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AN ECONOMETRIC ANALYSIS OF UNEMPLOYMENT INSURANCE BENEFIT ADEQUACY

The University of Arizona PH.D. 1986

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AN ECONOMETRIC ANALYSIS OF UNEMPLOYMENT INSURANCE BENEFIT ADEQUACY

by

Christopher Joseph O'Leary

A Dissertation Submitted to the Faculty of the

DEPARTMENT OF ECONOMICS

In Partial Fulfillment of the Requirements
For the Degree of

DOCTOR OF PHILOSOPHY

In the Graduate College

THE UNIVERSITY OF ARIZONA

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As members of the Final Examination Committee, we certify that we have read the dissertation prepared by Christopher Joseph O'Leary

entitled An Econometric Analysis of Unemployment Insurance Benefit Adequacy

and recommend that it be accepted as fulfilling the dissertation requirement for the Degree of Doctor of Philosophy.

Ronald L. Oaxaca	9-15-86 Date
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	Date

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SIGNED: Christopher J. O'Leary

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ABSTRACT

Explicit parameterizations of labor supply are specified and estimated on a sample of single unattached individuals using data from the Panel Study of Income Dynamics and a generalized Tobit maximum likelihood method which is consistent under the assumption that employed hours are exogenous. Results of these estimations are then used to compute triangle approximation and direct closed form solutions for labor market constraint compensation. Underemployment compensation estimates are generated and compared to actual and hypothetical payments which would accrue under the UI systems of representative states. Certain compensation results for overemployment are also offered.

Where they are directly comparable, results from Tobit estimation of the basic labor supply relations are found to strictly dominate ordinary least squares (OLS) results in terms of efficiency. While the OLS and Tobit parameter estimates differ dramatically in most cases, the latter are consistent with the bulk of recent empirical labor supply research.

A corollary purpose of estimating the several labor supply specifications is the search for an appropriate structure of preferences to be used in modeling the labor-leisure choice problem. Direct likelihood ratio tests yielded no best form, but suggested that more flexible parameterizations are to be desired.

Results on compensation amounts tend to support accepted standards of UI benefit adequacy. For all levels of unemployment the direct compensation results suggested that "one-half gross wage replacement" would slightly overcompensate individuals from a utility based perspective.

CHAPTER 1

INTRODUCTION

Formalized protection against the risk of unemployment in the form of cash benefits was virtually nonexistent in the United States fifty years ago. However, largely due to the advocacy of eminent labor economists John R. Commons (1921) and Paul H. Douglas (1932), provisions for the establishment of a federal-state system of Unemployment Insurance (UI) were included in the Social Security act passed by Congress in 1935 (see Broden 1962 and Nelson 1969 for a review of the legislative history of UI). As a result of "tax offset" inducements contained in companion legislation --the Federal Unemployment Tax Act--by July 1937, in all states, Alaska, Hawaii, and the District of Columbia, legislation had been enacted to create UI programs. The intervening years witnessed continuous growth and change in the UI system. In 1960 Puerto Rico came under the federal-state system, as did the U.S. Virgin Islands in 1978. Today, UI is undeniably an important institution in the nation's economy, directly affecting personal incomes, employer taxes, federal-state relations, and

interstate competition for industrial production and employment.

Since the inception of the UI program, controversy over the adequacy of benefit payments has continued. Opinions have ranged from the view that UI does little more than subsidize leisure to the position that benefit levels grossly undercompensate for the physical and psychic hardships caused by unemployment. Such a disparity of views is typical of debate on any normative question. (See Becker 1960 for an early history of public sentiment on several aspects of UI, and Curtin and Ponza 1980 for a summary of more recent attitudes.) For reasoned ethical directives to be offered on such matters, more fundamental considerations must first be examined. Adequacy is a relative concept meaning "sufficiency for purpose;" therefore, UI benefit adequacy is best judged with reference to the goals of the program.

The UI system was designed to be completely separate from relief programs, with eligibility determined by labor force attachment and benefit levels based on prior earnings experience. The objectives of Unemployment Insurance were succinctly set forth in a statement issued by the United States Department of Labor in 1955 (Haber and Murray 1966, p. 26):

> Unemployment Insurance is a program --established under Federal and State law-- for income

> maintenance during periods of involuntary unemployment due to lack of work, which provides compensation for wage loss as a matter of right, with dignity and dispatch, to eligible individuals. It helps to maintain purchasing power and to stabilize the economy. It helps to prevent the dispersal of the employers' trained work force, the sacrifice of skills, and the breakdown of labor standards during temporary unemployment.

While certain of these UI objectives have been reoriented, especially with regard to the geographic and occupational mobility of workers, all remain subordinate to the primary goal of providing compensation to the individual for wage loss experienced as a result of unemployment.

Many writers have investigated the significance of UI in performing the counter cyclical function of smoothing aggregate demand (Report of the Commission on Money and Credit 1961, Palomba 1968, Oaxaca and Taylor 1986), and it is this side-effect of the UI system which some emphasize (Lester 1962, Thirlwall 1969). In what follows, the traditional focus of the UI benefit adequacy discussion--the sufficiency with which UI meets the prime objective of compensating the individual for wage loss experienced as a result of unemployment--is investigated.

Following Feldstein (1974), the main emphasis of UI related research has been on the behavioral or efficiency impact of UI (a good survey of this literature can be found in Nicholson 1981), but there has of

late also been a resurgence of interest in the equity, including adequacy and distributional, aspects of UI. The methodology employed by recent researchers investigating the adequacy issue (principally Burgess and Kingston 1978a, 1978b) has closely paralleled that of earlier researchers (see Haber and Murray 1966, for a summary of state studies done in the 1950's). The typical approach is to question a sample of UI recipients about their expenditures on a class of goods and services deemed "necessary" and compare their level of UI benefits to the level of these expenses. Surveys of this type, although extremely valuable, have proven to be quite expensive. Becker (1961, p.23) noted that for the 1950s benefit adequacy studies "[t]he time spent per interview averaged about three hours, with a range from one to fourteen hours, exclusive of the time spent in re-interviews of the more difficult cases." The high expense of gathering data has also resulted in small sample sizes, but a more fundamental problem in this approach exists. These studies presume that the analyst may determine which categories of expenditure are "necessary" or which items a household may least do without.

Burgess and Kingston (1980) investigated the possibility of evaluating benefit adequacy on the basis of readily available survey (Continuous Wage and Benefit

History--CWBH) and claims data. They conclude, however, "that information on income and household composition must be supplemented with actual or estimated data on household expenditure patterns to predict individual benefit adequacy values with a reasonable degree of accuracy." (U.S. Department of Labor 1981, p. 43). It is hoped that by placing the analysis on a sound theoretical foundation the approach taken in this study, using only survey data, will yield a more satisfactory result.

A natural method for determining full compensation to the individual is to solve for that lump sum payment, which, when given to an unemployed individual, makes him indifferent between his current lot and his pre-unemployment one. It may be argued that UI is not intended to fully compensate the loss an individual experiences as a result of being unemployed -- so that an inducement will remain for returning to work. However, the historical emphasis on replacing a fraction of lost income ignores the differences among households in sources of income and hours of work (and leisure), so that the current scheme may actually result in overcompensation from a utility based perspective. The possibility of overcompensation was noted by Abowd and Ashenfelter (1981) who examined compensating wage differentials for anticipated unemployment. Using a two

sector model they conclude that the wage in the constrained sector will be less than that in the unconstrained sector "whenever the utility payment for UI benefits exceeds the utility loss from being required to consume too much leisure" (Abowd and Ashenfelter 1981, p. 146). Furthermore, the examination of employment increasing entitlement effects by Hammermesh (1979) may provide some justification for ignoring the adverse incentive effects of UI which received so much attention throughout the 1970s. The approach to measuring unemployment compensation taken here, which is based on the theory of a utility maximizing consumer-worker, provides a way to estimate an upper limit on the value of UI payments to an individual.

The principal objective of this study is to compare the cost of providing full unemployment compensation, under various assumptions on the structure of preferences, to the cost of granting benefits which satisfy traditional norms of adequacy. Some interesting results suggested by symmetry will also be presented.

In the next chapter a discussion of the accepted norms of benefit adequacy provides the framework for a review of the literature. A simple theoretical analysis of behavior under labor market constraints is given in Chapter 3 where explicit methods for computing full unemployment compensation are also developed. In

Chapter 4 the econometric methods to be used are discussed along with a critique of earlier approaches; formulae for computing full unemployment compensation are also given. The 1982 Panel Study of Income Dynamics (PSID) data which is used in this study is discussed in Chapter 5; the rationale for use of the PSID, sample selection, and variable definition are also discussed there. Because of the interest exhibited in the profession over the past twenty-five years, and their general usefulness in many policy evaluation settings, the basic labor supply results are presented separately in Chapter 6. In the subsequent chapter compensation results are reviewed in light of standard norms of benefit adequacy. Also, in Chapter 7, UI benefit adequacy in various representative states is assessed on the basis of compensation simulations. Policy applications, summary, and concluding comments are offered in the final chapter.

CHAPTER 2

STANDARDS OF BENEFIT ADEQUACY AND THE ASSOCIATED LITERATURE

In his now classic monograph, The Adequacy of the Benefit Amount in Unemployment Insurance, Father Joseph M. Becker (1961, p. 11) noted that; "A satisfactory norm of adequacy must have two elements--one positive, by which it can explain why benefits are as large as they are, and one negative, by which it can explain why they are no larger." Douglas (1932) had earlier stated these principles in more substantive form. He suggested that "[t]here is a minimum of life which must be defended by the system of benefits," (Douglas 1932, p. 85) and that "[t]he amounts which the unemployed receive in benefits should always be appreciably less than what they would earn if employed [so that]... the temptation to shun work in order to draw the benefit will be greatly reduced" (Douglas 1932, p. 4.). Douglas (1932) proposed that a balancing of these objectives might be achieved if unemployment benefits were to replace approximately one-half of lost wages for individuals who are unemployed and have demonstrated a significant attachment to the labor force.

One-half for Four-fifths: A Consensus Standard

Becker (1980) has investigated the question: Should there be a compulsory federal standard (for UI benefits)? None has ever been set, and the prevailing "New Federalism" attitude in Washington suggests that it is unlikely that the job of setting benefit levels will be taken out of the hands of the states in the near future. While federal legislation has never specified the exact rate at which lost wages should be replaced under UI, every president since Eisenhower has reaffirmed the position that "payments to the great majority of the beneficiaries should equal at least half of regular earnings" (Becker 1980, p. 11). Nixon specified that "great majority" should mean four-fifths of the nation's workforce (Becker 1980, p. 11). This criterion of benefit adequacy has come to be known as "one-half for four-fifths."

It may be said that something of a national consensus has been reached on this norm of adequacy. The Interstate Conference of Employment Security Agencies in its 1980 statement of policy positions declared that "benefits should equal at least half of a beneficiary's wage" (Becker 1980, p. 41). And while it is nowhere explicitly stated, judging from the benefit provisions in the various states, it is likely that a one-half replacement rate provision was a necessary

condition for a state UI law to be approved by the Social Security Board (SSB). Without SSB approval, employers in a state could not take advantage of the unemployment tax offset; all states qualified.

