EMPLOYMENT UNDER A NEGATIVE INCOME TAX PROGRAM: EVIDENCE FROM THE SEATTLE AND DENVER INCOME MAINTENANCE EXPERIMENTS

by: Philip K. Robins, Stanford Research Institute
Nancy Brandon Tuma, Stanford University

STANFORD RESEARCH INSTITUTE
Menlo Park, California 94025 · U.S.A.

Research Memorandum 48 *March 1977*

CHANGES IN RATES OF ENTERING AND LEAVING EMPLOYMENT UNDER A NEGATIVE INCOME TAX PROGRAM: EVIDENCE FROM THE SEATTLE AND DENVER INCOME MAINTENANCE EXPERIMENTS

By

PHILIP K. ROBINS
Stanford Research Institute

NANCY BRANDON TUMA
Stanford University

SRI Projects URD-8750/1190

Project Leader: Robert G. Spiegelman

Both authors contributed equally to this paper and the order of authorship is alphabetical.
The research reported in this paper was performed pursuant to contracts with the states of Washington and Colorado, prime contractors for the Department of Health, Education, and Welfare under contract numbers SRS-70-53 and SRS-71-18, respectively. The opinions expressed in the paper are those of the authors and should not be construed as representing the opinions or policies of the states of Washington or Colorado or any agency of the United States Government.

ACKNOWLEDGMENTS

The authors gratefully acknowledge the helpful comments of Lyle Groeneveld, Michael Keeley, Myles Maxfield, and Richard West, as well as the expert programming assistance of Paul McElherne and Gary Stieger.

ABSTRACT

In this paper we study the effects of a negative income tax program on rates of entering and leaving employment. We present a new statistical framework that permits the prediction of several different measures related to employment behavior based on estimates from a single model. The measures considered in this paper include the duration of unemployment, the duration of employment, and the steady-state probability of working. We analyze data on employment changes of family heads in the Seattle and Denver Income Maintenance Experiments. The results suggest that for wives and female heads of families an NIT program significantly and substantially lengthens unemployment spells and reduces the probability of working. The program's effects on husbands and on the length of employment spells of wives and female heads are small, although occasionally significant.

CONTENTS

APPENDICES

ILLUSTRATIONS

TABLES

1. INTRODUCTION

It has been widely argued that a negative income tax (NIT) program would reduce the labor supply of family heads.* Some recent experimental evidence supports these arguments.† In a national simulation study, Keeley et al. (forthcoming) find that an NIT program with a guarantee level equal to the poverty line ($5,000 for a family of four in 1974) and a tax rate equal to 50% would reduce labor supply by 6% for husbands, by 21% for wives, and by 11% for female heads of families.‡

The reduction in labor supply associated with an NIT program can result from an increase in the duration of unemployment, a decrease in the duration of employment, or a decrease in hours of work on a given job. Reductions in labor supply caused by longer spells of unemployment may have a very different impact on the national economy than reductions caused by fewer hours of work on a given job. In spite of the importance of these differences, the nature of the labor supply response to an NIT program has rarely been discussed. The only experimental evidence on this issue is provided by Spilerman and Miller (1977) who analyze data on male heads of families in the New Jersey Income Maintenance Experiment. They report that under an NIT program, the rate of job departure among Black and White men decreases significantly as a function of plan generosity and that spells of unemployment are significantly shorter among low-income

---

*An NIT program reduces the net wage rate (by taxing earnings) and increases nonwage income (by providing a guarantee). Because of income and substitution effects that act in the same direction, labor supply falls as a result of the program. For an exposition of the static theory that generates this result, see Ashenfelter and Heckman (1973) and Keeley et al. (1977).

†See, for example, Hall (1975), Keeley et al. (1977), Kehrer et al. (1976), and Watts and Rees (1977).

‡These reductions are average percentage changes in annual hours of work for families below the breakeven level.

men with a generous guarantee. If hours of work on jobs do not change, the Spilerman and Miller results imply an increase (rather than a decrease) in the labor supply of men under an NIT program.

This paper has two main objectives. The first is to show how classical economic theory implies that an NIT program should increase the rate at which people leave employment and decrease the rate at which they leave unemployment. The second is to test this theory using data on husbands, wives, and female heads of families in the Seattle and Denver Income Maintenance Experiments (SIME/DIME).* The effects of an NIT program on the probability of working are also studied.†

The plan of the paper is as follows. In Section 2, the effects of an NIT program on the rates of entering and leaving employment are discussed. It is argued that an NIT program shortens employment spells and lengthens unemployment spells and that these changes imply a reduction in the probability of working. Section 3 contains a description of the data set and a discussion of the model and method of estimation. In Section 4, the results are presented and discussed. In Section 5, the results are used to predict the effects of an NIT program on the probability of working, the expected duration of employment, and the expected duration of unemployment. The final section of the paper summarizes the major findings.

---

*For a description of the Seattle and Denver Income Maintenance Experiments see Kurz and Spiegelman (1971, 1972).

†The effects of an NIT program on changes in hours of work on a given job are not considered in this paper.

2. THEORETICAL FRAMEWORK

The economic theory of the labor supply of an individual indicates that desired hours of work within some period of time (e.g., a year) are reduced by an NIT program through substitution and income effects. This reduction can take place by reducing hours on a given job, by shortening spells of employment, or by lengthening spells of unemployment during the time period considered. In the analysis below, we consider separately the behavior of employed and unemployed individuals. The discussion may refer to different individuals at the same point in time or to the same individual at different points in time.

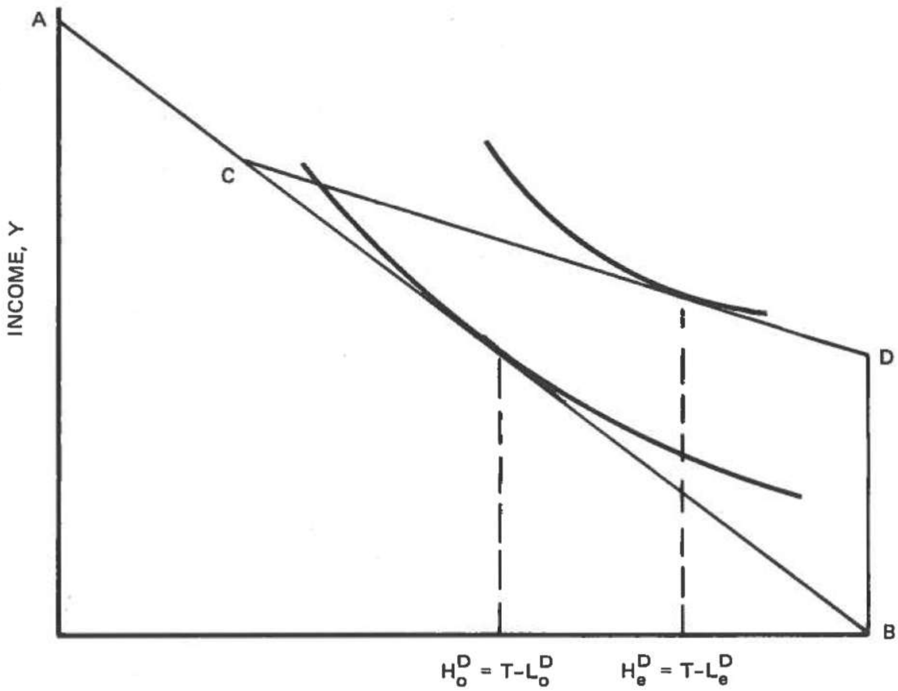
2.1 <u>The Effects of an NIT Program on the Rate of Leaving Employment</u>

Figure 1 depicts the situation for individuals who are employed. In an environment without an NIT program, the budget constraint of a particular individual is given by AB.* Desired hours of work are given by $H_o^D = T - L_o^D$ where T is the total time available and L_o^D is desired hours of leisure (nonmarket time). The slope of the budget line is equal to -W, where W is the net wage offered to the individual for each hour of work. At the desired hours of work, H_o^D, the shadow wage, W^S is equal to the wage offer W.†

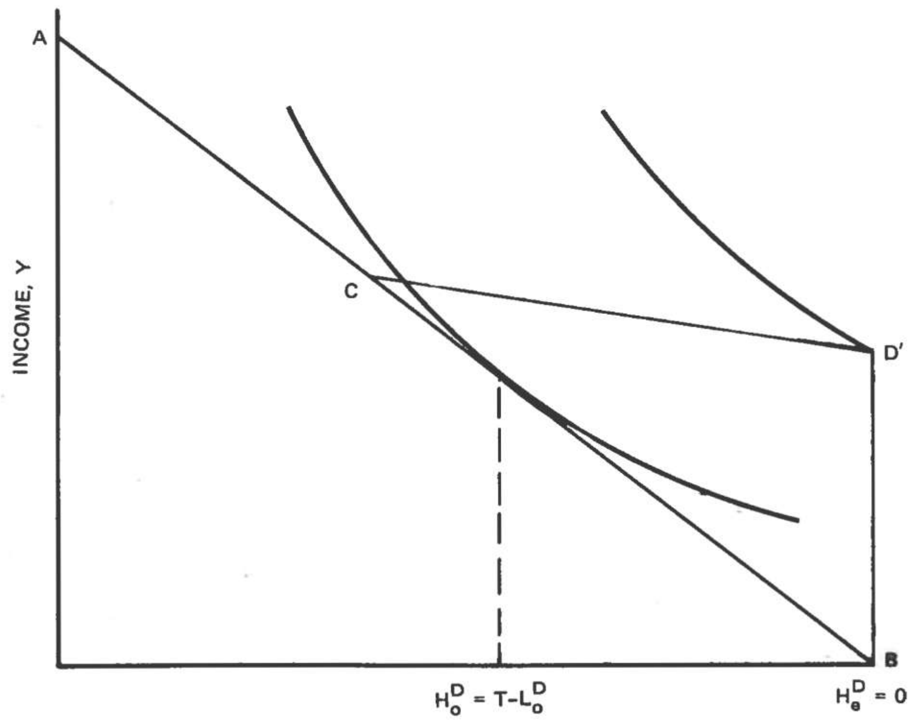
---

*It is assumed that nonwage income is zero and that there are no taxes prior to implementation of the NIT program; these assumptions are relaxed in the empirical analysis.

†The shadow wage is the marginal rate of substitution of income for leisure and is given by the slope of the indifference curve at a particular point. The shadow wage at zero hours of work represents the minimum wage that an individual will accept to go to work and is called the reservation wage.



PANEL (a) GUARANTEE LEVEL EQUAL TO DB AND TAX RATE EQUAL TO t_e



PANEL (b) HIGHER GUARANTEE AND TAX RATE

FIGURE 1 EFFECT OF AN NIT PROGRAM FOR EMPLOYED INDIVIDUALS

Figure 1(a) shows the situation in an environment with an NIT program having a guarantee level equal to DB and a tax rate equal to t_e. Under the NIT, the budget line facing the individual is given by ACD where C is the breakeven level.* To the right of C, on segment CD, the slope of the budget line is equal to $-W(1 - t_e)$, assuming the wage offer is unaffected by the NIT. Because of substitution and income effects, the individual's desired hours of work fall from H_o^D to H_e^D.† The wage and income changes, however, are not sufficient to induce this individual to leave employment.

