NBER WORKING PAPER SERIES

HOURS RESTRICTIONS AND LABOR SUPPLY

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Working Paper No. 1638

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
June 1985

We would like to thank Ronald McGuire and Alan McArthur for expert research assistance and the Institute of Industrial Relations at Berkeley for generous research support. The research reported here is part of the NBER's research program in Labor Studies. Any opinions expressed are those of the authors and not those of the National Bureau of Economic Research.

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ABSTRACT

This study presents a model of labor supply in which individuals may face constraints on their choice of work hours, and analyzes the sensitivity of parameter estimates and policy conclusions to the usual assumption of unrestricted choice. We set up the labor supply decision as a discrete choice problem, where each worker faces a finite number of employment opportunities, each offering fixed hours of work. The distribution from which these are drawn, as well as the number of draws, is estimated along with the behavioral parameters of individual labor supply. The standard model with unconstrained hours appears as a special case where the number of draws approaches infinity. We estimate the mean absolute difference between desired and actual work hours to be about ten hours per week. The results strongly support the notion that hours choices are constrained, and suggest that models which ignore restrictions on hours worked may yield biased estimates of the wage elasticity of desired hours. Further, we suggest that analysis of policies such as income transfers and the flat rate tax which do not consider their effects on the distribution of hours offered may be very misleading.

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I. Introduction

Most jobs appear to be associated with a fixed number of hours which must be worked each week, as well as a fixed wage or salary. The standard 9 to 5 day, five days a week, is the most obvious example, but other regular shifts or office hours leave most workers with very little discretion regarding hours supplied in the short run. At first glance, this common observation is inconsistent with the textbook model of the labor supply decision, in which each individual freely chooses the number of hours he will work, taking as given a fixed wage per hour. However, if a variety of hours packages are costlessly available, workers may simply choose those which 'impose' the desired number of hours. Enough mobility between jobs will thus preserve the simple model even if hours within each job are completely inflexible. Observed hours will always be equal to desired hours. If workers are <u>not</u> perfectly mobile between jobs, or have incomplete information regarding job opportunities, they may not choose their hours from the entire market distribution of jobs. In this case, models which assume that hours worked are determined by preferences only will be misspecified, and may produce biased estimates of labor supply elasticities. Further, policy analysis which considers the individual's response to tax and transfer changes, but does not take account of their effect on the constraints individuals face, may be very misleading.

In recent years, labor supply studies have appeared which depart from the standard framework to allow for various types of constraints on hours choices. A major impetus to this development has been the observation that cross-sectional variation in hours worked is explained very poorly by standard labor supply models. Inconveniently, even the simplest of hours regressions is seldom reported with a measure of goodness-of-fit, but studies reported in Cain and Watts (1973), such as those by Hall and by Boskin, typically report a standard error of about 1000 hours per year for a cross-section of white husbands.

A glance at the actual distribution of hours worked by a sample of prime-age married men suggests that its peculiar shape makes an important contribution to this poor fit. It also suggests that some form of constraint on hours choices might be a plausible addition to the model. Figure 1 shows the distribution of average weekly hours during 1972 for a group of 18 to 59 year old married men from the Denver Income Maintenance Experiment (DIME) sample. This is a low-income sample, but the hours distribution is typical of that which would be observed for a more representative sample. The most obvious characteristics of this distribution are the extreme peak at 40 hours per week and the asymmetry around this peak. These features are even more pronounced in a distribution of hours worked in one month.

A distribution of desired hours with this shape would be difficult to produce using a standard model of labor supply and customary assumptions about the distribution of unobservable worker characteristics. Given the preponderance of jobs between 36 and 40 hours, men who work an average of 26-35 hours per week are unusually scarce. In general, predicted distributions based on wages, non-labor income and demographic variables are smooth and unimodal, and fit the actual distribution very poorly.

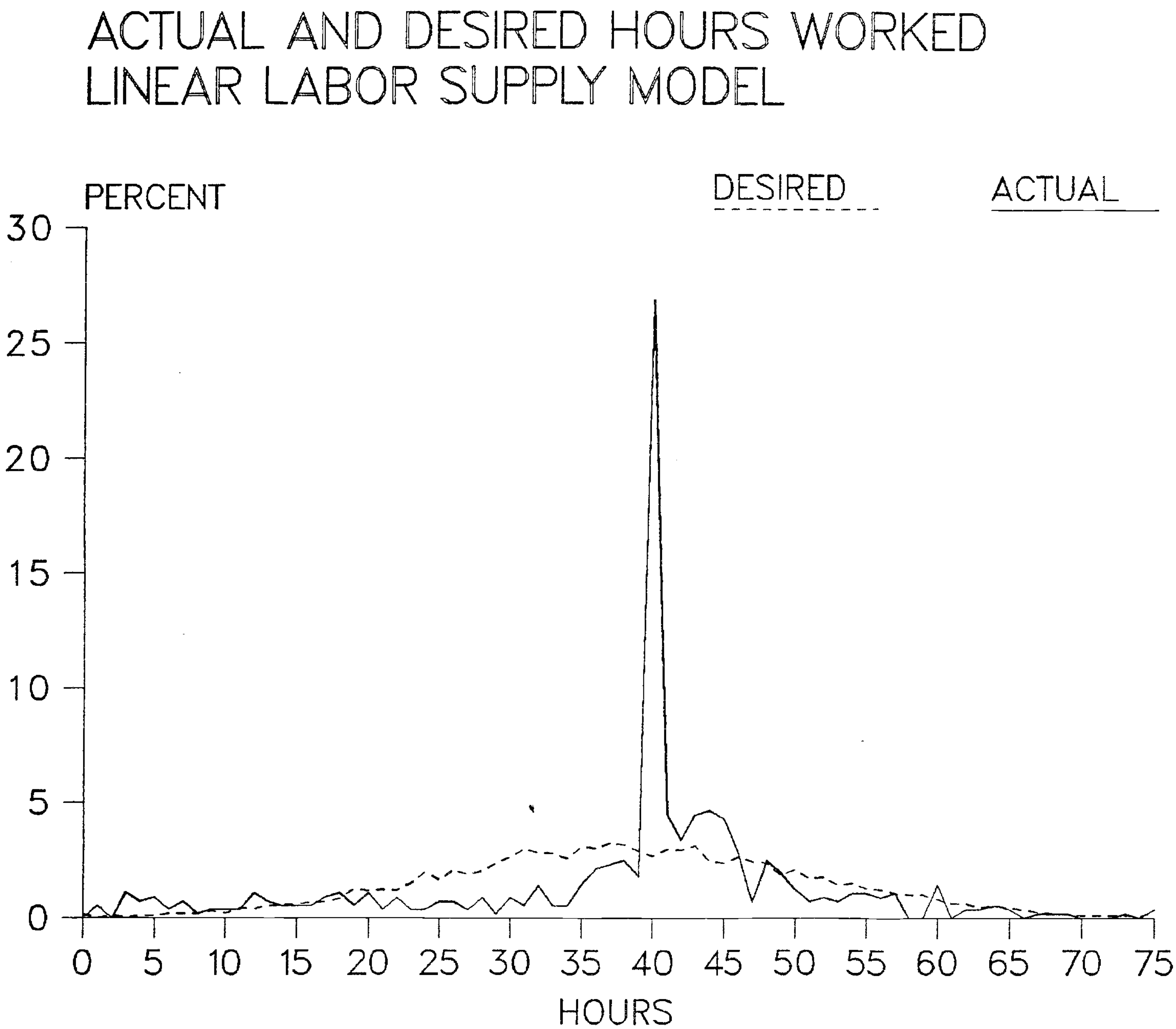
ACTUAL AND DESIRED HOURS WORKED
LINEAR LABOR SUPPLY MODEL
PERCENT
DESIRED
ACTUAL
30
25
20
15
10
5
0
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75
HOURS