In nearly all studies of benefit adequacy the norm of one-half wage replacement is somewhere applied. This is not a meaningless exercise. While most states do provide for benefit payments at the rate of approximately one-half of lost wages, there also exist maximum and minimum limits on these payments. Since the benefit maximum is typically defined to be one-half of the average weekly earnings of workers covered by UI, the bounds on benefit payments guarantee that many high wage workers will be undercompensated, even though many others will be fully or even over compensated, according to the one-half wage replacement criterion. The data in Table 1 detail the national experience on the average wage replacement ratio (WRR). The national average WRR is defined by

$$WRR = \frac{\sum_{i=1}^{n} WBA_i / n}{\sum_{j=1}^{m} WE_j / m}$$

WBA_i = the weekly benefit amount received by the ith UI recipient,

n = the number of UI recipients,

WE_j = the weekly earnings of the ith covered worker, and

m = the number of workers covered by UI.

Ignoring the very early years of UI when earnings of covered workers were unusually low, the WRR has ranged from thirty-two to thirty-seven percent, being approximately thirty-six percent in recent years. Controlling for the changing occupational mix of UI claimants, Height (1980) arrived at lower bound estimates of .10 to .29 percent increase in WRR per year over the period 1950-1977; and concluded that there has been some real gains in adequacy over the period. However, these gross average figures tell nothing about the proportion of beneficiaries who actually receive at least fifty percent of lost wages. Since in most states payments are made at the rate of fifty percent of lost wages up to the benefit maximum the proportion of beneficiaries receiving less than the maximum is a proxy for the proportion "adequately" compensated. In recent years, roughly sixty-six percent of payments have been below the maximum (Becker 1980, p. 13.), so that in broad terms the norm of "one-half for four-fifths" has not been met. It has been recommended that the benefit maximum should equal two-thirds of the average wage in covered employment to meet this standard (Becker 1980, p. 57). However, Crosslin and Ross (1980) estimate that the maximum would have to be seventy-five percent of the

Table 1. Average UI Weekly Benefit Amount (WBA), and Wage Replacement Ratio (WRR) in the United States, 1938-1981.[a]

Year	WBA	WRR	Year	WBA	WRR
1938	$10.94	.431	1960	32.87	.352
1938	10.66	.408	1961	33.80	.354
1940	10.56	.391	1962	34.56	.349
1941	11.06	.366	1963	35.28	.346
1942	12.66	.353	1964	35.96	.338
1943	13.84	.336	1965	37.19	.338
1944	15.90	.359	1966	39.76	.347
1945	18.77	.416	1967	41.25	.347
1946	18.50	.396	1968	43.43	.343
1947	17.83	.346	1969	46.17	.344
1948	19.03	.341	1970	50.31	.357
1949	20.48	.360	1971	54.35	.365
1950	20.76	.344	1972	55.82	.361
1951	21.09	.322	1973	59.00	.361
1952	22.79	.330	1974	64.25	.365
1953	23.58	.323	1975	70.23	.371
1954	24.93	.335	1976	75.16	.371
1955	25.04	.321	1977	78.71	.364
1956	27.02	.333	1978	83.67	.364
1957	28.17	.335	1979	89.68	.361
1958	30.54	.353	1980	98.95	.364
1959	30.40	.334	1981	106.61	.359

[a] Source: UI Financial Data, ET Handbook No. 394, United States Department of Labor, Employment and Training Administration (1982).

average wage in covered employment "if covered workers are the target group, 80 percent if insured workers are selected, and 85 percent for either claimants or beneficiaries" (Crosslin and Ross 1980, p. 72).

When assessing benefit adequacy by a wage replacement criterion an important question is: how lost earnings should be measured. The main concern in determining the wage base is the treatment of taxes. Naturally, an assessment of adequacy based on net wages will be more favorable than one based on gross wages. A graphic representation of this, taken from Height (1980), is given in Figure 1. Height's net wage replacement figures, which are adjusted for federal, state, and local income taxes and payroll taxes, range from .36 to .45 over the period 1950-1977.

Some researchers have arrived at very high net WRR figures. Feldstein (1974), who was concerned with the adverse incentive effects of UI, estimated that the net wage replacement ratio is often more than seventy percent. Munts and Garfinkel (1974) found replacement rates in Ohio in 1971-1972 to range from .38 to .89 for several distinct types of family units. And Mathematica Policy Research, Inc. (1977), determined the average ratio of benefits to lost wages in 1977 to be .66. Gramlich (1974), using micro data, however, found that during the 1970-1971 recession for families headed by

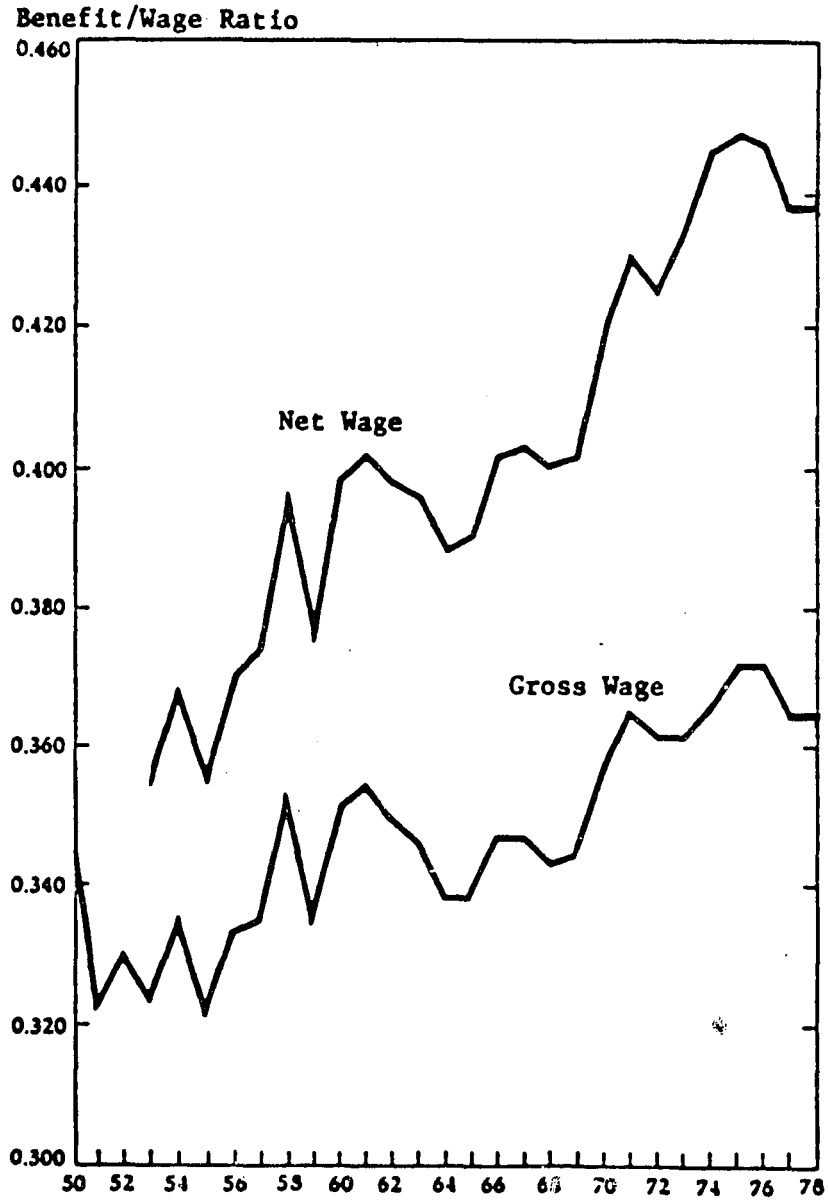

Figure 1. Average Net and Gross Wage Replacement Ratios in the United States, 1950-1977.[a]

[a] Source: U.S. Department of Labor, "Trends in Unemployment Insurance Wage Replacement Rates," December 10, 1979.

men, UI replaced only six to eight percent of lost earnings, and fourteen to eighteen percent for families headed by women. These are probably extreme estimates, but clearly the WRR is affected by the level of economic activity. If workers with relatively low marginal productivity and earnings are laid off first in a recession, the average wage of (covered) workers remaining on the job increases, lowering the WRR.

Both the net wage and the gross wage remain deficient bases for assessing adequacy in that neither accounts for the loss of fringe benefits experienced by the unemployed. The cost to employers of providing fringe benefits, exclusive of UI taxes, averaged 15.4 percent of the total payroll for all U.S. firms in 1981 (Hammermesh and Rees 1984, p .301), the year during which data to be used in this study was gathered. Therefore, the gross pre-unemployment wage may provide the best base for evaluating UI benefit adequacy, since fringes are granted at about the same rate as the sum of personal income taxes are levied. This recommendation will carry further weight if it may be presumed that the direct costs of working and looking for work are about equal.

Meeting Essential Expenditures: Support for the Consensus Standard?

During the 1950s the U.S. Department of Labor financed a series of Unemployment Insurance benefit

adequacy studies. The results of these studies have been summarized by Becker (1961), Lester (1962), and Haber and Murray (1966). Recently, while discussing the principles which should underlie any proposal for a federal benefit standard, Becker (1980) focused on the evidence from studies in Tampa, Fla. (1956), Anderson, S.C. (1957), Albany, N.Y. (1957), Portland, Ore. (1958), and St. Louis, Mo. (1958). These five similar studies were based on retrospective data on the income and expenditures of respondents during the period just prior to the survey date. Expenditures were divided into deferrable and non-deferrable categories. Spending on food, clothing, medical care, and housing constituted the non-deferrable group. Information was gathered on four household types. After examining these studies Becker (1980, p. 26) concluded that "[n]one of the states came close to the proposed goal of paying 80 percent of the beneficiaries half or more of their gross wage,...[and] [i]t is one of the weaknesses of the system that claimants without dependents' are treated much better than claimants with dependents." He suggested that benefit adequacy could be generally improved if benefit maximums were raised and programs for dependents allowances were expanded.

The 1950s studies did, however, demonstrate the usefulness of the one-half wage norm for assessing

benefit adequacy. On the average, benefits that were half or more of the wage were sufficient to cover non-deferrable expenses for all claimant household types (Becker 1980, p. 13). Table 2 presents a summary of the experience of those who fared best under the existing programs--households composed of a single beneficiary living alone. (Single persons living alone with no dependents make up the sample drawn from the 1982 PSID survey, which is analyzed in this study.) For this group in these studies the average wage replacement ratio ranged from .46 in Tampa to .58 in Portland, and on average benefits were sufficient to cover non-deferrable expenses, as defined above, in all cases except Tampa where the benefit averaged 95 percent of non-deferrable expenses. Indeed, the figures suggest that for this group a wage replacement ratio of 50 percent would result in a benefit level about equal to non-deferrable expenses. These wage replacement ratios do not, however, yield half wage replacement for the desired 80 percent or more of the group. It is also interesting to note that the group wage replacement ratios average about 50 percent more than their respective state ratios. This is not surprising since single persons with no dependents on average have relatively low incomes. But as is suggested by the national data in Table 1, the state wage replacement ratios have risen

Table 2. Experience of Single UI Beneficiaries Selected from Five Benefit Adequacy Surveys, 1956-1958.[a]

Survey	PCTGW[b]	PCTNW[c]	PCTND[d]	PCTMAX[e]	WRR[f]	SWRR[g]
Tampa	28	65	95	21	.46	.31
Anderson	51	84	118	37	.56	.36
Albany	51	72	114	46	.54	.34
Portland	52	79	118	42	.58	.39
St.Louis	34	58	106	49	.48	.33

[a]Source: Becker (1980), Table 1, pp. 11-12.