Figure 1(b) depicts an NIT program with a higher guarantee (given by D'B) and a higher tax rate than in Figure 1(a), which is sufficient to induce the individual to leave employment. Under this situation the reservation wage exceeds the wage offer and the individual chooses not to work. The probability of leaving employment within an interval of time $\{t, t + \Delta t\}$ is thus positively related to an increase in income and positively related to a decrease in the net wage rate.

The scenario depicted in Figure 1 is incomplete in the sense that events other than the NIT can induce an individual to leave employment during the period $\{t, t + \Delta t\}$. Examples of such events include a decrease in the demand for labor (which lowers the offered wage), an increase in the number of children (which, for women, is likely to raise the reservation wage), or an increase in Social Security benefits (which may accelerate the decision to retire). Regardless of whether these events lead to temporary or permanent changes in labor supply, the probability of leaving employment is greater under an NIT because of an increase

---

*The breakeven level is the level of income at which the individual ceases to receive benefits from the program. In this example, the breakeven level is equal to $(DB)/t_e$.

†In this example the income change experienced by the individual (evaluated at his pre-NIT hours of work) is equal to $\Delta Y = G - WH_o t_e$, where G is the NIT guarantee. The wage change is equal to $\Delta W = -Wt_e$. The change in desired hours of work is equal to $\alpha \Delta W + \beta \Delta Y$, where α is the substitution effect and β is the income effect. See Keeley et al. (1977a) for a more comprehensive discussion of these concepts.

in the likelihood that the reservation wage exceeds the wage offer net of taxes.* Thus, an expression can be written for the conditional probability of leaving employment (either permanently or temporarily) within some interval of time $\{t, t + \Delta t\}$ in response to an NIT program, given employment at time t:

$$\text{Prob}\left\{\begin{matrix}\text{leaving employment} \\ \text{before time } t + \Delta t\end{matrix} \middle| \begin{matrix}\text{employment} \\ \text{at time } t\end{matrix}\right\} = P_1(t + \Delta t | \Delta W, \Delta Y, t) \qquad (1)$$

where

$$\frac{\partial P_1}{\partial \Delta W} < 0 \quad \text{and} \quad \frac{\partial P_1}{\partial \Delta Y} > 0 \quad .$$

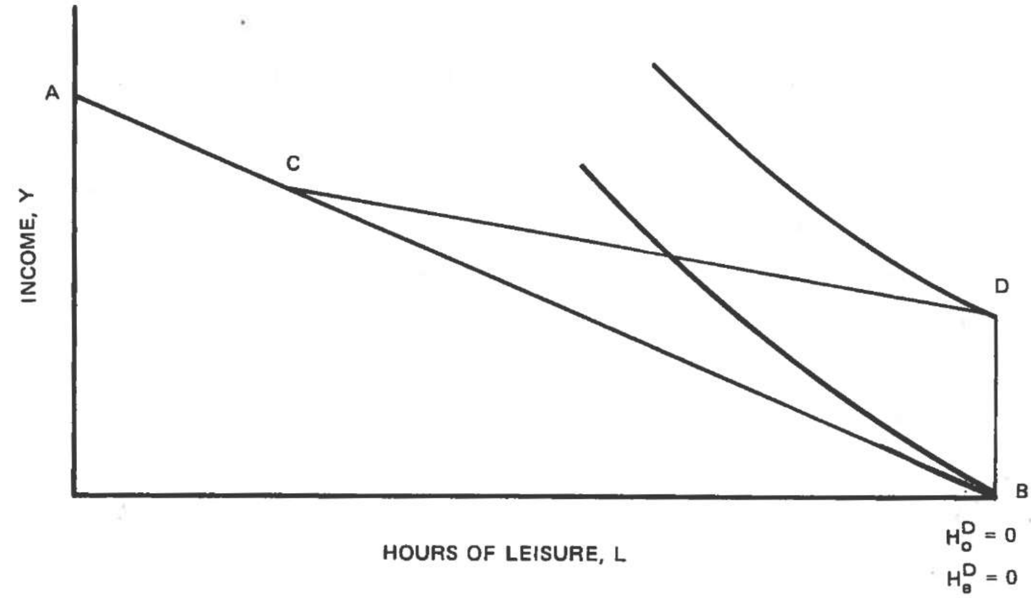
2.2 The Effects of an NIT Program on the Rate of Entering Employment

Figure 2 depicts the situation for persons who are unemployed. In Figure 2(a), the individual is voluntarily unemployed before implementation of the NIT. In the absence of other events that may induce entry into the labor force, persons who are voluntarily unemployed before the NIT remain voluntarily unemployed after the NIT. If leisure is a normal good, then the reservation wage increases under the NIT. Allowing for the occurrence of other events that induce entry into employment yields the result that the probability of entering employment under an NIT is lower than in the absence of an NIT because of the increase in the discrepancy between the reservation wage and the net wage offer.† Thus, the conditional probability of entering employment within an interval $\{t, t + \Delta t\}$, given voluntary unemployment at time t, is positively related to ΔW and negatively related to ΔY.

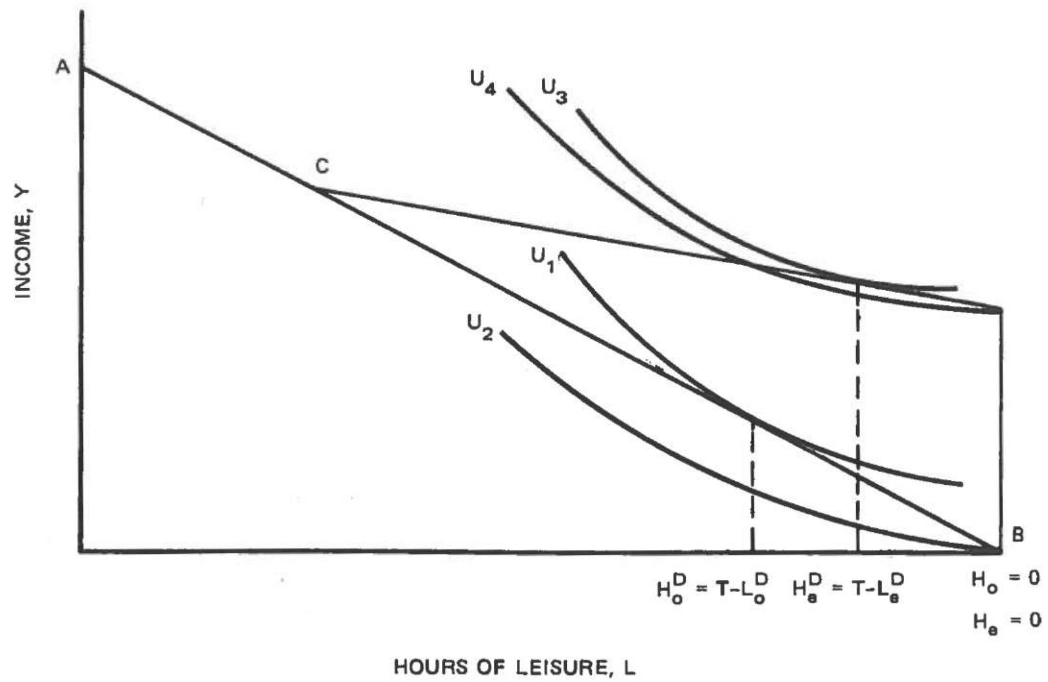
In Figure 2(b), the individual is involuntarily unemployed before implementation of the NIT (e.g., he is not working, but his desired hours of work are positive). Under the assumption that this individual is searching for employment for an amount of time equal to his desired hours of work H_o^D, there is a probability that during the interval

*This proposition generally holds if leisure is not an inferior good.

†This discrepancy between the reservation wage and the net wage offer is larger under an NIT because of an increase in the reservation wage and a decrease in the net wage offer.



(a) VOLUNTARY UNEMPLOYMENT BEFORE NIT



(b) INVOLUNTARY UNEMPLOYMENT BEFORE NIT

FIGURE 2 EFFECT OF AN NIT PROGRAM FOR UNEMPLOYED INDIVIDUALS

$\{t, t + \Delta t\}$, a job will be found. Until a job is found, the individual suffers a loss in utility equal to $U_1 - U_2$. After implementation of the NIT, desired hours of work fall to H_e^D (which may be zero) and the individual still suffers a loss in utility equal to $U_3 - U_4$. The intensity of search also falls to H_e^D because of the increased demand for leisure. If the probability of finding an acceptable job is proportional to the intensity of search, then it follows that the conditional probability of finding a job within the interval $\{t, t + \Delta t\}$, is lower under the NIT. Allowing for random or permanent shifts in the budget constraint arising from events other than the NIT does not alter this conclusion. Thus, as in the case of voluntary unemployment, the conditional probability of entering employment within the interval $\{t, t + \Delta t\}$ for the involuntarily unemployed is positively related to ΔW and negatively related to ΔY.

Combining the results for the voluntarily and involuntarily unemployed gives:

$$\text{Prob}\left\{\begin{array}{l|l}\text{leaving unemployment} & \text{unemployment} \\ \text{before time } t + \Delta t & \text{at time } t\end{array}\right\} = P_2(t + \Delta t \mid \Delta W, \Delta Y, t) \quad , \tag{2}$$

where

$$\frac{\partial P_2}{\partial \Delta W} > 0 \quad \text{and} \quad \frac{\partial P_2}{\partial \Delta Y} < 0 \quad .^*$$

2.3 The Effects of an NIT Program on the Probability of Working

The conditional probabilities represented by Equations (1) and (2) can be used to derive an expression for the effects of an NIT program on the steady-state probability of working. We define $r_j(t)$, the instantaneous rate of leaving state j at time t, as:

---

*In this paper we must ignore the possibility that the effects of ΔW and ΔY differ for the voluntarily and involuntarily unemployed. Data limitations, discussed in Section 3.1, preclude us from analyzing these groups separately.

$$r_j(t) = \lim_{\Delta t \to 0} \left\{ \frac{P_j(t + \Delta t | t)}{\Delta t} \right\} \quad , \quad j = 1,2 \quad . \tag{3}$$

For both states, the effects of ΔW and ΔY on $r_j(t)$ have the same sign as their effects on $P_j(t + \Delta t | t)$.

If the rates do not vary over time, then we can write the following:

$$p(t + \Delta t) \cong (1 - r_1 \Delta t)p(t) + r_2 \Delta t(1 - p(t)) \quad , \tag{4}$$

where

$p(t)$ = probability of working at time t

r_1 = rate of leaving employment

r_2 = rate of entering employment.