Figure 1

Superimposed on the actual distribution in Figure 1 is a distribution of desired hours, derived from a simple linear labor supply regression.[1]

How can we explain the paucity of observations at 30 hours per week? It seems likely to us that constraints have been misspecified in the standard model, and that jobs offering an average of 30 hours per week are difficult or costly to come by. This conjecture we intend to explore by specifying constraints of a general form and building them into the model. In doing so, we of necessity neglect other possible explanations. One is misreporting; many people may have worked 30 hours but reported 40 due to conventional attitudes about what constitutes a 'full-time' job. This is unlikely to provide more than a partial explanation, since the phenomenon appears invariant to the type of survey instrument used. It is also not clear that misreporting should be asymmetric around 40 hours. A second possibility is that, despite the poor fit of conventional models, very few people wanted to work 30 hours. This suggests that models with more flexible functional forms and/or more elaborate distributions for unobserved components of tastes should be estimated.

One simple way of explaining why workers are seldom observed to work 30 hours per week is to assert that jobs offering 30 hours are difficult to find. That is, workers face a limited choice of hours from a market distribution (so that desired hours need not equal actual hours) and some hours choices, seldom offered by firms, are scarce. Implicit in this is the notion that jobs are associated with fixed hours. If there are significant fixed costs in set-up, hiring and training, firms may not be indifferent regarding the hours worked by employees. Thus, firms may offer tied sales of wages and hours and workers will choose their preferred package from among those offered. The result will be a market distribution of wage-hours packages which need not be uniform over hours.[2] The actual distribution of offered hours will thus take into account workers' preferences, but may still act as a constraint on the individual job searcher.

We construct a model of labor supply with hours restrictions of a very simple, but very general form, at the cost of assuming that wages are constant over hours. At any point in time, each individual can choose from among a finite set of jobs offering fixed hours. These jobs have been drawn at random from a market distribution which is the same for everyone in the sample. Observed hours will correspond to the job which yields highest utility, where the alternative of not working at all is always available. A discrete choice between a limited number of jobs seems a reasonable but parsimonious representation of actual constraints on hours worked. The polar cases of no constraints on hours worked and completely exogenous hours are easily nested within the general case as infinite available jobs or only one available job, respectively.

Estimating this model should generate two results of interest. The first is a measure of the sensitivity of labor supply parameter estimates and behavioral predictions to the assumption that there are no constraints on the hours choices of individual workers. The second is an estimate of the degree of constraint experienced by individuals in their hours worked, in terms of the expected discrepancy between desired hours and the 'best' value of offered hours.

Previous studies have examined the effects of direct hours constraints on labor supply decisions, but the specification of these constraints has in general been very restrictive. For example, there exists a large literature focusing on 'take-it-or-leave-it' choices between the standard work week or not working at all. Citations can be found in Heckman, Killingsworth, and MaCurdy (1981) and a survey in Perlman (1969). Closely related are studies by Gustman and Steinmeier (1984) which allow potential retirees a choice between full-time work at a high wage, part-time work at a lower wage, or full retirement. The possible presence of quantity constraints on hours worked has received a great deal of attention in recent years, but tests for such constraints have contrasted the extreme cases of exogenous hours and free choice of hours, without considering the possibility of a discrete choice between several jobs with different hours. For example, see Ashenfelter (1980), Deaton and Muellbauer (1981), Ham (1982), Blundell and Walker (1982), and Lundberg (1985).[3] Most closely related to the approach we have taken in this paper are models in which each individual faces a stochastic lower bound on hours worked.[4] Moffitt (1982) estimates such a model using income maintenance experiment data. At the means of the independent variables, the estimated value of <u>minimum</u> hours was 39 hours per week, implying that the 'vast majority' of the sample was constrained in its hours choice. This result is perhaps not surprising given the observed distribution of hours, but it suggests to us that a discrete choice approach to hours constraints may give a more complete picture of the process generating that distribution.[5]

The next section presents in detail the model to be estimated, and Section III derives the likelihood function. Section IV describes the data and presents the results for the conventional and the constrained labor supply models. Section V contains some conclusions and outlines possible extensions.

II. The Model

There are many possible ways of representing a restricted choice of hours in a labor supply model, from a pure rationing approach to an explicitly dynamic search model in which information about and mobility between jobs is costly. The approach we take is, in the interests of computational feasibility, a compromise between the ad hoc assumption of exogenous hours, and a highly structured choice model. We represent the worker's choice as a static one between a limited number of job offers. By suppressing the time dimension, we do not wish to suggest that workers are immobile during the month or year we take as a time frame, but that observed choices may usefully be treated 'as if' they were the outcome of a static decision as represented in Figure 2.