[b]PCTGW: Percent of beneficiaries whose benefits were half or more of their gross wage.

[c]PCTNW: Percent of beneficiaries whose benefits were half or more of their net wage.

[d]PCTND: Average benefit as a percent of average non-deferrable expenditures.

[e]PCTMAX: Percent of beneficiaries who recived the maximum benefit amount.

[f]WRR: Ratio of average weekly benefit amount in state to average weekly net wage of receipients.

[g]SWRR: Ratio of average weekly benefit amount in state to average weekly wage in state covered employment.

since the 1950s; therefore, benefit adequacy for this group is likely to have improved.

The arbitrary deferrable-non-deferrable distinction employed in the 1950s studies was expanded by Blaustein and Mackin (1977). They added expenditures made on a regular basis to repay outstanding debt to expenditures for food, clothing, medical care and housing, and labeled this "recurring" expenses. Using this concept as a basis for evaluating UI benefit adequacy they found that over two-thirds of the beneficiary households in South Carolina had adequate income in 1977. Nonetheless, they recommended increasing benefit maximums to improve adequacy.

Burgess and Kingston (1978a, 1978b) who conducted a detailed benefit adequacy study in Arizona, expanded the Blaustein-Mackin definition of recurring expenses to include expenditures on transportation, insurance, regular services, and regular support payments. They labeled this concept "necessary and obligated" expenses, and used it to assess benefit adequacy for seven recipient household types. Of the 3,130 claimants in the Burgess-Kingston Arizona sample, 1,112 or 35.5 percent received a benefit that equaled half or more of their gross weekly wage. The percentage who received benefits sufficient to cover all "necessary and obligated" expenses was 14.1, and only 26.3 percent

of those who received half or more of their gross wage were able to cover all necessary and obligated expenses. In evaluating this poor performance, Becker (1980, p. 42) suggests that

> Arizona... should probably be considered representative of the lower fifth of the states... The inadequacy of some is explained almost entirely by a low maximum benefit, while in others (like Arizona or West Virginia) the structure of the benefit formula below the maximum is a seriously contributing cause.

Furthermore, the poor correspondence between replacing half the wage and meeting "expenses" is probably due to the liberal definition of the latter made in the Arizona study.

Theoretical support for the standard norm of adequacy may be found in the recent literature on optimal taxation in public finance. Baily (1978) and Flemming (1978) have developed models where the weekly benefit amount is optimally determined by the maximizing behavior of individuals covered by UI subject to a program budget constraint. Baily (1978), who used a two period model of behavior under labor market uncertainty, finds evidence for the standard norm of adequacy. He states (Baily 1978, p. 393):

> [that if the] degree of relative risk aversion by workers [is] unity, and if workers do not prolong their duration of unemployment very much as a result of UI payments [i.e., if the elasticity of a spell of unemployment with respect to a change in the benefit amount is about 0.15] then if the benefit-wage ratio is 50% it is about right.

The elasticity of unemployment with respect to the benefit amount assumed by Baily (1978) is in line with estimates found by Classen (1975) and Ehrenberg and Oaxaca (1976).

Flemming (1978), who employs a life cycle model, qualifies his statements with capital market considerations. He concludes (Flemming 1978, p. 403) that under perfect capital markets a replacement rate of 50% is too high, and "[i]f there is no lending or borrowing the optimal rates rise to about 75%." Reality lies somewhere between these extremes.

The norm of adequacy "one-half for four-fifths" is rooted in the common-sense recommendations of economists and politicians made over fifty years ago. The norm has been demonstrated to correspond roughly to the fundamental concern of satisfying needs of the unemployed, as well as being consistent with the fiscal integrity of the program. It is also appealing to policy makers and program managers because it is easy to apply. In Chapter 7 this norm is redressed in light of full unemployment compensation estimates. The theoretical foundation for this exercise is laid in the next chapter.

CHAPTER 3

UNEMPLOYMENT COMPENSATION AND CONSUMER BEHAVIOR

The popular approach of researchers examining unemployment during the early 1970s (for example, Mortenson 1970; Lucas and Rapping 1970) was to treat unemployment as the result of optimizing behavior by labor force members. More recently fruitful empirical work in labor market analysis (Goldfeld and Quandt 1975, Ashenfelter 1980, Hurd 1980) has been based on theoretical models which treat unemployment as a constraint on the ability of individuals to sell their labor services. This latter approach will be taken here where full compensation to the constrained individual is examined. The analysis is based on a model of behavior during a single income period (a static model covering one year) where the individual expects to maintain a given labor market status throughout the period.

Consumer-Worker Behavior in the Absence of Labor Market Constraints

The model is based on the theory of labor supply which is an application of the theory of consumer choice to the demand for leisure. The individual's problem is

to allocate his time between work--which provides the means to obtain market goods--and leisure in such a fashion as to maximize satisfaction. The consumer-worker is assumed to behave in a manner consistent with the maximization of a twice continuously differentiable utility function, subject to a constraint on total resources. Each individual is assumed to have an initial endowment of discretionary time, T, which may be used for supplying hours of labor services, H, in the market, or for non-market uses. All non-market uses of time are treated here as one use: leisure, L, abstracting from such uses of non-market time as time spent working in the home, and time spent commuting. Under these assumptions, market work and leisure time constitute an exhaustive partition of all uses of time, $T = H + L$.

The consumer-worker acts so as to maximize utility,

$$U = f(L, x_1, x_2, \ldots, x_n), \tag{1}$$

subject to a total resource constraint,

$$\sum_i p_i x_i + wL = wT + I, \tag{2}$$

which is composed of time and money income constraints. Where $x_1, x_2, \ldots, x_n$ are market consumption goods which directly provide utility, p_i is the price of the ith market good, w is the wage rate which represents the

price of time in each use, and I is non-labor income, that is, income from dividends, interest, property, gifts, or grants.

Since the statistical analysis is to be done using cross-section data at a point in time, it is appropriate to modify both the objective function and the constraint in this model by invoking Hicks' composite commodity theorem. Hicks' theorem maintains that if relative prices do not change, all goods can be lumped into one composite commodity, variously referred to as generalized purchasing power and Hicks-Marshall money (see Hicks 1946, pp.33-34). Specifically, this implies $\Sigma_i p_i x_i = Y$, where Y is the composite commodity, to be treated as the numeraire. This simplification also frees the subsequent statistical analysis from the need to impute any particular weights on the various categories of expenditure.

Satisfaction of each consumer-worker is now represented as depending simply on the market resources at his command, Y, and the time available to enjoy these resources, L. It is assumed that each individual, given his exogenous non-labor income, I, and the rate at which he can transform his labor services (H) into income, w, if unconstrained in the labor market, acts in a manner consistent with the problem: maximize

$$U(L,Y), \qquad (1')$$

subject to,

$$Y = wH + I, \tag{2'}$$

and reaches an optimum where H(w,I) hours of work are supplied to the market and Y(w,I) goods are consumed in the residual discretionary time available, L(w,I). Since T is the endowment of discretionary time, L(w,I) = T - H(w,I). It should be noted that the functions H(·), Y(·), and L(·) derived in this fashion are Marshallian or uncompensated functions.

The level of satisfaction achieved in this unconstrained equilibrium situation is:

$$\begin{aligned} V &= \max_{L,Y} \{ U(L,Y);\ Y = wH + I \} \\ &= V(L(w,I),\ Y(w,I)) \\ &= V(w,I) \end{aligned} \tag{3}$$

where V(w,I) is the indirect utility function and U(L,Y) is the direct utility function. The indirect utility function (3) may be solved for non-labor income to obtain:

$$I = E(w,V). \tag{4}$$

The function E(w,V) gives the minimum unearned income necessary to reach the utility level V, given the wage rate w. Since I = Y - wH, E(w,V) is referred to as the

excess expenditure function, because it determines the minimum lump sum income in excess of labor earnings needed to achieve a particular level of utility.

The excess expenditure function has a useful property, sometimes referred to as Shepard's Lemma (Silberberg 1978, p. 199), whereby the derivative of the expenditure function with respect to a price yields the Hicksian or compensated demand function for the associated good. The present application of this principle will prove to be useful below. Differentiating E(w,V) with respect to the wage rate yields:

$$\begin{aligned} \partial E(w,V)/\partial w &= E_w(w,V) \\ &= L(w,V) - T \\ &= -H(w,V), \end{aligned} \qquad (5)$$

the negative of the Hicksian labor supply function.

Consumer-Worker Behavior Under Labor Market Constraints

The development of the previous section presumed that an individual was free to choose the number of hours he wishes to sell at his current market wage. However, many workers do not have such presumed flexibility. In many instances, the effective choice is between working a standard day, week, or year or not working at all; in other cases an optimal wage-hour arrangement way be upset by an unexpected layoff.

These ideas may be exposed by using graphical techniques. In Figure 2 an indifference map represents an individual's preferences over leisure, L, and market goods, Y. If unconstrained, this consumer-worker would achieve equilibrium on indifference curve U^0 at (L^0,Y^0), assuming positive non-labor income ($I^0 > 0$), and given the market wage rate w^0, represented by the negative slope of the budget line AB. The period of analysis is taken to be one calendar year, and T is the total discretionary time available for work and leisure during the year. The case of central concern, where desired hours of work, $H(w,I) = H^0$, exceed actual (constrained) hours of work, $\underline{H}$, occurs at point D. This situation may result from what is formally called unemployment: a separation from work sometime during the period of analysis, or underemployment: no separation from work, but $\underline{H} < H^0$. In this case the individual is forced, by labor market constraints, to consume more leisure than desired, $L^1 > L^0$, and actually achieves a lower level of utility on U^1 at (L^1,Y^1). This outcome, nonetheless, strictly dominates the alternative of not working at all and achieving satisfaction represented by U^2.