If we subtract $p(t)$ from both sides of Eq. (4), divide by Δt, and take the limit as Δt approaches zero, we get a differential equation in $p(t)$:

$$\frac{dp(t)}{dt} = -r_1 p(t) + r_2(1 - p(t)) \quad . \tag{5}$$

Setting $dp(t)/dt = 0$ and solving for the steady-state probability p yields:

$$p = \frac{r_2}{r_1 + r_2} \quad . \tag{6}$$

Thus the equilibrium (or steady-state) probability of working depends on the rates of movement into and out of jobs. Because $\partial r_1/\partial \Delta W < 0$, $\partial r_2/\partial \Delta W > 0$, $\partial r_1/\partial \Delta Y > 0$, and $\partial r_2/\partial \Delta Y < 0$, it follows that

$$\frac{\partial p}{\partial \Delta W} = \frac{r_1 \frac{\partial r_2}{\partial \Delta W} - r_2 \frac{\partial r_1}{\partial \Delta W}}{(r_1 + r_2)^2} > 0 \quad , \tag{7}$$

$$\frac{\partial p}{\partial \Delta Y} = \frac{r_1 \frac{\partial r_2}{\partial \Delta Y} - r_2 \frac{\partial r_1}{\partial \Delta Y}}{(r_1 + r_2)^2} < 0 \quad . \tag{8}$$

Thus an NIT program in which ΔW is negative and ΔY is positive reduces the probability of working.

3. EMPIRICAL ANALYSIS

3.1 Experimental Design

The data used in the empirical analysis come from the heads of Black and White families participating in the Seattle and Denver Income Maintenance Experiments (SIME/DIME). About 4,800 families (2,000 in Seattle and 2,800 in Denver) participate in the experiments.* Roughly 60% of the families are assigned to one of eleven different financial treatments for a 3-, 5-, or 20-year period.† The financial treatments consist of selected combinations of three support (or guarantee) levels (S = \$3,800, \$4,800, or \$5,600 per year for a family of four with an adjustment based on family size), three initial tax rates (t_e = 0.50, 0.70 or 0.80), and two rates of decline in the tax (d = 0.0 or 0.025 per \$1,000 of income per year). At enrollment the change in disposable income experienced by a family on a particular income maintenance program, ΔY, is given by

$$\Delta Y = \text{Max}\left[S - (t_e - d \cdot Y_o) \cdot Y_o + t_o Y_o,\ 0\right] \tag{9}$$

where Y_o is gross annual family income at enrollment and t_o is the non-experimental tax rate.

Each interview collects extensive data on each family member's work history since the previous interview. Dates at which jobs begin or end are included in this information and form the basis for the analysis.

---

*About 800 Mexican-American families are participating in the Denver experiment. They are not included in the analysis reported in this paper because data on them were not available at the time the study was undertaken.

†There are also three manpower treatments, which are controlled in the empirical analysis. However, we do not focus attention on the effects of the manpower treatments.

The brief length of time between interviews (about 4 months) should minimize errors in these dates resulting from retrospection. Unfortunately, only limited information on movement between voluntary and involuntary unemployment is available, which necessitates treatment of "unemployment" as a homogeneous state.*

SIME/DIME data have several features worth noting. First, participants in SIME/DIME were selected from groups thought most likely to be the targets of a national NIT program and most likely to respond to such a program. Thus, those enrolled in SIME/DIME had to meet several requirements: The family had to contain either two heads (i.e., a married couple) or one head with at least one dependent;† family heads had to be between 18 and 58 years of age and be physically capable of working; pretransfer income (adjusted for family size) had to be less than $9,000 per year in a family of four with one working head and under $11,000 per year in a four-member family with two working family heads.

Another important feature of the SIME/DIME design is a stratified allocation of families to experimental treatments on the basis of four assignment variables: site, family type (one or two family heads), ethnicity (Black, White, or Mexican-American), and normal income (seven levels of "typical" pretransfer family income adjusted for family size). Within any particular combination of the four stratification variables, assignment of a family to an experimental treatment is random. However, the probability of being assigned to a particular treatment varies across combinations of the stratification variables. For example, the probability of being assigned to a treatment with a high breakeven level increases with normal income.

---

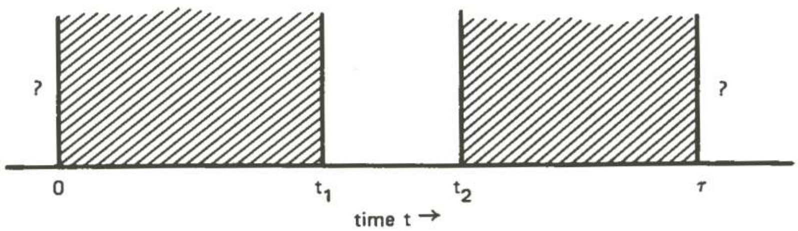
*Movements between voluntary and involuntary unemployment are artificially recorded to occur at interview dates. Consequently some movements between these two states will not be recorded at all, and those that are recorded will have artificial dates of the change. In a future study we will attempt to investigate this problem.

†Initial families in SIME/DIME do not include unrelated individuals; however, changes in family composition during the experimental period produce some families consisting of unrelated individuals.

The stratified random assignment to treatments, which was chosen to reduce the total costs of payments, causes problems in analyzing the effects of an NIT on changes in employment status. If the effects vary with the assignment variables, then simple experimental-control differences may be misleading except for families with a particular combination of the stratification variables. Unfortunately the number of families within a combination is too small for this type of analysis.* We also do not have preexperimental measures of the rates of leaving and entering employment among the SIME/DIME sample, so we are unable to examine changes in these rates. Under these circumstances it becomes extremely important to model the nonexperimental environment correctly.

3.2 Analytical Model and Method of Estimation

As indicated above, the SIME/DIME data provide information on the reported dates that heads enter and leave jobs. If we denote the family's enrollment date by time $t = 0$ and the time of the last observation of a head by τ,† then a typical head's work history can be represented as follows:



---

*See Spiegelman and West (1976) for a discussion of problems associated with estimating a response function under stratified random assignment.

†For most individuals the observation period ends with the last recorded interview. If a person changed marital status, moved out of the area, or left one job but remained employed, the observation period terminates at the time of this change. The mean length of the observation period is 77.7 weeks for husbands, 83.2 weeks for wives, and 88.3 weeks for female heads. For each sample over 90% of the individuals have an observation period less than 30 months.

where shading represents working (employment) and no shading represents not working (unemployment). In this example, the head, who is employed at enrollment, changes from working to not working at time t_1 and from not working to working at time t_2. We lack any information on the work history of the family head after τ and have only limited knowledge of his or her history prior to time 0. If we define a spell as a continuous period of time in a state (either employment or unemployment), then this example illustrates two spells of working and one of not working during the observation period. Most individuals who change jobs report alternating between having a job (working) and not having a job.*

As stated in Section 2, the instantaneous rate of leaving state j (where in our analysis j = 1 represents employment and j = 2 represents unemployment), is defined as the limit of the probability of leaving state j between t and t + Δt, given that state j is occupied at time t:

$$r_j(t) = \lim_{\Delta t \to 0} \frac{P_j(t + \Delta t | t)}{\Delta t} \quad , \quad j = 1,2 \quad . \tag{3 repeated}$$

Suppose that state j is occupied at $t' \leq t$, and denote the probability of leaving state j before t (conditional on being in the state at t') by $F_j(t|t')$. Then the instantaneous rate of leaving state j at time t is just

$$r_j(t) = \lim_{\Delta t \to 0} \left\{ \frac{F_j(t + \Delta t | t') - F_j(t|t')}{(1 - F_j(t|t'))\Delta t} \right\}$$

$$= f_j(t|t')/[1 - F_j(t|t')] \quad , \tag{10}$$

*Individuals reporting a job-to-job change are recorded as having an intervening unemployment spell lasting one day. Less than 2% of the completed unemployment spells in the sample are of this kind.

where

$$f_j(t|t') = dF_j(t|t')/dt \quad . \tag{11}$$

When t' equals t, Eq. (10) reduces to Eq. (3). Note that the rate is the ratio of two positive quantities (a probability density and a probability) and so must be positive.

In general we must also consider which state is entered when state j is left. However, in the present analysis, which assumes that individuals alternate between working and not working, with no other state possible, this is unnecessary: an individual who leaves employment is assumed to enter unemployment with probability one, just as the individual who leaves unemployment is assumed to enter employment with probability one.

In the present analysis we make the simplifying assumption that rates of changing employment status do not vary with time. Even though there are good reasons for thinking that the rates of change between working and not working may depend upon experimental time, age, length of time in or out of the job, season of the year, and the like, it is useful to begin by asking whether an NIT program has <u>any</u> effects on rates of changing employment status "on the average" over the period of our observations. An approximate answer to this question can be obtained by assuming time-invariant rates of change, r_j. In future work we intend to relax the assumption of time-invariance.

When rates are time-invariant, Equation (10) has a simple solution:

$$F_j(t|t') = 1 - \exp\left[\int_{t'}^{t} r_j \, du\right] \quad , \tag{12}$$

$$= 1 - \exp\left[-r_j(t - t')\right] \quad . \tag{13}$$

This is just the probability distribution function for an exponentially distributed random variable with parameter r_j, and has probability density

$$f_j(t|t') = \frac{dF_j(t|t')}{dt} = r_j \exp\left[-r_j(t - t')\right] \quad . \tag{14}$$

Note that the probability distribution function depends only on the length of the elapsed time interval $t - t'$, and not on the starting time, t'.

In the above equations the rate of leaving state j is implicitly assumed to be invariant within the population of interest. This is neither realistic nor useful if we are to examine the effects of an NIT program on changes in employment status. Instead we assume that the rate of leaving state j depends on a vector of exogenous variables $\underline{X}_j$: $r_j(\underline{X}_j)$. In this paper $\underline{X}_1 = \underline{X}_2 = \underline{X}$, so we do not subscript $\underline{X}$ below.

To estimate the effects of an NIT program on rates of changing work status, it is necessary to specify the functional relationship between the rate of change and the vector of exogenous variables $\underline{X}$. We have chosen a log-linear relationship between r and $\underline{X}$, which ensures that rates are positive:

$$\ln r_j = \underline{\beta}_j \underline{X} \tag{15}$$

or

$$r_j = e^{\underline{\beta}_j \underline{X}} \tag{16}$$

where $\underline{\beta}_j$ is a vector of parameters. An element in $\underline{\beta}_j$, β_{jk}, gives the effect of a unit change in variable X_k on the logarithm of the rate of leaving state j when the other variables in the model are held constant.*

*It should be noted that the relationship between the rate and the exogenous variables $\underline{X}$ in Equation (16) does not contain an unobserved stochastic component which would allow for heterogeneity in rates among a group that is homogeneous with regard to observable variables. We plan to add a residual random component to the rate in future work.

Letting γ_{jk} denote $e^{\beta_{jk}}$, Equation (15) can also be written as:

$$r_j = \gamma_{jo} \cdot \gamma_{j1}^{X_1} \cdot \gamma_{j2}^{X_2} \quad . \tag{17}$$

Thus γ_{jk} is the multiplier of the rates of leaving state j when there is a unit increase in variable X_k and other variables are controlled. If a variable X_k has no effect on the rate, then β_{jk} is zero and γ_{jk} equals one. Sometimes it is useful to interpret the effect of a variable X_k in terms of the percentage increase in the rate for a unit change in X_k; this is just $(\gamma_{jk} - 1)\cdot 100\%$.