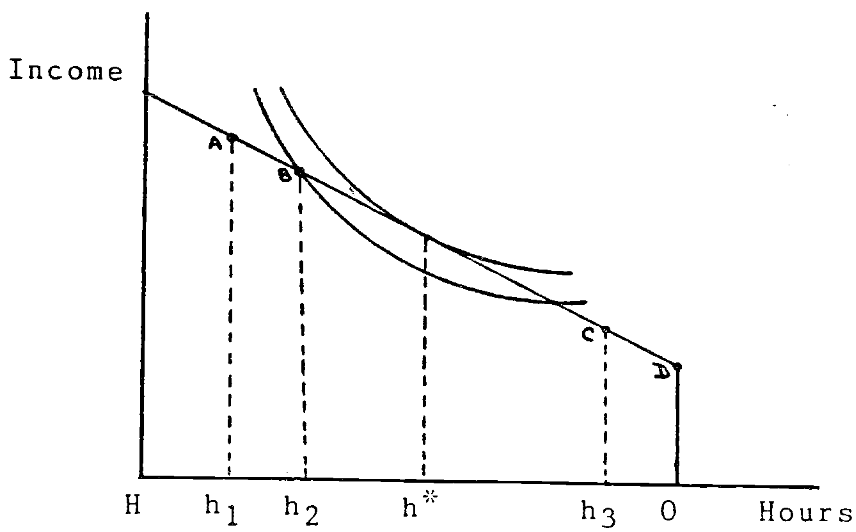

Figure 2

This worker has drawn three job offers with fixed hours h_1, h_2, h_3 from the market distribution and is always able to work zero hours and receive only non-labor income at point D. None of these correspond to desired hours, h^*. Observed hours will be determined by that one of the feasible points (A, B, C, and D) which yields the highest level of utility (in this case B -> h_2).

Estimating a labor supply model with constraints on hours places very heavy demands on the available data, which consist of observed wage-hours combinations and a vector of personal characteristics for a cross-section of workers. Since the worker chooses the utility-maximizing draw from a discrete set of alternatives, we need to specify preferences completely, rather than just a labor supply function. In addition to the parameters of the utility function, the number of job offers drawn and the shape of the market offer distribution must be estimated. Identification of these three sets of parameters requires that some restrictions be imposed on the model.

A. The Market Distribution of Offered Hours

On the demand side, we begin with the assumption that employers offer jobs with fixed hours of work. Rather than explicitly modelling the availability of jobs with different hours, we will attempt to estimate the distribution in an essentially unrestricted form. The standard assumption that wages are equal at all hours of work is maintained.

Workers face a limited choice from a market distribution of employment opportunities: N job offers, each associated with a fixed number of hours, drawn randomly from a discrete distribution.[6] The probability that any job drawn from the distribution requires h hours of work per week is the same for all workers, and is specified as

$$(1) \qquad P(h) = \mu_h / \sum_{i=1}^{H} \mu_i$$

where the μ's are a vector of constants describing the frequency of offers for each integer value of hours worked per week and H is maximum hours. In practice, the μ's will be set equal over some ranges of hours, to reduce the number of parameters which must be estimated. This step function for the hours distribution was chosen rather than a more standard parametric form, since we do not wish to place any a priori restrictions on the shape of the offer distribution. The option of voluntarily working zero hours is available to all workers, even if this is not one of the offers drawn.

B. Number of Job Offers

Two different specifications for the number of job offers, N, will be considered. The first specification treats N as random, drawn by each individual from a binomial distribution with a fixed maximum, and estimates the single parameter of this distribution. For example, if we set the maximum possible job offers at 10, the probability that an individual will receive N offers will be

$$p_n(N+1) = \binom{9}{N} p^N(1-p)^{9-N} \quad \text{for } N=0,\ldots,9$$

The estimated value of p will thus imply probabilities for integer values of N, with a mean of 9p+1 offers.

To test the distributional assumption that N is binomial, we also estimate a second specification in which the probabilities for different numbers of job offers within a range are allowed to vary freely, with no distributional form imposed.

C. Preferences

Workers wish to supply labor so as to maximize utility, which is a function of the number of hours worked and consumption. Worker i can expect to receive from any employer a wage w_i, so his utility in a job offering h_i hours and yielding consumption equal to c_i will be

$$(2) \qquad U_i(c_i,h_i) = Ac_i^{\gamma_1} - B_i h_i^{\gamma_2}$$

$$= A(w_i h_i + Y_i)^{\gamma_1} - e^{-(X_i\beta+\varepsilon_i)} h_i^{\gamma_2}$$

where Y_i is person i's nonlabor income and consumption is equal to the sum of labor and nonlabor income. The parameters $0 < \gamma_1 < 1$ and $\gamma_2 > 1$ are common to all workers, as is $A > 0$. To allow for variation in individual preferences, the parameters B_i are replaced by

$$e^{-(X_i\beta+\varepsilon_i)}.$$

The vector X_i contains observed individual characteristics, such as age and number of children, which might be expected to capture differences in preferences and ε_i represents unobserved characteristics.[8]

III. Estimation

The model described above was estimated using maximum likelihood methods. If the unobserved components of tastes, ε_i, were known, a complete preference ordering of all possible job offers could be constructed. In this case, the likelihood of observing person i choosing to work h_i hours is the probability that at least one job offering h_i was drawn from the market distribution, and that no other offers were preferred to h_i. For clarity of exposition, we first derive the likelihood term for an individual conditional on the value of ε_i, then treat the case where we know only the population density of ε.