Continuing reference to Figure 2, it is also possible that an individual's choice set amounts to the "take-it" point, C, and the "leave-it" (refuse the job) point, B. This individual is indifferent between

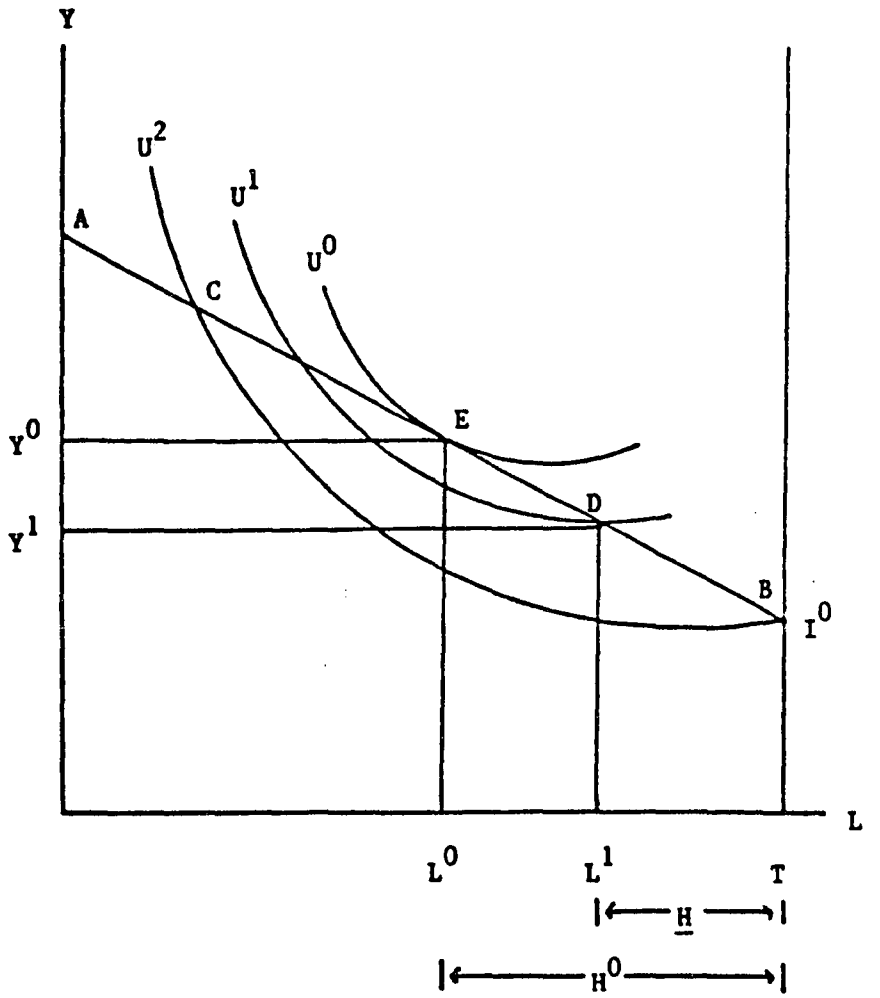

Figure 2. An Indifference Curve Representation of the Effect of Labor Market Rationing on an Individual Consumer-Worker

remaining out of the labor force and accepting the hours-income pair represented by point C. Should C be chosen, the result is suboptimal, and a condition of "overemployment" may be said to exist. Along with the full compensation estimates for the underemployed, some similar estimates for the overemployed are presented in Chapter 7.

While some writers have presented forcible "market" arguments in claiming that non-tangency points like (L^1,Y^1) and C are actually equilibrium states (see Killingsworth 1983, pp. 56-60 for a summary of this position), in the present analysis the traditional dis-equilibrium interpretation is adopted.

The analytic techniques required to investigate the effects of labor market constraints on consumer-worker behavior are formally similar to the methods used to evaluate the response to "straight rationing." Research on the effects of rationing began during World War II (Rothbarth 1940-41, Kaldor 1941, Nicholson 1942-43) and has continued to be popular (Tobin-Houthakker 1950-51, Pollack 1971, Neary and Roberts 1980). This literature details results germane to the current problem.

Perlman (1969) has provided an excellent survey of the original work on labor supply rationing. More recently, Ashenfelter (1980) developed a model of

household labor supply under rationing. This model has been applied by Blundell and Walker (1982), Deaton and Muellbauer (1981), Kneisner (1976), Parsons (1977), and Ransom (1982). Ham (1982) presented results based on a model of individual labor supply under rationing.

If a constraint is set on the quantity of labor services that an individual may sell at $H = \underline{H}$, the problem for the consumer-worker degenerates to: maximize

$$U = U(T-\underline{H}, Y), \tag{6}$$

subject to,

$$Y = w\underline{H} + I, \tag{7}$$

and

$$L = T - \underline{H}. \tag{8}$$

Assuming that desired hours of work do not equal the constrained level, i.e., $H(w,I) \neq \underline{H}$, solution of this problem yields:

$$L = T - \underline{H}, \tag{9}$$

leisure consumed, and

$$Y = Y(\underline{H}, w\underline{H} + I), \tag{10}$$

market goods demanded. Ashenfelter (1980, p. 550) has noted that this result for goods demand

> ... is apparently the basis for Clower's (1965) remark to the effect that Keynesian consumption functions, which do not distinguish between the effects of a consumer's wage and unearned income, are consistent with the usual model of consumer choice if the consumer-worker faces a constraint on labor supply.

In this constrained situation the level of satisfaction achieved by an individual is:

$$V^* = U(T - \underline{H}, Y(\underline{H}, w\underline{H} + I)) \qquad (11)$$
$$= \underline{V}(\underline{H}, I + w\underline{H}).$$

Equation (11) may be solved for the sum of non-labor income and exogenous earnings,

$$I + w\underline{H} = \underline{E}(\underline{H}, V^*), \qquad (12)$$

transposing exogenous labor income, the constrained excess-expenditure function,

$$I = \underline{E}(\underline{H}, V^*) - w\underline{H}, \qquad (13)$$

is obtained. These results are exploited in what follows.

Theoretical Approaches to Unemployment Compensation

Several theoretical approaches to approximating full unemployment compensation for an individual may be taken. Two methods to measure the welfare loss experienced by labor market constrained individuals are developed here. Variants of the first technique, which

are based on the work of Harberger (1971), have been employed by Ashenfelter (1980) and Hurd (1980), whose studies are the closest kin extant to the present research. A direct approach in the spirit of work by Rosen (1978), Hurd and Pencavel (1981), and Abowd and Ashenfelter (1981) is also taken. These two techniques provide the basis for generating comparative estimates of full unemployment compensation. The sensitivity of these estimates to functional specification is also investigated.

A Harberger Triangle Approach to Measuring Unemployment Compensation

Ashenfelter (1980), in the context of a household model where unemployment is treated as a rationing constraint, developed an approximation to a quantity which he refers to (Ashenfelter 1980, p.552) as the "lump-sum compensation required to restore the unemployed [rationed] worker's family to the welfare level of the fully employed family." This approximation is arrived at by taking a second-order Taylor Series approximation of the difference between the exogenous cost of achieving the unconstrained utility level in the presence of the ration and the cost of achieving the same level in the absence of any constraint, around the fully employed point. The result is "a conventional Harberger (1971) type triangle measure of welfare loss"

(Ashenfelter 1980, p. 553), which is applied to aggregate time series data.

Hurd (1980), who examined the cost of unemployment to the unemployed, used a hybrid of approximation and direct methods to examine the experience of respondents to the 1967 Survey of Economic Opportunity. He estimated the parameters of a Taylor Series approximation of the substitution effect of a wage change on hours of work, integrated to find the compensated labor supply function, solved for the utility constant wage acceptance locus by inversion, and then determined the required lump sum compensation to constrained individuals by evaluating the area under this locus between the actual (constrained) and fully employed levels of labor supply.

The idea behind this approach may be easily gleaned by examining Figure 3. The locus labeled H(w,V) is a Hicksian, or utility constant labor supply curve. The utility level around which this function is constructed, V, is that level which would be achieved at the individual's current market wage, w^0, if he were free to choose his hours of work. If this individual were constrained to work $\underline{H}$ hours, $\underline{H} < H^0$, at wage $\underline{w}$ and granted compensation equal to the triangular lined area to the left of H(w,V), he would be indifferent between this situation and the pair (H^0,w^0). Therefore, it is

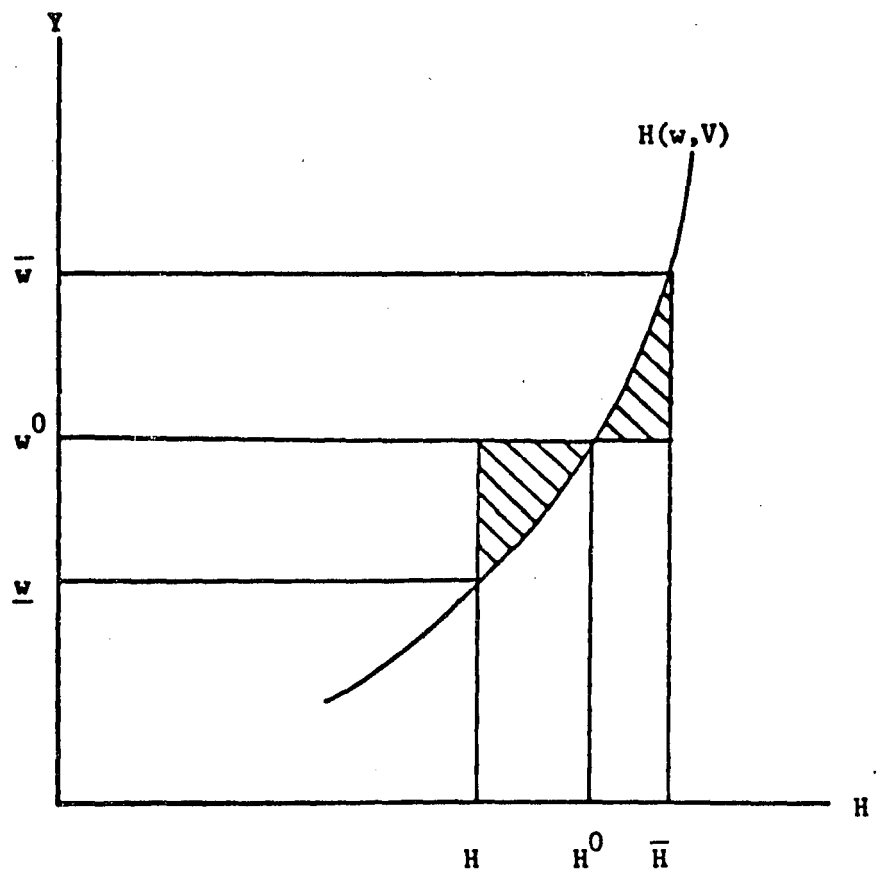

Figure 3. A Graphic Representation of Full Compensation via a Harberger Triangle Approximation

natural to use a triangle formula to estimate full unemployment compensation. Such an estimate will be best when the spell of unemployment is of short duration.

Continuing reference to Figure 3, if this individual were constrained to work $\bar{H}$ hours , $\bar{H} > H^0$, at wage w and granted compensation equal to the triangular crosshatched area to the right of H(w,V), he would be indifferent between this situation and the pair (H^0,w^0).

Analytic derivation of the triangle approximation to full unemployment compensation may be neatly achieved under the Tobin-Houthakker (1950-51) assumption that the ration just bites. Under this assumption, $H = H(w,V) = -E_w(w,V)$, and $V = V^*$. And the lump sum compensation can be stated as:

$$C(\underline{H}, w, V) = \underline{E}(\underline{H}, V) - w\underline{H} - E(w, V), \qquad (14)$$

The difference between the exogenous cost of achieving the unconstrained utility level in the presence and absence of a ration. The quantity may also be written:

$$C(\underline{H},w,V) = \underline{E}(-E_w(w, V), V) + wE_w(w, V) - E(w, V). \qquad (15)$$

Since it is assumed that $V = V^*$, $C(\cdot) \simeq 0$; differentiating (15) with respect to w establishes $\partial\underline{E}/\partial\underline{H} - w = 0$, and differentiating (15) a second time with respect to w yields $\partial^2\underline{E}/\partial\underline{H}^2 = 1/-E_{ww}$. Therefore, the second-order

Taylor Series approximation to C(·) around the fully employed point may be stated as:

$$C(\underline{H},w,V) \simeq (\partial \underline{E}/\partial \underline{H} - w)d\underline{H} + (1/2)(\partial^2 \underline{E}/\partial \underline{H}^2)(d\underline{H})^2$$
$$= (1/2)(d\underline{H})^2/-E_{ww}. \qquad (16)$$

And since $-E_{ww}$ is the first direct derivative of the compensated labor supply function, $-E_{ww} = S_{Hw}$, the utility constant effect of a wage change on labor supply, or the substitution effect of a wage change on labor supply. So that the approximation:

$$C(\underline{H}, w, V) \simeq (1/2)(d\underline{H})^2/S_{Hw} \qquad (17)$$

is simply one-half the squared duration of unemployment, $d\underline{H} = (H(w,I) - \underline{H})$, divided by the substitution effect (see Ashenfelter 1980, p.553).