The parameters in the model, i.e., the β_{jk}'s, can be estimated by the method of maximum likelihood (ML). A well-known advantage of this method is that ML estimators are consistent, efficient, and asymptotically normally distributed under very weak regularity conditions on the probability distribution function (e.g., Dhrymes, 1970), which conditions an exponential distribution meets. Another advantage of ML estimation is that we can incorporate in the analysis data on censored observations, that is, on employment and unemployment spells that do not end within the observation period.* Since the observation period in SIME/DIME is short compared to the average length of employment spells, this advantage is particularly important for our analyses.

Under the assumptions given above, the likelihood function for the sample observations--the sequence of times of changes in employment status occurring between enrollment and the end of the observation period--

---

*Selection of an analysis sample on the basis of the dependent variable can lead to biased coefficient estimates. For a discussion of this issue see Heckman (1977).

is as follows, based on an extension of a procedure by Bartholomew (1957):

$$L = \prod_{i=1}^{N} f(t_1, t_2, \ldots, t_K|\underline{X}) \cdot \left[1 - F(\tau - t_K|\underline{X}, t_1, \ldots, t_K)\right] \tag{18}$$

where N is the number of individuals in the sample, K_i is the number of spells of individual i in period $(0, \tau_i)$, and subscript i on all variables within parentheses has been suppressed for simplicity. The first term on the right-hand side is the joint probability density of the observed times of changes, conditional on the variables in $\underline{X}$. The second term is the probability that the $(K + 1)^{th}$ change does not occur between t_K and τ, conditional on $\underline{X}$ and the observed times of the previous K changes in employment status. Under the assumptions made above, namely that rates of change in employment status are exponentially distributed (and hence independent of the times of previous changes), this simplifies to:

$$L = \prod_{j=1}^{2} L_j$$

$$L_j = \prod_{i=1}^{N} \left\{ \prod_{k=1}^{K_i} \left[f_j(t_k - t_{k-1}|\underline{X})\right]^{s_{jk}y_k} \right\}$$

$$\cdot \left[1 - F_j(\tau - t_K|\underline{X})\right]^{(1-s_{j,K+1}y_{K+1})} \tag{19}$$

where j indicates the state occupied (1 = employment; 2 = unemployment); k indicates the number of the spell since enrollment; s_{jk} is one if the k^{th} spell refers to state j and is zero otherwise; and y_k equals one if the end of spell k is observed and is zero otherwise. Since L_1 depends on r_1, but not on r_2, while L_2 depends on r_2 but not on r_1, finding values of parameters that maximize L_1 and L_2 separately is the same as finding values of parameters that maximize L. For the empirical analyses reported in this paper, L_1 and L_2 are maximized separately to reduce computational costs; the computer program RATE (Tuma and Crockford, 1976) is used for this purpose.

3.3 Variables

The explanatory variables X used in the analysis include both control variables and variables representing the experimental treatments. The control variables contain measures of the assignment variables, the manpower treatments, and other exogenous variables likely to affect employment decisions in the preexperimental situation. Two different representations of the financial treatments are used. The first consists of a dummy variable that is one for those enrolled on a financial treatment. The second consists of the predicted changes in disposable income and net wage due to the financial treatment for those below the breakeven level at enrollment, and a dummy variable that is one for those above the breakeven at enrollment.* An additional experimental treatment, program length, is indicated in both models by a dummy variable that is one for those on the 3-year program. Table 1 reports the means of the explanatory variables used in the analysis by employment status of spells for husbands, wives, and female heads.

---

*The procedures used to construct these variables are described in Keeley et al. (1977a).

Table 1

MEANS OF VARIABLES USED IN THE ANALYSIS BY EMPLOYMENT STATUS OF SPELLS

Variable	Husbands		Wives		Female Heads	
	Employed	Unemployed	Employed	Unemployed	Employed	Unemployed
Number of family members	4.3	4.1	4.2	4.3	3.3	3.4
Number of children under 16 years of age	2.2	2.1	2.1	2.2	2.2	2.3
Age in years	32.9	31.9	30.1	30.3	34.3	32.7
Years of schooling	11.7	11.5	11.7	11.4	11.7	11.3
Ethnicity (1 = Black)	.38	.36	.46	.38	.54	.54
Location (1 = Denver)	.53	.49	.57	.52	.58	.50
Normal Income						
1 = 0 - $1,000	.01	.03	.01	.02	.08	.20
1 = $1,000 - 3,000	.05	.09	.04	.07	.20	.27
1 = $3,000 - 5,000	.16	.22	.13	.17	.29	.26
1 = $5,000 - 7,000	.29	.29	.26	.28	.21	.12
1 = $7,000 - 9,000	.29	.23	.28	.28	.16	.08
1 = $9,000 - 11,000	.17	.13	.24	.16	.02	.01
1 = $11,000 - 13,000	.01	.--	.02	.01	--	--
1 = not determined	.02	.03	.02	.02	.04	.06
Weeks worked in year prior to enrollment	41.2	32.9	24.8	11.6	35.2	19.2
Net wage at enrollment (predicted)	3.29	3.26	2.19	2.15	2.41	2.36
Disposable income in year prior to enrollment	6,612	5,615	7,116	6,283	3,945	2,514
1 = Financial treatment	.53	.56	.46	.51	.58	.61
1 = Manpower (counseling only)	.19	.20	.18	.17	.19	.19
1 = Manpower (counseling and 50% training subsidy)	.24	.25	.25	.15	.23	.23
1 = Manpower (counseling and 100% training subsidy)	.15	.15	.14	.14	.15	.16
Change in net wage* (ΔW)	-1.02	-1.15	-.61	-.72	-.92	-1.10
Change in disposable income* (ΔY)	1,402	1,341	1,393	1,375	1,174	1,219
1 = above breakeven†	.17	.15	.21	.16	.12	.07
1 = three year program†	.66	.66	.67	.69	.71	.80
Number of spells	2,991	1,837	1,692	2,189	1,523	1,418
Number of individuals	1,562	402	665	1,307	803	708

*Calculated over financial treatment families below the breakeven level.

†Calculated over financial treatment families.

4. EMPIRICAL RESULTS

Tables 2 and 3 present the estimated experimental effects on the rates of leaving and entering employment, respectively.* These tables contain the coefficient of the treatment variable in the log-linear rate model, the estimated asymptotic standard error of the coefficient, the percentage effect of the variable, the effect at the mean of the variable (when not a dummy variable), and the percentage effect at the mean of the variable.

Control families are included in the samples used to estimate both models. If the parameterized model is correctly specified, control families are not really required because the financial treatments are measured in terms of changes between the experimental and preexperimental periods.† Members of control families are included in the sample, however, to increase the efficiency of the estimated treatment effects. In the dummy-variable representation of the financial treatment, control families are required because the treatment effect is measured as an experimental-control differential, holding constant certain observed characteristics. If there are systematic differences between the treatment and control groups that are not captured by the observed characteristics included in this model, then the estimated treatment effects will be biased.

The empirical results for both the dummy-variable model and the parameterized model are roughly consistent, although the experimental effects appear to be somewhat larger (in absolute value) in the dummy-variable model. Generally speaking, the dummy-variable model "fits" the

---

*Estimates of nonexperimental and manpower effects for the parameterized model are presented in Appendix A. Estimates of these effects for the dummy-variable model are similar.

†Thus experimental families serve as their own controls in this model.

Table 2

MAXIMUM LIKELIHOOD ESTIMATES OF EXPERIMENTAL EFFECTS ON THE RATE OF LEAVING EMPLOYMENT

	Husbands		Wives		Female Heads	
	Parameterized Model	Dummy-Variable Model	Parameterized Model	Dummy-Variable Model	Parameterized Model	Dummy-Variable Model
ΔY($1,000's/year)						
Coefficient	.078**	--	.054	--	.118**	--
Standard error	.037	--	.053	--	.050	--
Percentage effect	8.1	--	5.5	--	12.5	--
Effect at mean	.109	--	.075	--	.139	--
Percentage effect at mean	11.5	--	7.8	--	14.9	--
ΔW($/hour)						
Coefficient	.029	--	-.131	--	-.025	--
Standard error	.057	--	.120	--	.099	--
Percentage effect	2.9	--	-12.3	--	-2.5	--
Effect at mean	-.030	--	.080	--	.023	--
Percentage effect at mean	-3.0	--	8.3	--	2.3	--
Dummy Variables						
Above-Breakeven						
Coefficient	-.120	--	.063	--	-.047	--
Standard error	.113	--	.151	--	.198	--
Percentage effect	-11.3	--	6.5	--	-4.6	--
Financial Treatment						
Coefficient	--	.222***	--	.045	--	.031
Standard error	--	.074	--	.102	--	.117
Percentage effect	--	24.9	--	4.6	--	3.1
3-Year Program						
Coefficient	-.097	-.221***	-.227**	-.160	-.176	.005
Standard error	.070	.077	.096	.112	.100	.115
Percentage effect	-9.2	-19.8	-20.3	-14.8	-7.3	.5
Number of spells	2,991		1,692		1,523	
Number of individuals	1,562		665		803	
Likelihood ratio test for treatment effects (χ^2)	8.03*	9.93***	6.55	2.87	7.73	.16
	(d.f. = 4)	(d.f. = 2)	(d.f. = 4)	(d.f. = 2)	(d.f. = 4)	(d.f. = 2)

*Significant at 10% level.

**Significant at 5% level.

***Significant at 1% level.

data better, as evidenced by the lower significance levels in the likelihood ratio tests for treatment effects. The parameterized model, however, has the advantage of being able to predict the effects of any single NIT program, in contrast to the dummy-variable model which can only predict the average effects of the eleven programs being tested in SIME/DIME, conditional on the assignment procedure used in the experiments.

4.1 Estimated Experimental Effects on the Rate of Leaving Employment

The estimated experimental effects on the rate of leaving employment (Table 2) are statistically significant only for husbands, although the signs of the effects for the other two groups generally conform to our theoretical expectations. In the dummy-variable model, those receiving financial treatment on the 5-year program have a significantly higher rate of leaving employment than the controls. In the parameterized model, the rate of leaving employment is positively associated with the change in disposable income. For each thousand-dollar increase in disposable income, the rate of leaving employment increases by 8% for husbands, by 6% for wives (not statistically significant), and by 13% for female heads of families. Evaluated at the mean changes in disposable income over experimental families below the breakeven level, the income effect is 12% for husbands, 8% for wives, and 15% for female heads of families.

None of the wage effects are statistically significant, although for wives the effect is quantitatively large. For each dollar decrease in the wife's net wage, the rate of leaving employment increases by 12%. Evaluated at the mean change over experimental families below the breakeven level, the wage effect is 8%.