For each individual i we can define a set of hours J_i which yield a level of utility less than or equal to the utility derived from observed hours h_i.

$$J_i = \{j: \ U_i(c_i(j),j) \leq U_i(c_i(h_i),h_i) \ , \ j=0,1,\ldots,H\}.$$

Recalling that $P(h_i)$ is the probability that a single draw will generate an offer of h_i hours, the probability that one draw will yield an offer which is not preferred to observed hours will be

$$Q_i = \sum_{k \varepsilon J_i} P(k)$$

Q_i is a function of individual preferences and the unobservable ε_i through the set J_i. The likelihood of observing h_i hours when the number of offers drawn is N is simply the probability that all N offers were equal to or not preferred to h_i, and that at least one offer was h_i, or

(3) $$[Q_i]^N * [1 - (1 - P(h_i)/Q_i)^N].$$

There is one special case, since the option of not working is always available. If we define an index function

$$V(h_i) = \{0 \text{ if } h_i = 0 \\ 1 \text{ otherwise}$$

then the full likelihood can be written

$$(4) \qquad L(h_i: X_i, Y_i, w_i, \varepsilon_i) = [Q_i]^N * [1 - (1 - P(h_i)/Q_i)^N]^{V(h_i)}$$

In practice ε_i is unobservable. The set of preferred hours for each individual will be a function of the unobservable component of preferences, so in general constructing the likelihood function will involve integrating over the distribution of ε. We assume that the ε_i's are i.i.d. normal random variables and rewrite the likelihood as

$$(5) \qquad L(h_i: X_i, Y_i, w_i) = \int_{-\infty}^{\infty} \phi(\varepsilon)[Q_i(\varepsilon)]^N * [1-(1-P(h_i)/Q_i(\varepsilon)^N]^{V(h_i)} d\varepsilon$$

where $\phi(\varepsilon)$ is the normal density with variance σ_ε.

Considering only integer values of hours, the set of hours not preferred to h_i becomes a step function in ε_i. Step changes occur at values of ε where person i is indifferent between working h_i hours and some other value of hours worked, j. Denoting this vector of values as $\varepsilon_{i,j}$, we can define J_{ij} as the set of hours not preferred to h_i when ε takes on the value $\varepsilon_{i,j}$, and rewrite (5) as

$$(6) \qquad L(h_i: X_i, Y_i, w_i) = \sum_{j=1}^{H} \{[\Phi(\varepsilon_{i,j}) - \Phi(\varepsilon_{i,j-1})] * R_i(j)\}$$

$$+ [1 - \Phi(\varepsilon_{i,H})] * R_i(H) + (1-V(h_i)) * \Phi(\varepsilon_{i,0})$$

where $\Phi(\cdot)$ is the cumulative density function corresponding to the density $\emptyset(\cdot)$,

$$R_i(j) = [Q_i(j)]^N * [1 - (1 - P(h_i)/Q_i(j))^N]^{V(h_i)}$$

and

$$Q_i(j) = \sum_{k \varepsilon J_{ij}} P(k).$$

The $\varepsilon_{i,j}$'s are summed over values of j from one to maximum hours per week, which in practice is set at 75, and the second term in (6) picks up the residual tail of the ε distribution. The third term, which is non-zero only when observed hours are zero, is the probability that no work is preferred to all jobs with positive hours. For reasonable values of the parameters γ_1 and γ_2, the values $\varepsilon_{i,j}$ are monotonic in j. The value of the unobservable at which the worker is indifferent between working the observed h_i hours or some alternative, j, can be calculated as

$$\varepsilon_{i,j} = -X_i\beta - \ln \left\{ \frac{(w_i h_i + Y_i)^{\gamma_1} - (w_i j + Y_i)^{\gamma_1}}{h_i^{\gamma_2} - j^{\gamma_2}} \right\}$$

Given the likelihood function (6) for each individual, the log likelihood for a random sample of M individuals would be

$$(7)\ \mathcal{L}(h: X, Y, w, \gamma_1, \gamma_2, \beta, \sigma_\varepsilon, \mu, N) = \sum_{i=1}^{M} \ln[L(h_i:\ X_i, Y_i, w_i, \gamma_1, \gamma_2, \beta, \sigma_\varepsilon, \mu, N)]$$

We wish to treat N, the number of job offers, as a random variable, drawn independently by each individual in the sample. This requires evaluating the probability of drawing each possible integer value of N and summing over these probabilities times the value of the likelihood in (6). The maximum number of job offers is set at ten, on the basis of preliminary results. The appropriate likelihood in this case is

$$(8)\qquad L(\cdot) = \sum_{j=1}^{H} \{[\Phi(\varepsilon_{i,j}) - \Phi(\varepsilon_{i,j-1})] * \sum_{N=1}^{10} p_n(N) R_i(j)\}$$

$$+ [1-\Phi(\varepsilon_{i,100})] * \sum_{N=1}^{10} p_n(N) R_i(100)$$

$$+ (1-V(h_i)) * [p_n(0) + (1-p_n(0))\Phi(\varepsilon_{i,0})]$$

where the $p_n(x)$ is the probability of receiving x job offers.

Equality constraints are imposed on μ's (parameters of the market distribution of hours) for groups of values for hours worked. For example, we assume that the probabilities of drawing offers of from one to 15 hours are equal. This distribution is estimated with nine steps, 1–15, 16–25, 26–35, 36–39, 40, 41–45, 46–55, 56–65, and 66–75 hours per week. A subsequent version of the model allowing more steps failed to reject this restriction. The parameter for the first group of hours is normalized so that the probabilities sum to one. One parameter of the utility function must be normalized, since it is defined only up to a positive monotonic transformation. We have set the parameter A in the income term equal to 1.0.

As in a conventional labor supply model, preference parameters are in essence identified by the joint distribution of hours, wages, and other individual characteristics. The variance of the distribution of unobservables is to a large extent determined by the general goodness-of-fit between the predicted desired hours and the actual distribution of hours. The innovation here is that the pattern of discrepancies between the 'best' predicted distribution and actual hours is employed to identify the constraints faced by the workers, represented by the shape of the offer distribution and the number of draws allowed. Note that in order to describe the degree of constraint faced by individuals, both the estimated distribution of N and the offer distribution must be taken into account, and the expected deviation between desired and actual hours will vary over individuals with different characteristics.