The triangle approximation to full unemployment compensation (17) is convenient and likely to be quite accurate when the duration of unemployment is short, but properly the approximation is correct only when the ration is set at the level that the individual would choose in the absence of rationing. Furthermore, estimation of (17) requires not only knowledge of the degree of unemployment, but also an estimate of the substitution effect. The substitution effect is a concept which can only properly be discussed in the context of tangency equilibria. For a worker employed

at a "take-it or leave-it" offer, a wage change may be observed in association with no hours response.

A Direct Utility Based Approach to Unemployment Compensation

If the notion of a representative structure for individual preferences can be accepted, a method for directly evaluating the required compensation to an individual constrained in selling labor services is immediate. The method developed here is based on just such an assumption and is in the spirit of work by Rosen (1978), who examined the excess burden of income taxation; Hurd and Pencavel (1981), who evaluated various wage subsidy programs; and Abowd and Ashenfelter (1981), who examined compensating wage differentials.

An individual faced with a binding constraint on the hours that he may sell in the labor market at, say, $\underline{H} < H(w,I) = T - L(w,I)$, achieves a utility level less than that attainable in the absence of labor market rationing,

$$U(T - \underline{H}, w\underline{H} + I) < U(L(w, I), Y(w, I)), \qquad (18)$$

or in terms of the indirect utility function,

$$V^*(\underline{H}, w\underline{H} + I) < V(w, I). \qquad (19)$$

As Abowd and Ashenfelter (1981, p. 142) note, the present theoretical approach to unemployment has

"immediate normative implications for public policies regarding unemployment benefits or compensation." Simply stated, full unemployment compensation to an individual who is constrained in selling labor services is that lump sum grant, $\tilde{c}$, which solves:

$$U(T - \underline{H}, w\underline{H} + I + \tilde{c}) = U(L(w,I), Y(w, I)). \quad (20)$$

Stating this condition in terms of the indirect utility function,

$$V^*(\underline{H}, w\underline{H} + I + \tilde{c}) = V(w, I), \quad (21)$$

the nature of $\tilde{c}$ as a Hicksian equivalent variation is obvious. Paraphrasing Layard and Walters (1978, p. 151), $\tilde{c}$ is the amount of money we would need to give an individual who is constrained in the labor market to make him as well off as if he were employed at equilibrium hours. It is the compensation he would need to forego an opportunity to be employed at equilibrium hours.

The functional dependence of this compensation measure is obviously:

$$\tilde{c} = \tilde{c}(w, I, \underline{H}). \quad (22)$$

The concept of full compensation embodied in this approach may be easily understood by referring to the indifference curve analysis of Figure 4. An

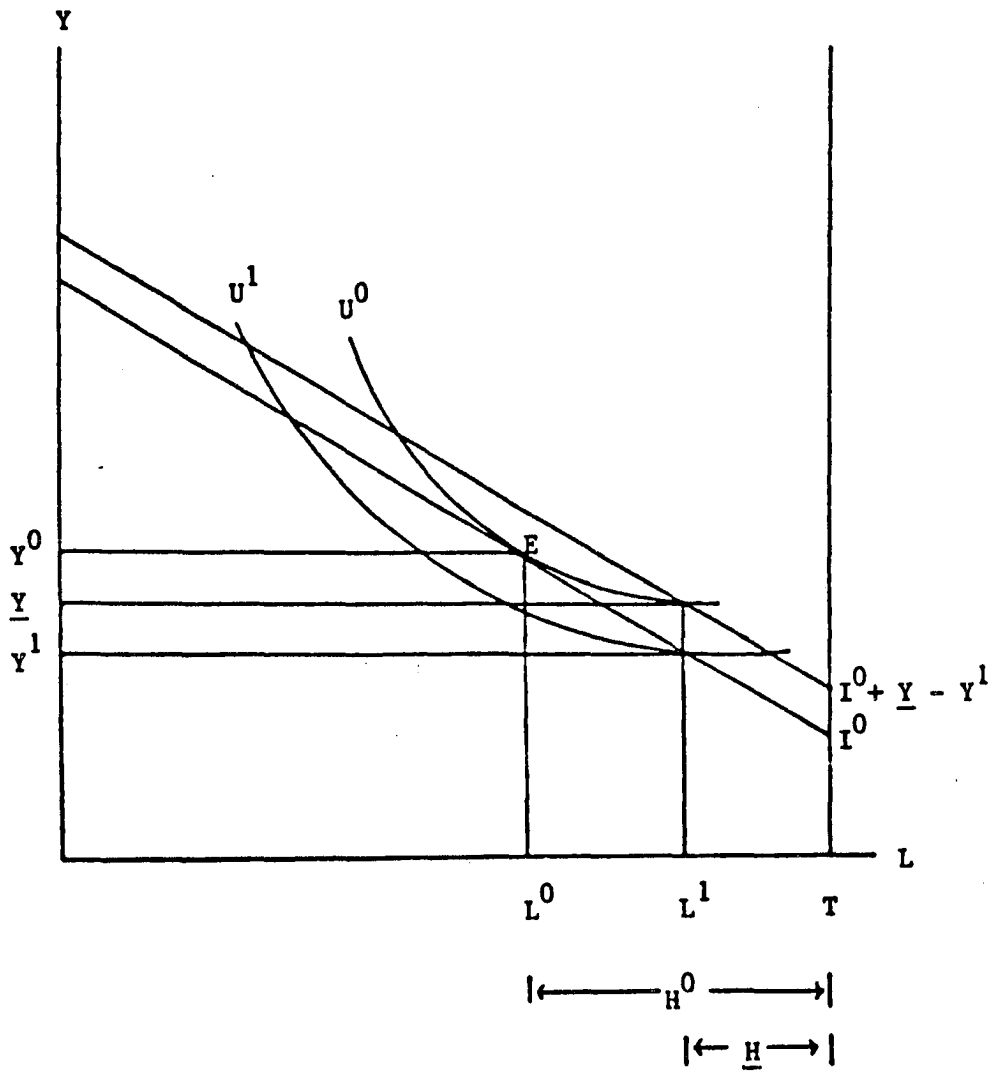

Figure 4. A Graphic Representation of Full Compensation for Underemployment via the Direct Method

unconstrained individual, with preferences as represented by the map of indifference curves on this diagram, would reach an unconstrained equilibrium on U^0 at (L^0,Y^0). If, for whatever reason, market opportunities allow sales of only $\underline{H} = T - L^1$ hours of labor services, a lower level of utility is reached on U^1 at (L^1,Y^1). While there is a hardship experienced as a result of the associated earnings loss $(Y^0 - Y^1)$, the utility loss is partly compensated by an increase in leisure, and the income required to fully compensate the constrained individual $(\underline{Y} - Y^1)$ is less than the earnings loss.

The direct method for measuring full compensation to a labor market constrained individual also applies to the case of overemployment. This idea is illustrated in Figure 5. As in the previous diagram, an unconstrained individual reaches equilibrium on U^0 at (L^0,Y^0). Overemployment at $\bar{H} = T - L^1$, $\bar{H} > H^0 = H(w,I)$, results in utility at the level U^1, $U^1 < U^0$. Labor earnings in excess of labor earnings at equilibrium, $(Y^1 - Y^0)$, are insufficient to compensate for the forced over-supply of labor. Labor earnings are insufficient in the amount $(\underline{Y} - Y^1)$, which amounts to full compensation in this case.

Given an explicit form of the direct utility function $U(L,Y)$, explicit parameterizations of the Marshallian labor supply, $H(w,I)$, and composite commodity

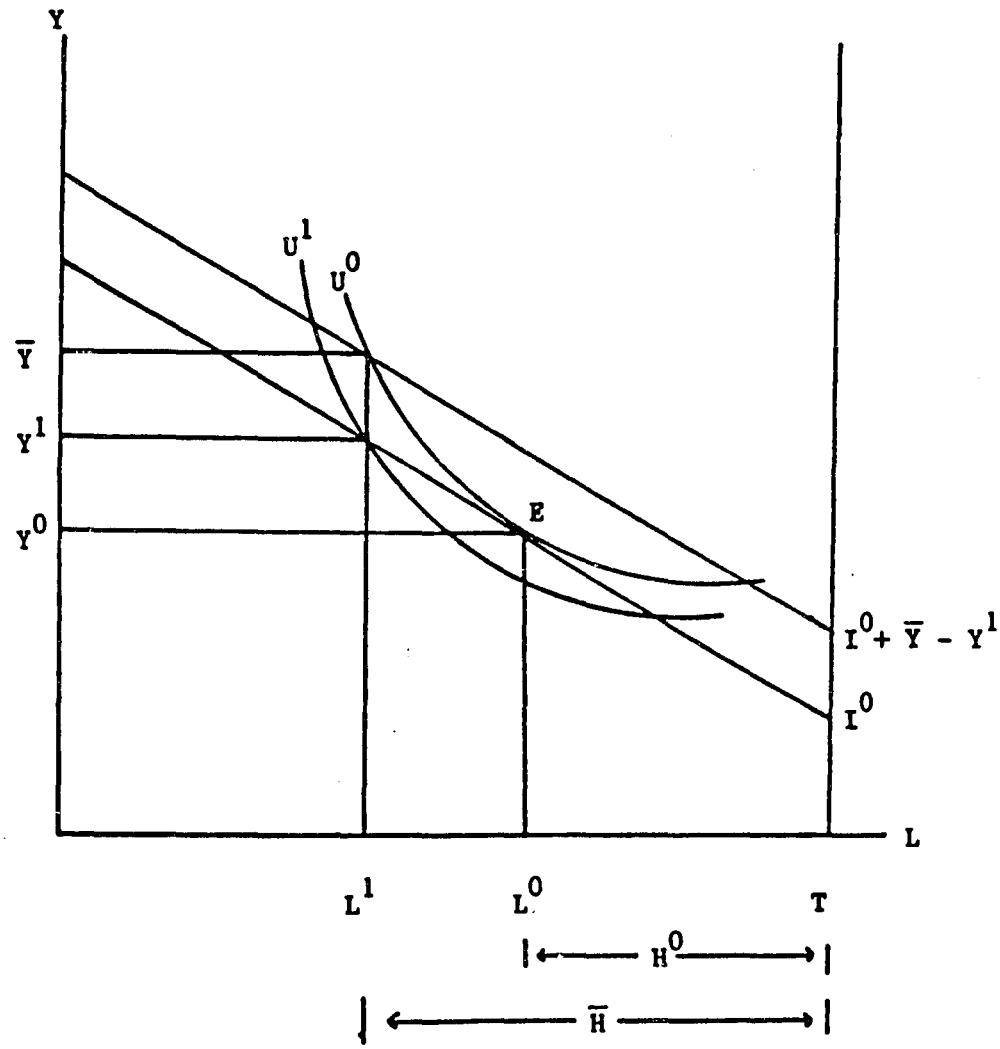

Figure 5. A Graphic Representation of Full Compensation for Overemployment via the Direct Method

demand, $Y(w,I)$, functions can be determined directly by maximizing $U(L,Y)$ subject to $Y = wH + I$. Since this is a simple two good model of consumer-worker behavior, given the adding up condition on neoclassical demand functions, the parameters of the utility function, the labor supply function, and the commodity demand function can all be determined by estimating the parameters of any one.