For both husbands and wives, there is a significant difference in the response of 3- and 5-year families. In the dummy-variable model, husbands on the 5-year program are 20% more likely to leave employment than husbands on the 3-year program. In the parameterized model, wives on the 5-year program are 20% more likely to leave employment than wives on the 3-year program. For both groups, 3-year families do not appear to be responding to the financial treatments.

4.2 Estimated Experimental Effects on the Rate of Entering Employment

The estimated experimental effects on the rate of entering employment (Table 3) are statistically significant for all three groups. In the dummy-variable model, those receiving financial treatment have a lower rate of entering employment than do controls. In the parameterized model, the rate of entering employment decreases with a decrease in the net wage and decreases with an increase in disposable income. For each dollar decrease in the net wage, the rate of entering employment decreases by 20% for husbands, by 37% for wives, and by 41% for female heads of families. Evaluated at the mean change in the net wage rate, the effects indicate a decrease of 19% for husbands, 20% for wives, and 31% for female heads of families. The income effect is significant only for wives. For each thousand-dollar increase in disposable income, the rate of entering employment decreases by 11% for wives. Evaluated at the mean, there is a 15% decrease in wives' rate of entering employment.

The length of the experiment has a significant effect on the husband's rate of entering employment. Husbands on the 5-year program are 25% less likely to enter employment than husbands on the 3-year program. As in the case of leaving employment, husbands on the 3-year program do not appear to be responding to the financial treatments.

Table 3

MAXIMUM LIKELIHOOD ESTIMATES OF EXPERIMENTAL EFFECTS ON THE RATE OF ENTERING EMPLOYMENT

	Husbands		Wives		Female Heads	
	Parameterized Model	Dummy-Variable Model	Parameterized Model	Dummy-Variable Model	Parameterized Model	Dummy-Variable Model
ΔY($1,000's/year)						
Coefficient	.021	--	-.120***	--	.048	--
Standard error	.037	--	.048	--	.051	--
Percentage effect	2.1	--	-11.3	--	4.9	--
Effect at mean	.028	--	-.165	--	.059	--
Percentage effect at mean	2.8	--	-15.2	--	6.1	--
ΔW($/hour)						
Coefficient	.178***	--	.311***	--	.341***	--
Standard error	.056	--	.109	--	.100	--
Percentage effect	19.5	--	36.5	--	40.6	--
Effect at mean	-.205	--	-.225	--	-.374	--
Percentage effect at mean	-18.5	--	-20.1	--	-31.2	--
Dummy Variables						
Above-Breakdown						
Coefficient	-.320***	--	-.334***	--	-.089	--
Standard error	.114	--	.133	--	.208	--
Percentage effect	-27.4	--	-28.4	--	-8.5	
Financial Treatment						
Coefficient	--	-.251***	--	-.505***	--	-.437***
Standard error	--	.077	--	.097	--	.117
Percentage effect	--	-22.2	--	-39.6	--	-35.4
3-Year Program						
Coefficient	.224***	.256***	-.016	.096	-.042	.057
Standard error	.073	.080	.091	.104	.105	.118
Percentage effect	25.1	29.2	-1.6	10.1	-4.1	5.9
Number of spells	1,837		2,189		1,418	
Number of individuals	402		1,307		708	
Likelihood ratio test for treatment effects (χ^2)	16.76*** (d.f. = 4)	12.84*** (d.f. = 2)	40.62*** (d.f. = 4)	45.77*** (d.f. = 2)	21.67*** (d.f. = 4)	23.76*** (d.f. = 2)

***Significant at 1% level.

5. IMPLICATIONS OF THE RESULTS

A major advantage of analyzing the impact of an NIT program on rates of change in employment status is that the estimated effects on rates can be used to predict the consequences of an NIT for a variety of related outcomes. In this section we focus on three of these outcomes: the probability of working at a point in time, the average duration of employment spells, and the average duration of unemployment spells.* In Section 2 we argued that the probability of employment would unambiguously be decreased by an NIT program that increases family income and decreases the net wage of an individual. However, this reduction could arise from a decrease in the length of employment spells, from an increase in the length of unemployment spells, or from both. In this section we explore the implications of our empirical findings for these three outcomes both for the experimental sample and for "typical" individuals on an NIT with particular characteristics.

5.1 Predictive Ability of the Models

Before examining the consequences of NIT programs for the three outcome measures, it is useful to compare observed proportions of individuals who are employed at enrollment with the average probability of working predicted by the estimated model when there are no NIT effects. If the sample is in equilibrium at enrollment, if the estimated models are properly specified, and if the effects of the nonexperimental variables are the same before and after enrollment, then the observed proportions

---

*The average (or expected) duration of a spell for an individual with a particular set of characteristics is just the inverse of the predicted rate at which the individual changes to another status; this is a consequence of the assumption that an individual's rate of change is time-invariant, implying that spell lengths are exponentially distributed. The probability of employment is obtained from Equation (6).

employed at enrollment and the average predicted probability of working should be essentially the same. Such comparisons permit an evaluation of the model that does not directly depend on the data used in estimation of the parameters.

Table 4 reports the average predicted probability of employment, along with the observed proportions who are employed, involuntarily unemployed, and voluntarily unemployed at enrollment, for husbands, wives, and female heads. The predictions are generated from the dummy-variable model. Comparing observed and predicted values, we see that the average predicted probability of working overestimates the observed proportion employed by about .01 for husbands, by about .03 for female heads, and by about .08 for wives. Based on these comparisons, we conclude that the nonexperimental portion of the estimated models is quite successful for husbands, moderately successful for female heads, and only fairly successful for wives.

It appears that the ability of the estimated models to predict preexperimental employment probabilities declines as the proportion in the group who are voluntarily unemployed increases. This suggests that the defects in the estimated models may be due to our treatment of voluntary and involuntary unemployment as a single homogeneous state. It also supports our a priori belief that future work on NIT impacts on changes in employment status should attempt to separate voluntary and involuntary unemployment, in spite of data difficulties.

Finally, it is worth noting that control-financial differences in predicted probabilities of employment are reasonably close to the control-financial differences in the observed proportions employed for each of the three groups.

5.2 Predictions for the SIME/DIME Sample

We have used the estimates from the dummy-variable and parameterized models (Tables 2 and 3) to predict the average probability of employment, the average duration of employment, and the average duration of unemployment for husbands, wives, and female heads in the SIME/DIME sample.

Table 4

PREDICTED AND OBSERVED PROPORTIONS IN AN EMPLOYMENT STATE

	Husbands		Wives		Female Heads	
	Controls	Financial Treatment	Controls	Financial Treatment	Controls	Financial Treatment
Predicted probability of employment, no NIT effects	.824	.789	.436	.400	.589	.545
Observed proportion employed	.812	.784	.369	.313	.545	.519
Observed proportion involuntarily unemployed	.131	.162	.124	.143	.225	.224
Observed proportion voluntarily unemployed	.057	.054	.505	.544	.230	.256

Estimated standard errors of the predictions have also been calculated.* The predictions, which are reported in Tables 5 and 6 for the respective models, are given separately for controls (Column 1), for those receiving financial treatment without NIT effects (Column 2), and for those receiving financial treatment with NIT effects (Column 3). We also report, for those receiving financial treatments, the difference that is attributed to the NIT treatments in SIME/DIME (Column 4).

For each of the three groups in both Tables 5 and 6, Columns 1 and 2 indicate that, quite aside from the effects of the NIT, those receiving financial treatment have lower probabilities of working, shorter employment spells, and longer unemployment spells than do controls. These differences reflect the stratified random assignment used to allocate families to financial treatments and indicate that the effect of the NIT treatments on changes in employment status would be overestimated if we ignored the effects of the assignment in the estimation. The relatively good fit between observed proportions employed at enrollment and the predicted probability of employment when there are not NIT effects, which we discussed in Section 5.1, suggests that the estimated models adequately take into account the effects of assignment on rates of change in employment status.

With regard to the effects of the NIT treatments, both Table 5 and Table 6 indicate that both wives and female heads of families enrolled on financial programs experience a statistically significant (.01 level), 7 percentage point decrease in the average probability of employment. Both tables also imply that the NIT effects are not due to effects on the length of employment spells of wives and female heads. Rather, the decreases in the probability of working arise from very large increases in the average length of unemployment spells. The duration of unemployment spells is predicted to increase by roughly 50% for both groups of women.

---

*Appendix B describes how the predictions and the estimated standard errors of the predictions are calculated.

Table 5

PREDICTIONS FOR THE SIME/DIME SAMPLE USING ESTIMATES FROM THE DUMMY VARIABLE MODEL†
(Estimated asymptotic standard errors in parentheses)

	Husbands				Wives				Female Heads			
Prediction	Controls (1)	Financials, No NIT (2)	Financials, NIT (3)	Difference Due to NIT (4)	Controls (1)	Financials, No NIT (2)	Financials, NIT (3)	Difference Due to NIT (4)	Controls (1)	Financials, No NIT (2)	Financials, NIT (3)	Difference Due to NIT (4)
Steady-state probability of employment	.824 (.006)	.789 (.008)	.770 (.007)	-.018* (.010)	.436 (.012)	.400 (.012)	.334 (.012)	-.067*** (.017)	.589 (.013)	.545 (.015)	.474 (.012)	-.071*** (.019)
Duration of employment (weeks)	120.9 (5.8)	107.4 (5.0)	100.3 (4.5)	-7.1 (5.7)	73.4 (4.0)	65.7 (3.6)	70.0 (4.0)	4.3 (4.8)	116.7 (8.1)	99.4 (6.8)	96.1 (5.6)	-3.4 (7.9)
Duration of unemployment (weeks)	25.4 (1.7)	28.9 (2.0)	31.0 (2.1)	2.1 (1.7)	108.6 (6.0)	111.2 (6.2)	172.4 (10.0)	61.2*** (9.9)	94.3 (7.3)	100.9 (8.3)	149.0 (11.2)	48.1*** (10.4)

†Significance levels are reported only for the "difference due to NIT."

*Significant at 10% level.

***Significant at 1% level.

Table 6

PREDICTIONS FOR THE SIME/DIME SAMPLE USING ESTIMATES FROM THE PARAMETERIZED MODEL†
(Estimated asymptotic standard errors in parentheses)

	Husbands				Wives				Female Heads			
Prediction	Controls (1)	Financials, No NIT (2)	Financials, NIT (3)	Difference Due to NIT (4)	Controls (1)	Financials, No NIT (2)	Financials, NIT (3)	Difference Due to NIT (4)	Controls (1)	Financials, No NIT (2)	Financials, NIT (3)	Difference Due to NIT (4)
Steady-state probability of employment	.817 (.006)	.780 (.003)	.776 (.007)	-.004 (.009)	.434 (.012)	.400 (.012)	.335 (.012)	-.064*** (.016)	.586 (.013)	.543 (.015)	.477 (.011)	-.065*** (.017)
Duration of employment (weeks)	115.3 (5.2)	101.9 (4.5)	105.0 (4.6)	3.1 (5.0)	74.6 (4.0)	67.0 (3.5)	68.6 (3.9)	1.6 (4.5)	118.8 (7.9)	102.2 (6.5)	95.8 (5.5)	-6.4 (7.0)
Duration of unemployment (weeks)	25.4 (1.7)	28.9 (2.0)	31.6 (2.2)	2.8 (1.8)	111.7 (6.1)	113.8 (6.3)	170.5 (10.2)	56.7*** (10.2)	97.3 (7.5)	104.7 (8.6)	152.9 (12.4)	48.2*** (11.6)

†Significance levels are reported only for the "difference due to NIT."