IV. Results

A standard labor supply model and two versions of the model described above have been estimated on a sample of 555 married men from the control group of the Denver Income Maintenance Experiment. This sample is described in detail in the Appendix. Model 1 is a standard labor supply model where all variation in hours is attributed to variation in tastes. The utility function in (2) was used, with the unobserved components of tastes (ε_i's) assumed to be normally distributed. The parameters of the utility function and the variance of ε were estimated by maximum likelihood. Model 2 includes restrictions on employment opportunities of the type described in Section II, treating N as a random variable with a binomial distribution over the sample. Model 3 relaxes this distributional assumption, and allows the probabilities of receiving from one to ten offers to vary freely.[8]

A. Preferences and Desired Hours

Model 1 was estimated so that the bias in estimated preference parameters resulting from ignoring hours constraints could be assessed. Misspecification of the budget constraint has been demonstrated to be a serious problem for the estimation of labor supply functions. Ignoring deviations from the standard linear budget constraint between leisure and income, such as fixed costs of working, tax schedules, etc., can severely bias estimates of preference parameters, and yield misleading predictions regarding changes in policy.[9]

The estimated parameters for our 'no hours constraint' Model 1 are presented in Table 1. The population-constant preference parameters are estimated with some precision, but individual characteristics other than wage and non-labor income have little explanatory power. Table 2 reports income elasticities for the mean wage rate, and for wages one standard deviation above and below the mean (all other variables are held at sample means). These estimates appear quite reasonable--the income elasticities and the implied compensated wage elasticities have theoretically correct signs--though the wage elasticities are rather high for a sample of married men. This, however, is quite typical of the DIME sample.

Column 2 of Table 1 reports the parameter estimates for Model 2, in which N is random and distributed binomially. Preliminary estimates with non-random N suggested that 10 job offers would be a reasonable maximum. The estimated value of p indicates that the mean number of job offers is about three.[10] To determine an appropriate upper bound for N, we experimented with several different values. In all cases, it was possible to reject the hypothesis that the average number of jobs is greater than 5. The wage elasticities implied by Model 2 are much smaller than the estimates from Model 1 and the variance of the distribution of the unobservable has also decreased. Together, these differences imply that Model 2, which allows for restricted hours choices, predicts a distribution of desired hours which has a considerably smaller variance over the sample than does the standard model.

Model 3, which removes the binomial restriction on the distribution of N, generates results which are even more dramatic in this respect, since the values of the uncompensated wage elasticity falls in half again. Note from Table 1, however, that Model 2 cannot be rejected as a restriction on Model 3. The predicted probabilities for different values of N are similar to those generated by Model 2 (see Table 3), but were very imprecisely estimated.

B. <u>The Market Distribution of Offered Hours</u>

Table 4 shows the offer distributions generated by Models 2 and 3, and contrasts them with the actual distribution of hours worked. The main discrepancies are a large number of offers in the 1-15 hour range which are seldom accepted, and a shortage of offers over 40 hours per week.

C. <u>Constraints on Hours Worked</u>

The extent to which an individual is constrained in his choice of hours depends upon both the number of jobs available to him, and the distribution of offered hours, relative to desired hours. A calculation of

TABLE 1

PARAMETER ESTIMATES FOR UTILITY FUNCTION*

	Specification for Number of Job Offers		
	Model 1 No Hours Constraint	Model 2 Constrained Hrs. (Binomial N)	Model 3 Constrained Hrs. (Unrestricted N)
β: Constant	7.2992 (0.8154)	20.2865 (4.6812)	29.7740 (8.0592)
Education	0.0058 (0.0051)	−0.0104 (0.0288)	−0.0039 (0.0456)
Age	0.0272 (0.0199)	−0.0053 (0.0075)	−0.0091 (0.0123)
Children < 16	−0.0119 (0.0323)	0.0035 (0.0466)	0.0243 (0.0829)
$\sqrt{\gamma_1}$	0.7892 (0.0339)	0.6725 (0.1075)	0.5327 (0.2211)
γ_2	2.6001 (0.1896)	5.2490 (1.0825)	2.4807** (0.3392)
σ_ε	1.0979 (0.1161)	0.6963 (0.1555)	0.6488 (0.1925)
p		0.2125 (0.0594)	
LNL	−2442.8	−1920.3	−1920.0

* Asymptotic standard errors in parentheses.

** Estimated as $(\gamma_2 - 1)^2$. Implied value of γ_2 is 7.1539.

Model 1: $N = \infty$.

Model 2: N random-binomial distribution for N-1, mean job offers = 9p + 1.

Model 3: N random-no restrictions on $p_n(1)$ to $p_n(10)$.

TABLE 2

LABOR SUPPLY ELASTICITIES

	Wage Rates*		
	$2.42	$3.49	$4.56
Uncompensated Wage Elasticity			
Model 1: No Hrs. Constraint	0.38	0.36	0.35
Model 2: Binomial Distribution of Job Offers	0.13	0.12	0.11
Model 3: Unrestricted Distribution of Job Offers	0.05	0.05	0.05
Income Elasticity			
Model 1: No Hours Constraint	-0.05	-0.04	-0.03
Model 2: Binomial Distribution of Job Offers	-0.03	-0.02	-0.02
Model 3: Unrestricted Distribution of Job Offers	-0.02	-0.02	-0.01

* 1972 dollars.

TABLE 3

ESTIMATED PROBABILITIES FOR VALUES OF N: MODELS WITH RANDOM NUMBER OF JOB OFFERS

	Model 2 Binomial N	**Model 3** Unrestricted N
$p_n(1)$	.1165	.2393
$p_n(2)$	.2829	.1503
$p_n(3)$	.3053	.6039
$p_n(4)$	.1922	.0063
$p_n(5)$	.0778	.0002
$p_n(6)$	.0210	0
$p_n(7)$	.0038	0
$p_n(8)$	.0004	0
$p_n(9)$	0	0
$p_n(10)$	0	0

TABLE 4

DISTRIBUTION OF HOURS WORKED AND PREDICTED OFFER DISTRIBUTION

Hours Per Week (Annual Average)	Actual Dist. of Sample (%)	Offer Dist. Predicted by Model 2 (%) Binomial N	Offer Dist. Predicted by Model 3 (%) Unrestricted N
1-15	8.47	26.60	24.60
16-25	6.85	9.98	11.47
26-35	7.57	7.05	9.27
36-39	8.83	5.71	8.09
40	26.85	14.56	18.03
41-45	21.44	10.79	10.84
46-55	13.87	10.35	7.89
56-65	5.05	9.55	6.59
66-75	1.08	5.43	3.23

the discrepancy between desired and actual hours for each man in our sample requires knowledge, not only of the value of N and the offered hours drawn by each, but also the value of ε, the unobserved component of preferences. We can, however, calculate the expected value of this discrepancy for an individual with given observed characteristics, since we have estimated the distributions for ε, N, and offered hours.