The approach taken here proceeds from the estimation of a representative labor supply function. Special care must be taken in this exercise, and the particulars of this problem are addressed in the next chapter. Assuming that estimation can be satisfactorily carried out, the estimates of the parameters of the system are determined and empirical labor supply, commodity demand, and utility functions can be written out.

With this information and the knowledge of the presence of labor market constraints, the lump sum compensation required to raise a rationed worker's utility to the level of an identical fully employed worker can be determined by evaluating an explicit parameterization of equation (22). To examine the sensitivity of the compensation estimates generated in this way, this exercise is carried out for four different explicit functional specifications. The basis for

this analysis is developed in the next chapter, but to make firm the approach, one particular case is worked out in detail here.

An example based on the Linear Expenditure System. While the compensation construct (22) is theoretically superior to (17) since it holds exactly even when constrained labor supply is significantly different from optimal hours, deriving an explicit closed form solution to (22) is not always an easy matter. One case where the problem is tractable is based on the Linear Expenditure System (LES) derived from the Stone-Geary utility function:

$$U(L,Y) = \alpha \ln(L - \gamma_1) + (1 - \alpha)\ln(Y - \gamma_2); 0 < \alpha < 1, \quad (23)$$

where the parameters α and $(1 - \alpha)$ are interpreted as marginal budget shares devoted to leisure and market goods, and γ_1 and γ_2 represent leisure and income origin translation parameters respectively. Maximizing (23) subject to the budget constraint (2′) yields leisure demand,

$$L = \gamma_1 + (\alpha/w)((wT + I) - w\gamma_1 - \gamma_2), \quad (24a)$$

or labor supply,

$$H = (T - \gamma_1) - (\alpha/w)(I + w(T - \gamma_1) - \gamma_2), \quad (24b)$$

and commodity demand,

$$Y = \gamma_2 + (1 - \alpha)((wT + I) - w\gamma_1 - \gamma_2), \qquad (24c)$$

functions. Given the adding up condition on neoclassical demand functions, the parameters of (24a) through (24c) can be determined by estimating the parameters of any one of the demand system equations. The particulars of this problem are discussed in Chapter 4. Denoting the estimated parameter values by the parameters themselves, substitution of (24a) and (24c) into the right-hand side of (20) yields the right-hand side of equation (21),

$$[T-\left(\frac{(1-\alpha)w(T-\gamma_1)-\alpha(I-\gamma_2)}{w}\right)-\gamma_2]\times [(1-\alpha)\{w(T-\gamma_1)+(I-\gamma_2)\}]^{(1-\alpha)} \qquad (25)$$

the indirect Stone geary utility function. For this case the left-hand side of (21) is:

$$(T - \underline{H} - \gamma_1)(w\underline{H} + I + \tilde{c} - \gamma_2)^{(1- a)} \qquad (26)$$

Equating (26) and (25) and solving for $\tilde{c}$ yields:

$$\tilde{c} = \gamma_2 - I - w\underline{H} + (1 - \alpha)\{w(T - \gamma_1) + (I - \gamma_2)\}\times \left(\frac{\alpha\{w(T - \gamma_1) + (I - \gamma_2)\}}{w(T - \underline{H} - \gamma_1)}\right)^{(\alpha/(1-\alpha))} \qquad (27)$$

a closed-form solution for full unemployment compensation when utility is Stone-Geary.

CHAPTER 4

METHODOLOGY AND FUNCTIONAL SPECIFICATION

As discussed in the previous chapter, the parameters of average representations of preference structures are to be determined in this study through the estimation of empirical labor supply functions. It is to this task that attention is now directed.

Estimating Labor Supply

Abbott and Ashenfelter (1976, p. 396) point out that the methods for specifying an empirical labor supply function which is faithful to the utility maximization hypothesis--i.e., satisfies the neoclassical restrictions: adding up, homogeneity, symmetry and negativity (negative semi-definite Slutsky matrix)--are basically three: (1) Specify an explicit indirect utility function and apply Roy's identity; (2) The Rotterdam approach, which uses restrictions from neoclassical demand theory to impose restrictions for estimation on a finite differential approximation of the commodity demand-labor supply system; and (3) The method used by Ashenfelter (1980) and the one used here, to specify an explicit form for the direct utility function

and solve the necessary maximum conditions for the commodity demand and labor supply functions.

Special attention must be given to the treatment of labor market constrained and unconstrained individuals in the econometric procedure. Ham (1980, 1982), Keeley (1981), and Killingsworth (1982) have provided reviews of previous empirical treatments of unemployed and underemployed workers in labor supply analysis. This discussion is examined here and the results are extended to the case where overemployment is also a possibility.

The traditional approach to labor supply estimation implicitly assumes that individuals are not constrained in their attempt to sell labor services. Rationale for such an approach is offered by papers in the Phelps (1970) volume. The results presented therein are connected by the "natural rate" of unemployment thesis, where unemployment is treated as a voluntary and transitory phenomenon. Lucas and Rapping (1970), for example, posit that unemployment is a form of leisure time. However, this approach, which assumes that actual hours are equal to desired hours may result in undesireable properties for the usual parameter estimators.

Consider the following empirical specification for desired labor supply:

$$H_i^d = H^d(w_i, I_i) + e_i, \qquad (28)$$

where $H^d(\cdot)$ summarizes the functional form of the labor supply function, the determinants of desired hours are the hourly wage rate, w_i, and non-labor income, I_i, and e_i is an error term which satisfies the usual least squares assumptions. Given data on H, w, and I, and a form of $H^d(\cdot)$ linear in the parameters, the relation could be estimated by Ordinary Least Squares (OLS). Killingsworth (1982) labels this the procedure of "first generation" studies of labor supply. Potential problems are suggested when it is observed that reported data on actual hours, H_i^a, is not always equal to the theoretical concept of desired hours. Noting this fact, (28) could be stated in terms of observables as:

$$H_i^a = H^d(w_i, I_i) + H_i^a - H_i^d + e_i \ , \tag{29}$$

or,

$$H_i^a = H^d(w_i, I_i) + v_i, \tag{30}$$

where $v_i = H_i^a - H_i^d + e_i$. Taking expectations yields: $E(v_i) = E(H_i^a - H_i^d) + E(e_i)$, and since by assumption $E(e_i) = 0$, if $E(H_i^a - H_i^d) = 0$, and if $(H_i^a - H_i^d)$ is uncorrelated with w_i and I_i, least squares estimation of equation (30) is appropriate.

It is unlikely, however, that the incidence and degree of overemployment will, on average, cancel out the affect of underemployment. More importantly, if the

determinants of labor supply are correlated with the degree of labor market constraint, least squares parameter estimators will be inconsistent and biased in an unknown way. For example, if underemployed individuals are likely to have low wages and non-labor income, "first generation" estimators are biased and inconsistent.

Several approaches to estimating labor supply, which explicitly recognize the existence of constraints on the ability of an individual to sell labor services, have been taken. The simplest of these approaches is to remove constrained individuals from the sample. This has been done by Wales and Woodland (1976, 1977) who removed the underemployed; and DaVanzo, DeTray, and Greenberg (1976), who removed unemployed individuals from their sample for analysis. However, as Heckman (1976, 1979) has pointed out, such censoring of the sample will lead to inconsistent parameter estimates if the probability of being constrained is correlated with the error term and the independent variables of the empirical labor supply specification. As suggested above, the correlation is likely to exist. Furthermore, this technique does not capture all potential labor market constraints, since hours of work can still differ from the desired level in the absence of an actual separation from work.

Another approach to dealing with labor supply constraints, which has been used by Garfinkel (1973), Hurd (1976), Greenberg and Kosters (1973), Cohen et al. (1970), and Masters and Garfinkel (1977), is to transform the labor supply measure (the dependent variable in an empirical labor supply specification) by adding hours unemployed to hours actually worked. Such a transformation, however, leads to bias, since while individuals below their equilibrium hours have their hours adjusted upward, there is no corresponding downward adjustment for individuals who are overemployed. Other transformations of the dependent variable, some of which have been explicitly designed to address this issue of constraints, have also been used. The experience with this approach is discussed further in the next chapter on data and variables.

Rea (1974) and Kalachek, Mellow and Raines (1978) independently proposed a method for dealing with individuals who experience an exogenously determined spell of unemployment. Their procedure relies on the assumption that desired hours equal some fraction, θ, of unemployed hours, U_i, in addition to actual hours,

$$H_i^d = \theta U_i + H_i^a. \tag{31}$$

The procedure is to regress actual hours on determinants of labor supply and an individual's unemployed hours,

$$H_i^a = H^d(w_i, I_i) + \theta U_i + e_i. \qquad (32)$$

This method, however, is subject to all of the biases discussed above, since the problems of under- and over-employment are not addressed. It constrains θ to be the same for all workers. Also, if the incidence and duration of unemployment are correlated with the determinants of labor supply and the error term in (32), simultaneous equations bias is present and the parameter estimates will be inconsistent.

Ham (1980) developed a Tobit scheme to estimate the parameters of a linear labor supply function under the assumption that employed, rather than unemployed, hours are exogenous for constrained workers. This approach is adopted here since it provides a way to capture the effect of both the existence and degree of any labor market constraint in the estimation process. Furthermore, the maximum likelihood (ML) method adopted provides consistent, asymptotically unbiased, and asymptotically efficient parameter estimates, under the assumption of employment constraints.

In this study a worker will be treated as constrained in the labor market if he is either unemployed, underemployed, or overemployed. For this case, if employed hours are exogenous, the modified Tobit (see Tobin 1958) technique used by Ham (1977) may be applied.

This is an application of the two-limit Tobit method discussed in Maddala (1985).

In the present application, unlike in Ham (1980, 1982), no distinction is made between underemployment (working less than desired hours with no separation from work) and unemployment (working fewer than desired days because of a separation from work). Such a distinction is best treated in a model of hours and weeks of labor supply as developed in Hanoch (1980a) and Ham and Hsiao (1985).