***Significant at 1% level.

On the whole, the predictions in Tables 5 and 6 are quite similar. This means that the dummy variable and parameterized models have similar implications for the SIME/DIME sample, as would be expected. The two models do differ somewhat with regard to the effects of the NIT treatments on husbands. For husbands enrolled in financial programs, the dummy-variable model predicts that the NIT treatments cause a 2 percentage point decrease in the probability of employment, which is significant at the .10 level, whereas the parameterized model predicts that the NIT treatments have a negligible and insignificant effect on the probability of working. As noted in the discussion of results in Section 4, the dummy-variable model shows slightly stronger experimental effects for husbands than does the parameterized model, especially for rates of leaving employment. It seems likely that these differences are responsible for the somewhat different predictions for husbands given in Tables 6 and 7. The two models are consistent, however, in predicting that the effects of SIME/DIME treatments on rates of change in employment status of husbands are small in magnitude.

5.3 Predictions for a Typical Individual

While the mean predictions given in Tables 5 and 6 are informative, they combine the effects of several different NIT programs. One advantage of the parameterized model is that it is capable of predicting the effects of a single NIT program. In Table 7 we present predicted effects for a typical SIME/DIME individual under four different NIT programs using the coefficients of the parameterized model. Each of the NIT programs is characterized by a particular change in disposable income and net wage rate.* The typical individual is represented by the mean of the background variables for families on financial treatment programs, and

---

*The parameterized model can also be used to predict the effects of a single NIT program over an entire sample. Because of differences in preprogram budget constraints, the changes in disposable income and net wage rate associated with a particular NIT program would vary considerably across individuals.

Table 7

PREDICTED EFFECTS OF A NEGATIVE INCOME TAX ON THREE OUTCOME VARIABLES
FOR A TYPICAL INDIVIDUAL†
(Estimated asymptotic standard errors in parentheses)

	Effects for Husbands			Effects for Wives			Effects for Female Heads		
Program	Duration of Employment (weeks)	Duration of Unemployment (weeks)	Steady-State Probability of Working	Duration of Employment (weeks)	Duration of Unemployment (weeks)	Steady-State Probability of Working	Duration of Employment (weeks)	Duration of Unemployment (weeks)	Steady-State Probability of Working
ΔY = $750									
ΔW = -$.75	-3.3	1.8***	-.019***	-7.8*	31.7***	-.107***	-8.2	14.3***	-.081***
	(3.5)	(.6)	(.007)	(4.4)	(8.5)	(.025)	(5.1)	(4.7)	(.024)
ΔW = -$1.50	-1.4	4.1***	-.034**	-12.7	61.8***	-.173***	-9.5	35.3***	-.150***
	(7.0)	(1.4)	(.015)	(8.2)	(21.7)	(.044)	(9.9)	(12.4)	(.048)
ΔY = $1,500									
ΔW = -$.75	-8.2*	1.5*	-.025**	-9.9**	42.5***	-.134***	-14.2***	11.7**	-.095***
	(4.5)	(.85)	(.010)	(4.8)	(10.6)	(.027)	(5.7)	(5.5)	(.029)
ΔW = -$1.50	-6.4	3.8***	-.040**	-14.6*	75.4***	-.197***	-15.5*	32.1***	-.163***
	(6.8)	(1.4)	(.016)	(7.7)	(23.5)	(.041)	(9.2)	(11.8)	(.047)

†Typical individual is represented by the mean of the background variables for financial families under the assumption that the family is below the breakeven level, is on the 5-year program, and receives no manpower treatment.

*Significant at 10% level.

**Significant at 5% level

***Significant at 1% level.

assumes that the family is below the breakeven level, is on the 5-year program, and is receiving no manpower treatment. The four NIT programs have changes in disposable income of $750 and $1,500 and changes in net wage rates of -$.75 and -$1.50. These changes are within the range of the programs being tested in SIME/DIME.*

As Table 7 indicates, under all four NIT programs the duration of employment is reduced, the duration of unemployment is increased, and the steady-state probability of working is reduced. The effects are smallest for husbands and largest for wives. The changes tend to be statistically significant except for the effects on the duration of employment for husbands.

Table 8 allocates the effect on the probability of working to longer unemployment spells and shorter employment spells.† As the table indicates, most of the effect on the probability of working is due to longer periods of unemployment. The proportion due to longer unemployment spells ranges from 48% to 94% for husbands, from 65% to 74% for wives, and from 47% to 79% for female heads of families.

---

*A wide range of NIT guarantee levels and tax rates are possible for any given change in disposable income and net wage rate. The mean changes in disposable income in our various samples range from $1,170 to $1,400 and the mean changes in the net wage rate range from -$.60 to -$1.16.

†There are two ways of performing this allocation. One way is to calculate the change under the assumption that employment spells are unaffected and then allow employment spells to change. The other is to assume that unemployment spells are unaffected and then allow unemployment spells to change. The latter method is used in this paper, although both methods produce similar results.

Table 8

ALLOCATION OF THE EFFECT ON THE PROBABILITY OF WORKING TO LENGTH OF PERIODS OF UNEMPLOYMENT AND EMPLOYMENT FOR A TYPICAL INDIVIDUAL†
(Estimated asymptotic standard errors in parentheses)

	Total Effect of NIT Program on the Steady-State Probability of Working			Effect Due to Longer Periods of Unemployment			Effect Due to Shorter Periods of Employment		
Program	Husbands	Wives	Female Heads	Husbands	Wives	Female Heads	Husbands	Wives	Female Heads
ΔY = \$750									
ΔW = -\$.75	-.019***	-.107***	-.081***	-.015***	-.076***	-.054***	-.004	-.032*	-.026
	(.007)	(.025)	(.024)	(.005)	(.018)	(.017)	(.005)	(.019)	(.017)
ΔW = -\$1.50	-.034**	-.173***	-.150***	-.032***	-.127***	-.118***	-.002	-.046	-.031
	(.015)	(.044)	(.048)	(.011)	(.033)	(.034)	(.009)	(.039)	(.034)
ΔY = \$1,500									
ΔW = \$.75	-.025**	-.138***	-.095***	-.012*	-.096***	-.045**	-.012*	-.043**	-.049**
	(.010)	(.027)	(.029)	(.007)	(.020)	(.020)	(.007)	(.021)	(.020)
ΔW = -\$1.50	-.040**	-.210***	-.163***	-.030***	-.145***	-.109***	-.009	-.066*	-.053
	(.016)	(.041)	(.047)	(.011)	(.032)	(.034)	(.010)	(.037)	(.034)

†Typical individual is represented by the mean of the background variables for financial families under the assumption that the family is below the breakeven level, is on the 5-year program, and receives no manpower treatment.

*Significant at 10% level.

**Significant at 5% level.

***Significant at 1% level.

6. SUMMARY AND CONCLUSIONS

In this paper we investigate the nature of the labor supply response to a negative income tax program by looking at changes in the rates of entering and leaving employment of family heads in the Seattle and Denver Income Maintenance Experiments. Our empirical results indicate that for wives and female heads of families, an NIT program substantially lengthens unemployment spells. In the SIME/DIME sample the duration of unemployment increases by 55% for wives and by 48% for female heads of families. The duration of unemployment of husbands is not significantly affected by the NIT.* The duration of unemployment is sensitive to the change in the wage rate, but not to the change in disposable income.

Our results also indicate that an NIT program slightly shortens employment spells of husbands on the 5-year program but has insignificant effects on the length of employment of wives and female heads. The duration of employment is sensitive to the change in disposable income, but not to the change in the net wage rate.

We show that the combined results for the duration of unemployment and employment imply a reduction in the probability of working. In the SIME/DIME sample, the probability of working is reduced by 2% for husbands, by 17% for wives, and by 13% for female heads of families. These reductions in work effort are about the same as those produced by an NIT program that increases disposable income by $750 per year and decreases the net wage rate by $.75 per hour.

Our empirical results are consistent with an increase in either job search or leisure. If leisure increases, the costs of an NIT program

*However, the duration of unemployment of husbands on the 5-year program (which represents about one-third of the total number of families receiving financial treatments) is significantly increased.

will be permanently higher than the costs predicted on the basis of pre-NIT hours of work. If job search increases, individuals may eventually obtain more desirable and higher-paying jobs which would tend to reduce program costs in the long run.

Appendix A

MAXIMUM LIKELIHOOD ESTIMATES OF NONEXPERIMENTAL AND MANPOWER TREATMENT EFFECTS

Table A-1

MAXIMUM LIKELIHOOD ESTIMATES OF EFFECTS OF NONEXPERIMENTAL AND MANPOWER TREATMENT VARIABLES ON THE LOGARITHM OF THE RATE OF LEAVING EMPLOYMENT
(Parameterized Model)

	Husbands	Wives	Female Heads
Constant	-1.961*** (.669)	-1.971*** (.494)	-2.153*** (.640)
Normal income			
1 = Income not determined	.494*** (.187)	-.128 (.238)	.409 (.385)
1 = \$0-\$1,000	-.178 (.291)	1.103*** (.328)	.533 (.370)
1 = \$1,000-\$3,000	.528*** (.148)	-.030 (.198)	.461 (.356)
1 = \$3,000-\$4,000	.560*** (.107)	.052 (.133)	.448 (.352)
1 = \$5,000-\$7,000	.318*** (.095)	-.116 (.111)	-.112 (.354)
1 = \$7,000-\$9,000	.153* (.091)	-.161 (.102)	.005 (.354)
1 = \$9,000-\$13,000	--	--	--
Location (1 if Denver)	.286*** (.056)	.281*** (.073)	.266*** (.079)
Ethnicity (1 if Black)	-.149** (.060)	-.240*** (.082)	-.241*** (.080)
Age	-.029*** (.005)	-.025*** (.006)	-.021*** (.005)
Years of schooling	-.052*** (.012)	-.026 (.057)	.021 (.049)
Number of family members	-.295*** (.110)	.273*** (.080)	-.211* (.113)
Number of children under 16	.242** (.110)	-.272*** (.083)	.185 (.115)
Weeks worked in year prior to enrollment	-.024*** (.002)	-.018*** (.002)	-.015*** (.003)
Manpower treatment			
1 = M1 (counseling only)	.146** (.073)	.002 (.100)	-.139 (.108)
1 = M2 (counseling + 50% subsidy)	.116* (.068)	.205** (.087)	-.057 (.100)
1 = M3 (counseling + 100% subsidy)	.110 (.084)	.298*** (.103)	.109 (.114)
Preexperimental disposable income (\$1,000s)	-.006 (.016)	-.000 (.018)	-.017 (.031)
Preexperimental net wage	.109 (.233)	-.618 (.527)	-.573 (.431)
Number of spells	2,991	1,692	1,523

*Significant at 10% level.