To compute the distribution of desired hours and the difference between desired and actual hours of work we use Monte Carlo techniques. We draw for each individual a value for ε from a normal distribution, then use the estimated distributions of N to choose a random number of job offers. The appropriate number of offers are drawn randomly from the offer distribution, and the estimated utility parameters are used to calculate the utility associated with each offer. The average over the sample of the highest-utility jobs offer yields the value for constrained hours reported in Table 5. These values are, of course, close to the mean of actual hours, but considerably below our predictions of desired hours for both Model 2 and Model 3. The average man in our sample receives three job offers, and is working several hours a week less than he would like because offers in the most preferred 45-50 hour range are scarce. The average absolute deviation between desired and actual hours is from 10 to 12 hours per week. This is a sizable but, we believe, plausible measure of the extent to which workers are constrained.

Figure 3 reproduces the patterns of predicted desired hours (smooth and symmetric), predicted offered hours (a step function with a peak at 40 and excess weight in the lower tail), and actual hours. Desired and offered hours are calculated using parameter estimates from Model 3. Figure 4 shows the distribution of the deviation between desired and actual hours. Note that most of the sample are working fewer hours than they would prefer.

The most important application for estimates of individual labor supply response is the analysis of welfare and production effects of changes in the tax and transfer system. The results presented in Table 5 suggest that there are at least two serious problems with the standard approach to such policy analysis. First, estimates of the elasticity of desired labor supply with respect to the tax rate are very sensitive to the assumption of no hours constraints. For the two models presented here the estimated effects of both the standard income tax and a flat rate tax with the same average tax rate are considerably smaller when we allow for hours constraints.

Second, if we assume that the distribution of offered hours does not shift in response to a change in the tax code, the predicted changes in actual hours are considerably smaller than changes in desired hours. These discrepancies suggest that traditional labor supply models, which ignore hours constraints, are likely to overestimate tax responses. This overestimation results from biased utility parameters due to misspecification <u>and</u> from ignoring the direct effect of restricted hours. However, the assumption that the distribution of offered hours does not change is an untenable one. It is possible that even a small change in the tax structure could produce a large change in the distribution of offered hours. Thus any analysis which incorporates only the supply response to a tax change may produce significant over- or under-estimates of the true response in the presence of restricted hours choice.

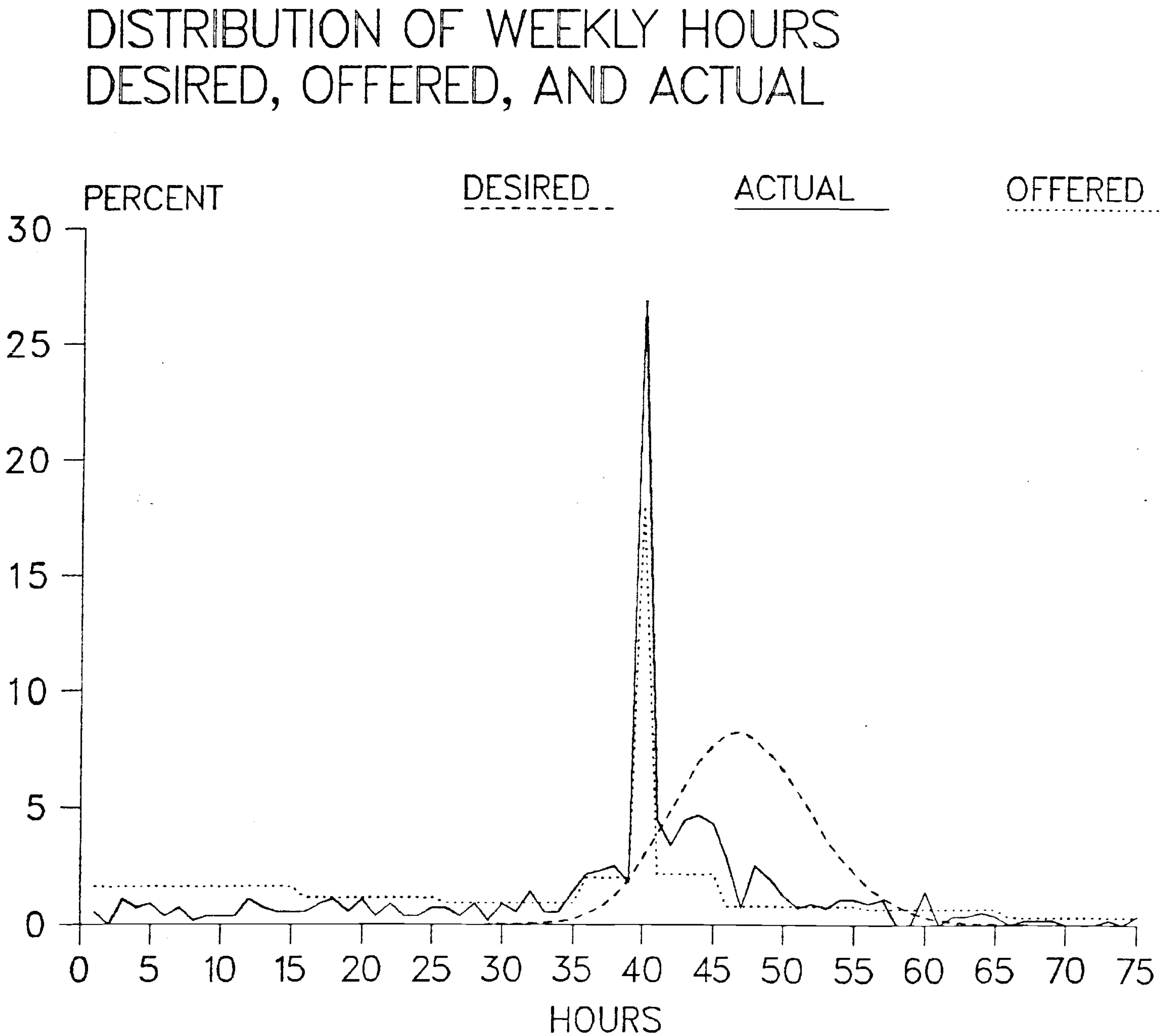
DISTRIBUTION OF WEEKLY HOURS
DESIRED, OFFERED, AND ACTUAL
PERCENT
DESIRED
ACTUAL
OFFERED
30
25
20
15
10
5
0
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75
HOURS