To form the Tobit likelihood function, again, denote actual hours of labor supply by H_i^a, and desired hours of labor supply, H_i^d. And assume that e_i in the empirical labor supply specification, $H_i^d = H^d(w_i, I_i) + e_i$, is a normally distributed mean zero error term with distribution function $F(\cdot)$ and density function $f(\cdot)$. For present purposes, suppose that a method exists to partition a set of data on S individuals into three mutually exclusive and exhaustive subsets: S_1 which contains observations on those individuals who are not constrained ($H_i^d = H_i^a$); S_2, which contains those who experience underemployment or unemployment ($H_i^d > H_i^a$); and S_3, which contains observations on those workers who are classified as being overemployed ($H_i^d < H_i^a$). Subtracting H_i^a from both sides of (28) yields:

$$H_i^d - H_i^a = H^d(w_i, I_i) - H_i^a + e_i. \qquad (33)$$

It may easily be seen that when desired hours are worked,

$$H_i^d - H_i^a = 0 \Rightarrow H^d(w_i, I_i) - H_i^a = -e_i, \qquad (34a)$$

and when underemployment is experienced,

$$H_i^d - H_i^a > 0 \Rightarrow H^d(w_i, I_i) - H_i^a > -e_i, \qquad (34b)$$

and when overemployment is experienced,

$$H_i^d - H_i^a < 0 \Rightarrow H^d(w_i, I_i) - H_i^a < -e_i. \qquad (34c)$$

Multiplying through (34a - 34c) by (-1) the probabilities of equilibrium, under-employment and overemployment may be stated respectively as:

$$\text{Prob}(H_i^a - H^d(w_i, I_i) = e_i) = f(H_i^a - H^d(w_i, I_i)), \qquad (35a)$$

$$\text{Prob}(H_i^a - H^d(w_i, I_i) < e_i) = 1 - F(H_i^a - H^d(w_i, I_i)), \qquad (35b)$$

$$\text{Prob}(H_i^a - H^d(w_i, I_i) > e_i) = F(H_i^a - H^d(w_i, I_i)). \qquad (35c)$$

The Tobit likelihood function for a given sample is stated in terms of standardized variates. Since the error term is assumed to have a mean of zero, $E(e_i) = 0$, denoting the standard error of the equation σ, the likelihood function may be stated as:

$$L = \prod_{i \subset S_1} (1/\sigma)\{f[(H_i^a - H^d(w_i, I_i))/\sigma]\} \times$$
$$\prod_{i \subset S_2} \{1 - F[(H_i^a - H^d(w_i, I_i))/\sigma]\} \times \qquad (36)$$
$$\prod_{i \subset S_3} \{F[(H_i^a - H^d(w_i, I_i))/\sigma]\},$$

which may be interpreted as the probability of observing the constraint mix which appears in a given sample.

In the absence of labor market rationing, the likelihood function reduces to the product of the first term evaluated at all observations in the sample. And for $f(\cdot)$ normal this is equivalent to ordinary least squares. In the present case, however, since the normal equations are non-linear, labor supply parameter estimates must be found by some iterative routine. Paraphrasing Goldberger (1964, p. 130), the population with the set of Maximum Likelihood (ML) parameter estimates would generate the given sample with a higher probability than would a population with any other set of parameter estimates.

The ML parameter estimates are generated on the Control Data Cyber 175 mainframe computer at the University of Arizona using the Davidon-Fletcher-Powell (DFP) algorithm in the GQOPT (see Goldfeld and Quandt 1972) non-linear optimization program written by Stephen Goldfeld and Richard Quandt at Princeton University. Maddala (1985, pp. 157-8) has demonstrated that

> the likelihood function for the [standard] Tobit model has a single maximum. Thus, no matter what the starting value, as long as the iterative process is continued to a solution, that solution will be the global maximum of the likelihood function. Also, as proved by Amemiya (1973), this estimator is consistent.

Concavity of the likelihood function is also guaranteed in the present case when $H^d(w_i, I_i)$ is linear in the parameters (see Maddala 1985, p.161). An empirical search for a global maximum is undertaken for each case considered here.

Ultimately, a sensitivity analysis of compensation estimates to the choice of preference structure will be carried out. Sets of compensation estimates for the triangle approximation and direct formulae will be generated by assuming various preference structures.

In the next section of this chapter the labor supply specification associated with each utility function is laid out. These parameterizations are the vehicle for estimating the utility function parameters; they give explicit form to $H^d(w_i, I_i)$ in equation (36). In some cases, appropriate transformation of the predictors in the empirical labor supply equation allows ordinary least squares (OLS) estimation of the parameters. For these cases an evaluation of OLS parameter estimate bias and efficiency vis-á-vis ML is undertaken.

Labor Supply Specifications

As discussed in the previous chapter, given an explicit form for the direct utility function, U(L,Y), an explicit parameterization of the labor supply function, H(w,I), can be determined by maximizing U(L,Y), subject to the constraint, Y = wH + I. Furthermore, the adding-up condition on neoclassical demand functions guarantees that in this two-good case estimates of all parameters of the commodity demand-labor supply system can be found by estimating the parameters of the labor supply function. And related to the present application, Barten (1969) demonstrated that maximum likelihood estimates of a commodity demand system are independent of the equation omitted during estimation.

In this section the foundation for an analysis of the sensitivity of compensation estimates to functional specification is developed. Explicit forms for four distinct, but related U(L,Y) and the associated H(w,I) are stated and discussed.

Many of the popular explicit forms for the direct utility function used in empirical work are some type of a generalization of the familiar homothetic and linearly homogenous Cobb-Douglas form:

$$U(L, Y; \alpha) = L^{\alpha}Y^{1-\alpha} \; ; \quad 0 < \alpha < 1. \tag{37}$$

This form was first stated in 1901 by Wicksell (see Wicksell 1928) and tested by Cobb and Douglas (1928) in the production context. By maximizing (37) subject to the budget constraint, $Y = wH + I$, and solving the necessary conditions, the associated labor supply function is found to be:

$$H = T(1 - \alpha) - \alpha(I/w). \tag{38}$$

Recalling that $T = H + L$, it may be seen from (38) that $\alpha = [wL/(wT + I)]$, that is, α is the budget share of full income devoted to leisure. Similarly substituting from the budget equation, $(1 - \alpha) = [Y/(wT + I)]$, $(1 - \alpha)$ is the budget share of full income devoted to market goods. By requiring $0 < \alpha < 1$, linear homogeneity is imposed.

While a generalized form of (38) has been reasonably estimated by Wales (1978), (38) is not a satisfactory parameterization of labor supply. Since $0 < \alpha < 1$ and $\partial H/\partial w = (\alpha I/w^2)$, it is the case that Cournot wage effects are necessarily positive. Nonetheless, empirical results will be presented for this case. It is also easy to demonstrate a more general view of the present estimation procedure using the Cobb-Douglas specification.

The usual approach to operationalizing a labor supply specification such as (38), which is derived from

an explicit utility function, is to tack on an additive random error term. This procedure is rationalized by noting that labor supply differs across individuals with the same w and I due to unobservable "taste" factors. Since taste differences formally mean preference differences, a random utility approach, where the random element is incorporated at the initial stage, is appropriate.

Substituting from the budget, $Y = wH + I$, and time, $T = H + L$, constraints into (37), and noting that H randomly differs across individuals with the same w and I yields,

$$U(L, Y; \alpha, e) = [T - (H - e)]^{\alpha} [w(H - e) + I]^{1-\alpha}, \quad (39)$$

the Cobb-Douglas random utility function, where -e denotes the random difference in hours.

Killingsworth (1982) identifies the unifying characteristic of "second generation" labor supply studies to be the integral treatment of the labor force participation decision. The marginal rate of substitution function implied by (39) is:

$$MRS_{LY} = (\partial U/\partial L)/(\partial U/\partial Y)$$
$$= [\alpha/(1 - \alpha)][w(H - e) + I]/[T - (H - e)]. \quad (40)$$

The reservation wage which is the slope of the indifference curve at I where H = 0 is from (40):

$$w^* = [\alpha/(1 - \alpha)][I - we]/[T + e]. \qquad (41)$$

By definition of the reservation wage, an individual will work if the market wage exceeds the reservation wage, $w > w^*$. This condition is satisfied if:

$$-e < (1 - \alpha)T - \alpha(I/w). \qquad (42)$$

And assuming preferences to be represented by (39):

$$H > 0 \quad \text{iff} \quad -e < (1 - \alpha)T - \alpha(I/w) \qquad (43a)$$

$$H \leq 0 \quad \text{iff} \quad -e \geq (1 - \alpha)T - \alpha(I/w) \qquad (43b)$$

When (43a) holds hours of work are given by setting $w = MRS_{LY}$ in (40), and solving for H. This exercise yields:

$$H = (1 - \alpha)T - \alpha(I/w) + e, \qquad (44)$$

which is the empirical analogue to (38), the Cobb-Douglas labor supply parameterization. From this the likelihood function (36) may be formed.

The second explicit functional form considered is free of the Cobb-Douglas restriction that the uncompensated labor supply curve be positively sloped. It is restricted to be homothetic only from a vector (γ_1, γ_2) in leisure-goods space (indeed, it is Cobb-Douglas from that point); it is, in general, nonhomothetic. It is the basis for the Linear Expenditure System (LES), which provides an example in Chapter 3, and is

usually referred to as the Stone-Geary utility function:

$$U(L,Y;\ \alpha,\ \gamma_1,\ \gamma_2) = \alpha\ln(L - \gamma_1) + (1-\alpha)\ln(Y - \gamma_2), \quad (45)$$

where the parameters α and $(1 - \alpha)$ are interpreted as marginal budget shares devoted to leisure and market goods ($0 < \alpha < 1$), and γ_1 and γ_2 may be interpreted as subsistence requirements for leisure and market goods, though γ_1 and γ_2 need not be positive. The associated labor supply parameterization is:

$$H = (1 - \alpha)(T - \gamma_1) - \alpha(I/w) + \alpha\gamma_2(1/w) \quad (46)$$

The LES is exhaustively reviewed in a justly famous monograph by Goldberger (1967), and was first estimated in the present two-good labor supply context by Leuthold (1968). The theoretical roots of this specification are the work of Klein and Rubin (1947), Samuelson (1947) and Geary (1949), an early application is Stone (1954).

The third specification examined is based on the Constant Elasticity of Substitution (CES) utility function. The CES was first written in the production context by Solow (1956) and empirically tested by Arrow, Chenery, Minhas, and Solow (1961). Properties of the CES utility function are reviewed by Brems (1968). It is applied to the work-leisure choice problem by Layard and Walters (1978). In the present notation the CES utility function is written:

$$U(L, Y; \alpha, \rho) = [\alpha(L)^{-\rho} + (1 - \alpha)(Y)^{-\rho}]^{(-1/\rho)}, \qquad (47)$$

where, $0 < \alpha < 1$, and $-1 < \rho < 0$ or $0 < \rho$, and $\rho \neq 0$. When the CES form is used in the production context α is interpreted as the distribution parameter; however, in the utility context, while α is related to the non-constant budget shares, no general interpretation is immediate. The parameter ρ, which is referred to as the substitution parameter, is related to the elasticity of substitution, σ, in the following way: $\sigma = [1/(1 + \rho)]$. The restrictions on ρ guarantee strictly convex indifference curves. While (47) is homogeneous of degree one, due to the numerator in the exponent $(-1/\rho)$ being set to minus one, and homothetic, it is a generalization of the Cobb-Douglas form since $\sigma = 1$ is not imposed. That is to say, the substitution parameter ρ is not restricted in estimation.