**Significant at 5% level.

***Significant at 1% level.

Table A-2

MAXIMUM LIKELIHOOD ESTIMATES OF EFFECTS OF NONEXPERIMENTAL AND MANPOWER TREATMENT VARIABLES ON THE LOGARITHM OF THE RATE OF ENTERING EMPLOYMENT
(Parameterized Model)

	Husbands	Wives	Female Heads
Constant	-4.968***	-4.710***	-5.435***
	(.724)	(.455)	(.645)
Normal income			
1 = Income not determined	.005	.494**	-.607
	(.198)	(.220)	(.401)
1 = $0-$1,000	-.943***	-.588*	-.958***
	(.251)	(.308)	(.381)
1 = $1,000-$3,000	-.508***	-.258	-.619*
	(.148)	(.179)	(.371)
1 = $3,000-$5,000	-.262**	-.172	-.479
	(.105)	(.125)	(.364)
1 = $5,000-$7,000	.005	-.070	-.361
	(.095)	(.103)	(.364)
1 = $7,000-$9,000	.206**	.011	.003
	(.094)	(.096)	(.361)
1 = $9,000-$13,000	--	--	--
Location (1 if Denver)	.778***	.546***	1.048***
	(.057)	(.068)	(.081)
Ethnicity (1 if Black)	-.408***	.277***	-.285***
	(.062)	(.077)	(.083)
Age	-.045***	-.021***	-.008
	(.005)	(.005)	(.005)
Years of schooling	.019	.166***	.015
	(.012)	(.052)	(.049)
Number of family members	-.147	.116	-.340***
	(.123)	(.097)	(.138)
Number of children under 16	.202	-.111	.288**
	(.125)	(.098)	(.138)
Weeks worked in year prior to enrollment	.019***	.027***	.020***
	(.002)	(.002)	(.002)
Manpower treatment			
1 = M1 (counseling only)	-.165**	-.102	.064
	(.075)	(.092)	(.105)
1 = M2 (counseling + 50% subsidy)	-.257***	-.020	-.178***
	(.070)	(.079)	(.101)
1 = M3 (counseling + 100% subsidy)	-.200**	-.212**	-.263**
	(.085)	(.101)	(.124)
Preexperimental disposable income ($1000s)	.055***	-.037**	.051*
	(.015)	(.017)	(.028)
Preexperimental net wage	.767***	-.784*	.618
	(.251)	(.468)	(.429)
Number of spells	1,837	2,189	1,418

*Significant at 10% level.

**Significant at 5% level.

***Significant at 1% level.

Appendix B

PREDICTIONS AND THEIR ESTIMATED STANDARD ERRORS

Appendix B

PREDICTIONS AND THEIR ESTIMATED STANDARD ERRORS

Prediction

The model described in this paper can be used to predict a variety of observable outcomes related to employment and unemployment of either an individual or members of a population. In the main text, we focus on only two of these: the steady-state probability of working and the expected duration in an employment status (1 = employment, 2 = unemployment).

As derived and stated in the paper, the steady-state probability of working is:

$$p = r_2 \big/ \left(r_1 + r_2\right) \qquad \text{(6, repeated)}$$

where r_1 is the rate of leaving employment and r_2 is the rate of leaving unemployment. We assume that r_j is a log-linear function of exogenous variables:

$$\ln r_j = \underline{\beta}_j \underline{X} \qquad \text{(15, repeated)}$$

or

$$r_j = e^{\underline{\beta}_j \underline{X}} \qquad \text{(16, repeated)}$$

where $\underline{X}$ is a vector of exogenous variables and $\underline{\beta}_j$ is a parameter vector. This implies that

$$p = e^{\underline{\beta}_2 \underline{X}} \Big/ \left(e^{\underline{\beta}_1 \underline{X}} + e^{\underline{\beta}_2 \underline{X}}\right) = 1 + \left[e^{\left(\underline{\beta}_1 - \underline{\beta}_2\right) \underline{X}}\right]^{-1} \quad . \qquad \text{(B-1)}$$

Note that this is just the assumption of the usual binary logit model (Berkson, 1944; Theil, 1970).

As stated in the paper, the assumptions of the model also imply that t, the time of departure from employment state j, given occupancy of j at time t′, has probability density:

$$f_j(t|t') = r_j e^{-r_j(t-t')} \quad . \qquad \text{(14, repeated)}$$

If t′ is the time of entry into state j, then $u_j = t - t'$ is the completed length of stay in state j. Then the expected duration in state j is just:

$$E(u_j) = \int_0^\infty u_j r_j e^{-r_j u_j} du_j = 1/r_j = e^{-\underline{\beta}_j \underline{X}} \quad . \qquad \text{(B-2)}$$

The equations for p and $E(u_j)$ given above (B-1 and B-2) apply to any individual. The average within some population can be found by summing the predicted values for the individuals in the population and then dividing by the sample size, N:

$$\overline{p} = \frac{1}{N} \sum_{i=1}^{N} \left[1 + e^{\left(\underline{\beta}_1 - \underline{\beta}_2\right)\underline{X}_i} \right]^{-1} \qquad \text{(B-3)}$$

$$\overline{E(u_j)} = \frac{1}{N} \sum_{i=1}^{N} e^{-\underline{\beta}_j \underline{X}_i} \quad . \qquad \text{(B-4)}$$

We are also interested in the effects of an NIT on these predictions. Let $\underline{X}_j$ be partitioned into two parts: $\underline{Z}$, a vector of variables representing the NIT program, and $\underline{W}$, a vector containing the other causal variables. Similarly, let $\underline{\beta}_j$ be partitioned into $\underline{\alpha}_j$, the vector of parameters giving the effect of $\underline{Z}$ on r_j, and $\underline{\gamma}_j$, the vector of parameters giving the effect of $\underline{W}$ on r_j. Then the rate of leaving state j with no NIT program, r_{jo}, is:

$$r_{jo} = e^{\underline{\gamma}_j \underline{W}}$$

while the rate of leaving state j under an NIT program with characteristics $\underline{Z}$ is

$$r_{je} = e^{\left(\underline{\alpha}_j \underline{Z} + \underline{\gamma}_j \underline{W}\right)} = r_{jo}\, e^{\underline{\alpha}_j \underline{Z}} \quad .$$

If p_o and p_e represent the probability of working under no NIT and under an NIT, respectively, then the difference in the probability of working due to the NIT program is just:

$$p_e - p_o = \left[1 + e^{\left(\underline{\alpha}_1-\underline{\alpha}_2\right)\underline{Z}} e^{\left(\underline{\gamma}_1-\underline{\gamma}_2\right)\underline{W}}\right]^{-1} - \left[1 + e^{\left(\underline{\gamma}_1-\underline{\gamma}_2\right)\underline{W}}\right]^{-1} , \qquad \text{(B-5)}$$

and the average difference is:

$$\overline{p_e - p_o} = \frac{1}{N}\sum_{i=1}^{N}\left[1 + e^{\left(\underline{\alpha}_1-\underline{\alpha}_2\right)\underline{Z}_i} e^{\left(\underline{\gamma}_1-\underline{\gamma}_2\right)\underline{W}_i}\right]^{-1} - \left[1 + e^{\left(\underline{\gamma}_1-\underline{\gamma}_2\right)\underline{W}_i}\right]^{-1} . \qquad \text{(B-6)}$$

Similarly, let $E(u_{jo})$ and $E(u_{je})$ represent the expected duration in state j under no NIT and under an NIT, respectively. The difference due to the NIT is:

$$E\left(u_{je}\right) - E\left(u_{jo}\right) = \frac{1}{r_{je}} - \frac{1}{r_{jo}} = e^{-\underline{\gamma}_j\underline{W}}\left(e^{-\underline{\alpha}_j\underline{Z}} - 1\right) \qquad \text{(B-7)}$$

and the average difference is:

$$\overline{E\left(u_{je}\right) - E\left(u_{jo}\right)} = \frac{1}{N}\sum_{i=1}^{N} e^{-\underline{\gamma}_j\underline{W}_i}\left(e^{-\underline{\alpha}_j\underline{Z}_i} - 1\right) . \qquad \text{(B-8)}$$

Estimated Standard Errors of Predictions

Standard errors of predictions can be estimated using the theorem from Goldberger (1964, pp. 122-125) that

$$\mathrm{Var}(f) = \frac{\partial f'}{\partial \underline{\theta}} \cdot \mathrm{Var}(\underline{\theta}) \cdot \frac{\partial f}{\partial \underline{\theta}}$$

where $f = f(\underline{\theta},\underline{X})$, $\underline{\theta}$ is a vector of the maximum likelihood estimates of parameters, and $\underline{X}$ is a vector of exogenous variables. The variance-covariance matrix of the parameters, $\mathrm{Var}(\underline{\theta})$, is estimated by the inverse of the matrix of second partial derivatives of the logarithm of the likelihood with respect to the parameters.

$$\mathrm{Var}(\underline{\theta}) = \left(\frac{\partial^2 \ln L}{\partial \underline{\theta}^2}\right)^{-1} \quad .$$

The elements of $\partial f/\partial \underline{\theta}$ for the predictions studied in this paper are given in Table B-1.

Table B-1

ELEMENTS OF $\partial f/\partial \underline{\theta}$ USED IN CALCULATING ESTIMATES OF THE STANDARD ERRORS OF PREDICTIONS

f	Equations*	Elements of $\partial f/\partial \underline{\theta}^{\dagger}$
$\overline{p}$	(B-1, B-3)	$\frac{\partial f}{\partial \beta_{jk}} = \frac{\phi_j}{N} \sum_{i=1}^{N} X_{ki_i} p_i \left(1 - p_i\right)$
$\overline{p_e - p_o}$	(B-5, B-6)	$\frac{\partial f}{\partial \alpha_{jk}} = \frac{\phi_j}{N} \sum_{i=1}^{N} Z_{ki} p_{ei} \left(1 - p_{ei}\right)$
		$\frac{\partial f}{\partial \gamma_{jk}} = \frac{\phi_j}{N} \sum_{i=1}^{N} W_{ki} \left[p_{ei}(1-p_{ei}) - p_{oi}(1-p_{oi})\right]$
$\overline{E\left(u_j\right)}$	(B-2, B-4)	$\frac{\partial f}{\partial \beta_{jk}} = -\frac{1}{N} \sum_{i=1}^{N} X_{ki} e^{-\underline{\beta}_j \underline{X}_i}$
$\overline{E\left(u_{je}\right) - E\left(u_{jo}\right)}$	(B-7, B-8)	$\frac{\partial f}{\partial \alpha_{jk}} = -\frac{1}{N} \sum_{i=1}^{N} Z_{ki} e^{-\left(\underline{\alpha}_j \underline{Z}_i + \underline{\gamma}_j \underline{W}_i\right)}$
		$\frac{\partial f}{\partial \gamma_{jk}} = -\frac{1}{N} \sum_{i=1}^{N} W_{ki} e^{-\underline{\gamma}_j \underline{W}_i} \left(e^{-\underline{\alpha}_j \underline{Z}_i} - 1\right)$

*The first equation number refers to N = 1.