Figure 3

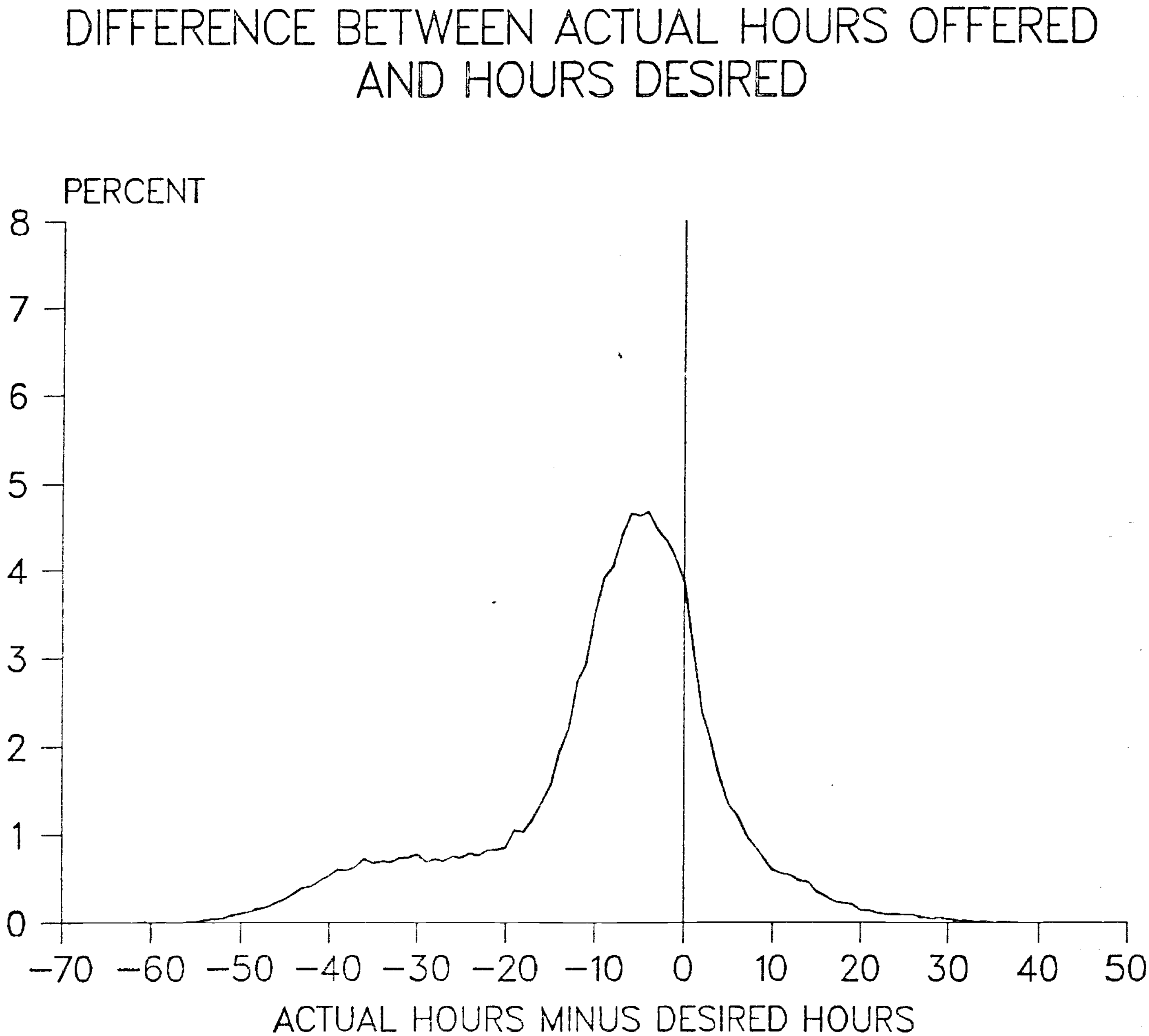
DIFFERENCE BETWEEN ACTUAL HOURS OFFERED AND HOURS DESIRED
PERCENT
8
7
6
5
4
3
2
1
0
−70 −60 −50 −40 −30 −20 −10 0 10 20 30 40 50
ACTUAL HOURS MINUS DESIRED HOURS

Figure 4

TABLE 5

CONSTRAINTS ON HOURS AND SIMULATED TAX EFFECTS
(Simulated Sample Averages)*

	Model 1 No Hours Constraint	**Model 2** Binomial N	**Model 3** Unrestricted N
Desired Hours	38.3	47.2	47.2
Constrained Hours	(34.1)	40.7	38.3
Difference	(-4.3)	-6.5	-8.9
Mean Absolute Difference	(14.7)	9.8	11.6
1972 Income Tax:			
--Δ Desired Hours	-2.16	-0.79	-0.80
--Δ Actual Hours	(-0.67)	-0.43	-0.26
Flat Tax:			
--Δ Desired Hours	-0.91	-0.18	-0.20
--Δ Actual Hours	(-0.32)	-0.10	-0.06

* Plus or minus .1 hrs/week is an upper bound for the 95 percent confidence interval for these averages. Numbers in parentheses were calculated using utility parameter estimates from Model 1 and estimates of the distribution of available hours from Model 3.

D. Specification Tests

Since DIME is a low income sample, there is likely to be some concern over the assumption that ε, the unobserved component of utility, is distributed normally, rather than according to some truncated or skewed distribution. To check for misspecification of the distribution of ε we apply a test proposed by Ruud (1981), in which the argument of the normal density function is replaced by a polynomial in that argument. In practice, we replace $\Phi(\varepsilon)$ with $\Phi(\varepsilon+C_2\varepsilon^2+C_3\varepsilon^3+C_4\varepsilon^4+C_5\varepsilon^5)$ in Model 3. Maximization of the likelihood function with all C's held equal to zero generates a Lagrange multiplier statistic which is distributed $\chi^2(4)$. The value was 6.18, so we cannot reject the null hypothesis of normality for ε.

The restriction that the market distribution of offered hours is a 9-step function was also tested, by estimating a model with 17 steps. The $\chi^2(8)$ test statistic was 11.8 (compared to a 90 percent critical value of 13.4), so we fail to reject our distributional assumption for the μ's.