†$\phi_1 = 1$ and $\phi_2 = -1$.

REFERENCES

Ashenfelter, Orley and James Heckman, "Estimating Labor-Supply Functions," in Glen G. Cain and Harold W. Watts (eds.) Income Maintenance and Labor Supply: Econometric Studies: Chicago, Rand McNally, 1973: 265-278.

Bartholomew, D. J., "A Problem in Life Testing," Journal of the American Statistical Association A122 (1957): 232-239.

Berkson, J., "Application of the Logistic Function to Bioassay," Journal of the American Statistical Association 39 (1944): 357-365.

Dhrymes, Phoebus J., Econometrics: Statistical Foundations and Applications: New York, Harper and Row, 1970.

Goldberger, Arthur S., Econometric Theory: New York, John Wiley and Sons, 1964.

Hall, Robert E., "Effect of the Experimental Negative Income Tax on Labor Supply," in Joseph A. Pechman and P. Michael Timpane (eds.) Work Incentives and Income Guarantees: The New Jersey Negative Income Tax Experiment: Washington DC, the Brookings Institution, 1975: 115-156.

Heckman, James J., "Sample Selection Bias as a Specification Error (With an Application to the Estimation of Labor Supply Functions)," mimeo, February 1977.

Keeley, Michael C., Philip K. Robins, Robert G. Spiegelman, and Richard W. West, "The Labor Supply Effects and Costs of Alternative Negative Income Tax Programs, Part I, The Labor Supply Response Function," Research Memorandum 38, Center for the Study of Welfare Policy, Stanford Research Institute, April 1977.

__________, "The Labor Supply Effects and Costs of Alternative Negative Income Tax Programs," Journal of Human Resources, forthcoming.

Kehrer, Kenneth C., John F. McDonald, Robert A. Moffitt, and Lois B. Shaw, "The Gary Income Maintenance Experiment Initial Findings Report, Volume II, Initial Central Labor Supply Findings," Report by Mathematica Policy Research, February 1976.

Kurz, Mordecai and Robert G. Spiegelmen, "The Design of the Seattle and Denver Income Maintenance Experiments," Research Memorandum 18, Center for the Study of Welfare Policy, Stanford Research Institute, May 1972.

Kurz, Mordecai and Robert G. Spiegelmen, "The Seattle Experiment: The Combined Effects of Income Maintenance and Manpower Investments": American Economic Review, 61, May 1971: 22-29.

Spiegelman, Robert G. and Richard W. West, "Feasibility of a Social Experiment and Issues in Its Design," American Statistical Association, 1976 Proceedings of the Business and Economic Statistics Section, 1976: 168-176.

Spilerman, Seymour and Richard E. Miller, "The Effects of Negative Income Tax Payments on Job Turnover and Unemployment Duration," pp. 221-251, in Harold W. Watts and Albert Rees (eds.) The New Jersey Income-Maintenance Experiment, Volume II, Labor-Supply Responses: New York, Academic Press: 1977.

Theil, H., "On the Estimation of Relationships Involving the Qualitative Variables," American Journal of Sociology 76 (1970): 103-154.

Tuma, Nancy Brandon and Douglas Crockford, "Invoking RATE," Research Memorandum, Center for the Study of Welfare Policy, Stanford Research Institute, 1976.

Watts, Harold W. and Albert Rees (eds.), The New Jersey Income-Maintenance Experiment, Volume II, Labor-Supply Responses: New York, Academic Press, 1977.

CENTER FOR THE STUDY OF WELFARE POLICY
RESEARCH MEMORANDA*

The following Research Memoranda and Reprints are available upon written request to:

Center for the Study of Welfare Policy
SRI International
333 Ravenswood Avenue
Menlo Park, California 94025

Research Memorandum Number	Title and Authors
15	*The Assignment Model of the Seattle and Denver Income Maintenance Experiments,* J. Conlisk and M. Kurz, July 1972.
18	*The Design of the Seattle and Denver Income Maintenance Experiments,* M. Kurz and R. G. Spiegelman, May 1972.
19	*The Payment System for the Seattle and Denver Income Maintenance Experiments,* M. Kurz, R. G. Spiegelman, and J. A. Brewster, June 1973.
21	*The Experimental Horizon and the Rate of Time Preference for the Seattle and Denver Income Maintenance Experiments: A Preliminary Study,* M. Kurz, R. G. Spiegelman, and R. W. West, November 1973.
22	*Social Experimentation: A New Tool in Economic and Policy Research,* M. Kurz and R. G. Spiegelman, November 1973.
23	*Measurement of Unobservable Variables Describing Families,* N. B. Tuma, R. Cronkite, D. K. Miller, and M. Hannan, May 1974.
24	*A Cross Sectional Estimation of Labor Supply for Families in Denver 1970,* M. Kurz, P. Robins, R. G. Spiegelman, R. W. West, and H. Halsey, November 1974.
25	*Job Search: An Empirical Analysis of the Search Behavior of Low Income Workers,* H. E. Felder, May 1975.
26	*Measurement Errors in the Estimation of Home Value,* P. Robins and R. W. West, June 1975
27	*A Study of the Demand for Child Care by Working Mothers,* M. Kurz, P. Robins, and R. G. Spiegelman, August 1975.
28	*The Impact of Income Maintenance on the Making and Breaking of Marital Unions: Interim Report,* M. Hannan, N. B. Tuma, and L. P. Groeneveld, June 1976.
29	*The Estimation of Labor Supply Models Using Experimental Data: Evidence from the Seattle and Denver Income Maintenance Experiments,* M. C. Keeley, P. K. Robins, R. G. Spiegelman, and R. W. West, August 1976.

*Research Memoranda 1 through 14, 16, 17, and 20 are obsolete and are not available for distribution.

30 *Determinants and Changes in Normative Preferences of Spouses*, R. C. Cronkite, May 1977.

31 *Homogamy, Normative Consensus, and Marital Adjustment*, R. C. Cronkite, May 1977.

32 *The Determinants of Participation of Single-Headed Families in the AFDC Program*, Arden Hall, May 1977.

33 *The Supply of Day Care Services in Denver and Seattle*, Arden Hall and Sam Weiner, June 1977.

34 *The Impact of Income Maintenance and Manpower Subsidies on the Decision to Invest in Human Capital: Interim Results from the Seattle and Denver Income Maintenance Experiments*, H. E. Felder, A. Hall, Y. Weiss, October 1977.

35 *First Dissolutions and Marriages: Impacts in 24 Months of the Seattle and Denver Income Maintenance Experiments*. N. B. Tuma, L. P. Groeneveld, and M. T. Hannan, August 1976.

36 *The Estimation of Nonlinear Labor Supply Functions with Taxes from a Truncated Sample*, Michael Hurd, November 1976.

37 *The Welfare Implications of the Unemployment Rate*, Michael Hurd, November 1976.

38 *The Labor Supply Effects and Costs of Alternative Negative Income Tax Programs: Evidence from the Seattle and Denver Income Maintenance Experiments, Part I: The Labor Supply Response Function*, M. C. Keeley, P. K. Robins, R. G. Spiegelman, and R. W. West, May 1977.

39 *The Labor Supply Effects and Costs of Alternative Negative Income Tax Programs: Evidence from the Seattle and Denver Income Maintenance Experiments, Part II: National Predictions Using the Labor Supply Response Function*, M. C. Keeley, P. K. Robins, R. G. Spiegelman, and R. W. West, May 1977.

40 *Cost of Compliance with Federal Day Care Standards in Seattle and Denver*, Sam Weiner, May 1977.

41 *An Interim Report on the Work Effort Effects and Costs of a Negative Income Tax Using Results of the Seattle and Denver Income Maintenance Experiments: A Summary*, M. C. Keeley, P. K. Robins, R. G. Spiegelman, and R. W. West, June 1977.

42 *The Reporting of Income to Welfare: A Study in the Accuracy of Income Reporting*. H. I. Halsey, M. Kurz, R. G. Spiegelman, and A. Waksberg, August 1977.

43 *Variation Over Time in the Impact of the Seattle and Denver Income Maintenance Experiments on the Making and Breaking of Marriages*, N. B. Tuma, M. T. Hannan, and L. P. Groeneveld, February 1977.

44 *A Model of the Effect of Income Maintenance on Rates of Marital Dissolution: Evidence from the Seattle and Denver Income Maintenance Experiments*, M. T. Hannan, N. B. Tuma, and L. P. Groeneveld, February 1977.

45 *Job Satisfaction and Income Maintenance: Evidence from the Seattle and Denver Income Maintenance Experiments*, P. K. Robins, October 1977.

46 *Unemployment Insurance, Wage Changes and Search Behavior: An Analysis*, H. E. Felder, October 1977.

47 *Impact of Income Maintenance on Geographical Mobility: Preliminary Analysis and Empirical Results from the Seattle and Denver Income Maintenance Experiments*, M. C. Keeley, October 1977.

48 *Changes in Rates of Entering and Leaving Employment under a Negative Income Tax Program: Evidence From the Seattle and Denver Income Maintenance Experiments*, P. K. Robins and N. B. Tuma, March 1977

CENTER FOR THE STUDY OF WELFARE POLICY REPRINT SERIES

M. Kurz and R. G. Spiegelman, "The Seattle Experiment: The Combined Effect of Income Maintenance and Manpower Investments," *American Economic Review* (May 1971).

Michael C. Keeley, "A Comment on an Interpretation of the Economic Theory of Fertility," *Journal of Economic Literature* (June 1975).

Takeshi Amemiya, "The Modified Second-Round Estimator in the General Qualitative Response Model," Technical Report No. 189, The Economics Series, Institute for Mathematical Studies in the Social Sciences, Stanford University, Stanford, Ca., December 1975.

R. G. Spiegelman and R. W. West, "Feasibility of a Social Experiment and Issues in Its Design: Experiences from the Seattle and Denver Income Maintenance Experiments," in *1976 Business and Economic Statistics Section Proceedings of the American Statistical Association.*

Takeshi Amemiya, "The Specification and Estimation of a Multivariate Logit Model," Technical Report No. 211, The Economics Series, Institute for Mathematical Studies in the Social Sciences, Stanford University, Stanford, Ca., June 1976.

Michael C. Keeley, "The Economics of Family Formation: An Investigation of the Age of First Marriage," *Economic Inquiry* (April 1977).

Philip K. Robins and Richard W. West, "Measurement Errors in the Estimation of Home Value," *Journal of the American Statistical Association* (June 1977)

Michael T. Hannan, Nancy Brandon Tuma and Lyle P. Groeneveld, "Income and Marital Events: Evidence from an Income-Maintenance Experiment," *The American Journal of Sociology* (May 1977).