V. Conclusions

The results presented in this paper call into question policy analysis based on labor supply models which assume that workers may freely choose how much they work. For example, models which allow for the possibility of hours constraints yield very different estimates of the effects of tax changes on desired hours of work. Further, since our results suggest that hours constraints have a significant impact on hours worked, the possibility that changes in the distribution of available hours could occur in response to changes in the tax or transfer system becomes important. To correctly analyze the effects of such changes, we must model not only the labor supply decision but also labor demand, and in particular the process determining the distribution of available hours of work.

One approach to incorporating hours constraints in an empirical labor supply model is presented in this paper. The specification for hours constraints we use is a fairly general one. Each worker chooses from among a finite set of jobs offering fixed hours, which have been drawn at random from a market distribution. We estimate the mean number of job offers received to be about three, and the mean absolute difference between desired and observed hours to be ten hours per week. For this sample, therefore, hours choices appear to be significantly constrained, with a large proportion of the sample choosing one of the abundant 40-hour jobs. It is noteworthy that, since mean desired hours are estimated to be 47.2 hours per week, most individuals are working less than they wish.

Our representation of hours constraints is a stylized one, but gives apparently sensible results and is suggestive of the way in which future research might proceed. The estimates of individual disequilibrium and of wage and income elasticities are, of course, conditional upon our specification for preferences and the distribution of offered hours. However, specification tests failed to reject our assumptions that the unobservable component is normally distributed and that the offer distribution can be represented as a step function with nine steps. Fruitful extensions to the model presented here might include experimentation with other functional forms for utility or attempts to incorporate tied wage-hours offers, which are implied by a market equilibrium involving hours restrictions.

Most of the individual variation in hours worked is left unexplained by simple models of unconstrained labor supply. There is a fundamental indeterminacy here--we are unable to distinguish with certainty between unobserved components of preferences and unobserved constraints. However, in markets where we have some reason to suspect that behavior may be constrained in the short run, it seems to us good policy to operate on both fronts simultaneously. Building hours constraints into a labor supply model explicitly is a first step in one direction; refining our specification of preferences is a desirable continuation in the other. In addition, we must begin the task of modelling the demand side of hours constraints.

FOOTNOTES

1. The independent variables were the wage rate, non-labor income, age, education, and number of children. The value of R^2 was less than 0.03. The distribution was constructed by adding a normal random variable, with a standard error equal to the s.e.e. for the estimated equation, to the predicted value for each of the 555 workers in our sample.

2. The derivation of this sort of equilibrium is presented in S. Rosen (1974) and, in the particular context of hours worked and wages, in Lewis.

3. Burtless and Hausman (1978) allow for differences between workers' desired and actual hours worked, but require those deviations to have a normal distribution and to be independent of observed worker characteristics. Given the discussion above, we would expect the distribution to be decidedly non-normal and deviations to be correlated with a worker's desired hours, which is a function of observed characteristics.

4. Closely related are models incorporating fixed costs of working, such as those of Cogan (1980, 1981) and Hausman (1980).

5. We are not aware of any attempts to estimate labor supply models incorporating in a general way both restricted choice over the market distribution of offered job packages and the relationship between wages and hours within packages. Indeed, estimation of such a model does not at present seem feasible. Gustman and Steinmeier (1984) allow for tied wage-hours offers, but permit a choice between only two packages. Estimates of the market equilibrium wage-hours locus by

Rosen (1976) and Lundberg (1984) assume that individuals may choose freely from the entire distribution of offered packages.

6. These should be interpreted, not as individual jobs in the literal sense, but as employment opportunities which may include multiple jobs with non-conflicting hours.

7. Based on some preliminary estimates of the unconstrained model, individual differences in preferences have been incorporated in the coefficient of the hours term, though any of the parameters might be allowed to vary over individuals.

8. The possibility of zero offers, and thus involuntary unemployment, has been excluded from this version, which uses annual hours and includes no non-workers. It has, however, been included in versions employing monthly hours, with no significant change in the conclusions.

9. For example, see Cogan (1980, 1981) and Hausman (1980) for the effects of incorporating fixed costs to the worker, and Hausman (1983) for a comprehensive discussion of empirical studies of labor supply with taxation.

10. The expected number of job offers is 1 + 9*p, since we do not consider the possibility of receiving no job offers.

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APPENDIX

Data

A sample of 555 married men from the control group of the Denver Income Maintenance Experiment (DIME) has been used for of this study. Work experience during 1972 is the relevant measure of hours, but a time series of up to 48 months of data for each individual is also available. Monthly information includes total hours worked at all jobs, straight-time hourly wage on each job, income received from all other sources (including earnings of other family members and transfer payments--support payments from DIME were not received by this group), and number of children under 16 years of age in the household. Table A.1 presents some important characteristics of this sample, and more information can be found in Lundberg (1981).

All men in this sample are between the ages of 18 and 59. The only individuals excluded from the available population were 10 individuals for whom education data were missing, and 15 who did not work at all during 1972 (the latter have been included in the distributions in Figures 1 and 2). Monthly data for September 1972 were used in a preliminary version of this model. The inclusion of individuals who did not work during this month did not appear to affect the estimated degree of constraint.

The DIME data possess several advantages for this type of analysis, such as excellent monthly information on hours and separate questions for the wage rate and monthly income. A possible disadvantage arises from the selection criteria applied to yield a low-income control group for the experiment--the sample is not representative of the entire population and this may cause problems in making distributional assumptions for the unobserved element of preferences (but see the results of a specification test in IV.D), as well as limiting the generality of results regarding the degree of hours constraints. Estimates from this sample, however, benefit from higher quality data than are available elsewhere, and provide a useful starting point for applications to more representative samples.

TABLE A.1

CHARACTERISTICS OF DIME CONTROL SAMPLE--MARRIED MEN

	Minimum	Mean	Maximum
Hourly wage	$ 0.26	$ 3.49	$ 9.23
Weekly average of hours worked during Sept. 1972	0	39.86	93.80
Weekly average of hours worked during 1972	1.10	38.41	75.38
Other income per week (excludes public transfers)	0	$35.08	$265.74
Years of education completed	2.0	11.19	18.0
Age	18.0	33.74	59.0
No. of children under 16	0	2.17	6
No. of observations		555	