Maximizing (47) subject to (2′) and solving the necessary conditions yields the CES labor supply parameterization:

$$H(w, I; \delta, \sigma) = [\delta(w)^{\sigma}T - I]/[\delta(w)^{\sigma} + w], \qquad (48)$$

where $\sigma = [1/(1 + \rho)]$, and $\delta = [(1 - \alpha)/\alpha]^{\sigma}$. This expression may also be incorporated into (36) for estimation.

Inspection reveals the Cobb-Douglas (38) and the Stone-Geary (46) labor supply functions to be linear in

the parameters. Therefore, appropriate transformation of the predictors allows ordinary least squares (OLS) estimation. The CES labor supply specification (48) is obviously non-linear in the parameters; however, from the necessary conditions for a utility maximum,

$$[(wH + I)/(T - H)] = \delta(w)^{\sigma} \qquad (49)$$

may be written. The natural logarithm of (49) is linear in the parameters and may be estimated by OLS. Results from ordinary least squares estimation of these specifications will be presented for comparison purposes.

The principal generalization noted in moving from the Cobb-Douglas to the Stone-Geary utility function was the relaxation of homotheticity. This was achieved by a linear translation of the origin, to a new point (γ_1, γ_2) sometimes called the subsistence vector. Sato (1977) has discussed a generalized non-homotheticity coefficient for the Cobb-Douglas and the CES cases. Unfortunately, in this generalized case, no convenient interpretation for the non-constant non-homotheticity parameter exists. The fourth functional form considered here is a non-homothetic version of the CES. The generalization is achieved in the same fashion as the Stone-Geary (from the Cobb-Douglas), linear translation of the origin. The utility function:

$$U(L,Y;\alpha,\rho,\gamma_1,\gamma_2) = [\alpha(L-\gamma_1)^{-\rho}+(1-\alpha)(Y-\gamma_2)^{-\rho}]^{(-1/\rho)}, \qquad (50)$$

is therefore referred to here as the Stone-Geary Generalized Constant Elasticity of Substitution (SG-CES) utility function. It is also a simple version of the S-branch utility tree used by Barnett (1980). It was first proposed by Brown and Heien (1972) as a generalization of the linear expenditure system. The parameter restrictions stated above ($0 < \alpha < 1$, $-1 < \rho$, $\rho \neq 0$) apply. The function (50) is non-homothetic, homogenous of degree one, and exhibits constant elasticity of substitution, $\sigma = [1/(1 + \rho)]$.

The labor supply function found by maximizing (50) subject to (2′) and solving the necessary conditions is:

$$H(w,I;\delta,\sigma,\gamma_1,\gamma_2) = [\delta(w)^{\sigma}(T-\gamma_1)-I-\gamma_2]/[\delta(w)^{\sigma}+w]. \qquad (51)$$

Unfortunately, for comparison purposes, the parameters of this expression cannot be estimated by linear methods.

Four parameterizations have been presented; they are Cobb-Douglas (CD), Stone-Geary (SG), Constant Elasticity of Substitution (CES), and Stone-Geary Generalized Constant Elasticity of Substitution (SG-CES). Certain parameters are common to all forms, and the various forms amount to incremental generalizations of one another. The set of four forms is well suited for an analysis of sensitivity to specification.

Conspicuous by their absence from this list of four is any of the popular "flexible functional forms" for the utility function of the type popularized by Christensen, Jorgenson, and Lau (1975), and Blackorby, Primont, and Russell (1978). However, Erwin Diewert's remark to Hausman (1981, p. 667) that "three independent parameters are needed...in the two good case...for the [labor supply] specification [to] correspond to a flexible functional form for the underlying preferences," is comforting. Certainly (51) satisfies this criterion.

CHAPTER 5

THE DATA, VARIABLES, AND SAMPLE

In this chapter the rationale for selecting the particular data set used, the problems associated with defining empirical proxies for the theoretical variables, and the reasoning used to arrive at the sample analyzed are all discussed. These interrelated issues, which lie at the core of empirical method, must be faced squarely if the output of the exercise is to have any value.

The Panel Study of Income Dynamics Data

The Panel Study of Income Dynamics (PSID) has been conducted by the Survey Research Center (SRC) of the Institute for Social Research (ISR) at the University of Michigan each Spring since 1968. Principal funding for the PSID has been provided to the ISR by the Office of Economic Opportunity, the Urban Institute, the National Science Foundation, and the U.S. Department of Health and Human Services. The focus of the PSID is to gather information on short-run changes in the economic status of American households. The study used personal interviews with heads of households as its major data

collection technique. Volume I of A Panel Study of Income Dynamics (Institute for Social Research 1972) describes the early history of the study and details basic procedures that are common to all years of interviewing; a brief summary of the salient features follows.

About 40 percent of the households interviewed by the SRC in 1968 bad been interviewed in 1966 and 1967 by the Bureau of the Census as part of the Survey of Economic Opportunity (SEO). Since the SEO concentrated on low-income families, a cross section of sample dwellings in the United States was added to the above sample so that families at all income levels were represented. The supplementary dwellings were selected from the SRC's master sampling frame (see Kish and Hess 1964). In 1968, interviews were taken with 4802 families, 1872 from the SEO selection frame and 2930 from the SRC sampling frame. Since that first year the sample has increased because of new family formation and decreased because of non-response loss. The first five waves of interviews were conducted face-to-face and lasted about an hour. The fifteenth wave, which contains the most recent data to be made generally available, was principally conducted by telephone interview. The average length of interviews conducted during 1982 was 20.8 minutes. Respondents were paid $10.00 for

an interview, and $5.00 for returning an address correction postcard. During this survey PSID workers gathered data on respondents from the District of Columbia and all states except Vermont.

Wave XV of the PSID, collected in the Spring of 1982, describes respondent behavior during 1981. A sample from this data is used in the present study. In 1982, survey workers conducted 6,742 interviews out of 6,919 households selected for an overall response rate of 97.4 percent. The sample analyzed in this study was culled from the 6,742 to arrive at a sub-sample of respondents with characteristics which correspond to the model of individual consumer-worker behavior developed in Chapter 3. Particulars of the sample composition are discussed below, but first guideposts for this process are discussed. The correspondence between empirical measures and theoretical concepts is now reviewed.

The Variables

When any theoretical relation in economics is to be investigated empirically the obvious questions are: what is the appropriate functional specification, and what is the appropriate estimating scheme? A proper answer to these questions naturally depends on more basic considerations. While the variables to be included in the relation and the likely interdependence among them is suggested by theory, the quality of the

data available and the correspondence between the measures which can be constructed from the data and the theoretical variables often largely determine the appropriate statistical methodology.

In this section the theoretical basis for identifying the variables relevant to the estimation of labor supply functions from survey data is briefly reviewed.

As in nearly all empirical investigations of labor supply behavior, the theoretical model which forms the basis for the present empirical work is a static one. In such a model the conceptual measure of labor supply is desired lifetime hours of work, with the associated determinants--the net wage rate and initial wealth--also being lifetime variables. As is typical of empirical analyses based on the one-period model, the data to be used in the current research summarized the behavior of individuals in the sample over only a single year. Justification for applying the one-period model to cross section data gathered at a point in time has been provided by Hanoch (1980a) in his analysis of the variation in hours per week and weeks per year. Hanoch's analysis is based on the view that leisure on working days is a commodity distinct from leisure on non-working days. He shows that in an environment where opportunities for transforming leisure into income are

not restricted by institutional factors both types of leisure have the same (implicit) price, and therefore aggregate hours of labor service offered per year is a reasonable proxy for lifetime hours.

The principal variables in the analysis, desired hours of labor supply, the net wage rate, and exogenous income are now considered individually. At various points reference is made to the estimation strategy developed in the previous chapter, and the Panel Study of Income Dynamics (PSID) data which will be used.

Hours

Several different measures of the dependent variable have been used in the various empirical labor supply studies undertaken over the past twenty years. Cain and Watts (1973) alone document the use of eighteen different measures. The wide array of measures used has resulted from the variety of information available in the samples used as well as the differing objectives of the various studies.

Ideally the measure of labor supply which should be used when estimating the parameters of an empirical labor supply function using annual survey data is desired hours per year. However, due to the presence of disequilibrium (rationing constraints) in the labor market, even ignoring measurement error, reported hours may not actually equal desired hours. Unless the

deviation of desired hours from reported hours is random and uncorrelated with the independent variables, when reported hours are used as the dependent variable in an empirical labor supply function, OLS provides biased and inconsistent estimators of the parameter values.

As discussed above, some researchers (Cohen et al. 1970, Greenberg and Kosters 1973, Garfinkel 1973, Hurd 1976, and Masters and Garfinkel 1977) have addressed the issue of labor market disequilibrium by constructing a measure of desired hours by adding reported hours of unemployment (usual hours per week multiplied by weeks of unemployment) to reported hours of work. However, since no corresponding downward adjustment is made for workers who are overemployed, the OLS estimator of labor supply parameters remains biased and inconsistent.

Sample selectivity bias of the type discussed by Hanoch (1980b) is present in nearly all labor supply studies (Kalacheck and Raines 1970, Parker 1971, Rosen and Welch 1971, and Greenberg and Kosters 1973) which use survey data, because of the way that the hours data is solicited. Hours worked per year must be calculated as the product of survey week hours worked and weeks worked per year for many of the popular data sets (the Survey of Economic Opportunity, the Current Population Survey, and the Census data). Since individuals with

low annual hours of work are most likely to report zero survey week hours of work, such individuals are likely to be excluded from the sample analyzed.

Masters and Garfinkel (1977) attempted to avoid this sample selection problem by measuring desired hours as the product of twenty times weeks worked per year for part-time workers and forty times weeks worked per year for full-time workers. However, since this procedure significantly reduces the variance of the hours distribution it is likely to cause bias in estimation. Fortunately, in the data set to be used, the PSID, survey-week selectivity bias is not a concern since respondents are asked to report the "usual" number of hours worked per week and the "usual" number of weeks worked per year.

Even though usual hours of work are reported in the data set to be used here, these hours are not necessarily equal to desired hours. If individuals questioned in a survey give a "correct estimate" of the degree to which they are constrained in supplying labor, the data may be adjusted and ordinary least squares may be used to estimate the parameters of the labor supply function on the full sample. A respondent's "estimate" of desired hours is available to a limited extent in some surveys (e.g., the 1977 Quality of Employment Survey; see Quinn and Staines 1979). However, it is

unclear exactly what individuals have in mind when responding to questions about how much they would like to work. Do they presume their current wage would prevail, or that some premium rate would apply? Do they mean with regard to their primary job, or something else?

In Wave XV of the PSID qualitative information is available on the presence of labor supply constraints. Figure 6 summarizes how the raw data were used to assign a respondent to one of three constraint regimes: in equilibrium or working desired hours (EQ), unemployed (underemployed) or working fewer than desired hours (UN), and overemployed or working more than desired hours (OV). Using this information on the presence of constraints, and the data on usual hours, the maximum likelihood method discussed in Chapter 4 is used to generate consistent labor supply parameter estimates.

The Wage Rate

The appropriate measure of wages to use in estimating a labor supply function over annual survey data is an exogenous, hourly marginal wage rate net of taxes, because it is to variations in this quantity that the individual adjusts his hours on the margin. Several problems arise when attempting to form this quantity from the information available in the typical sample.

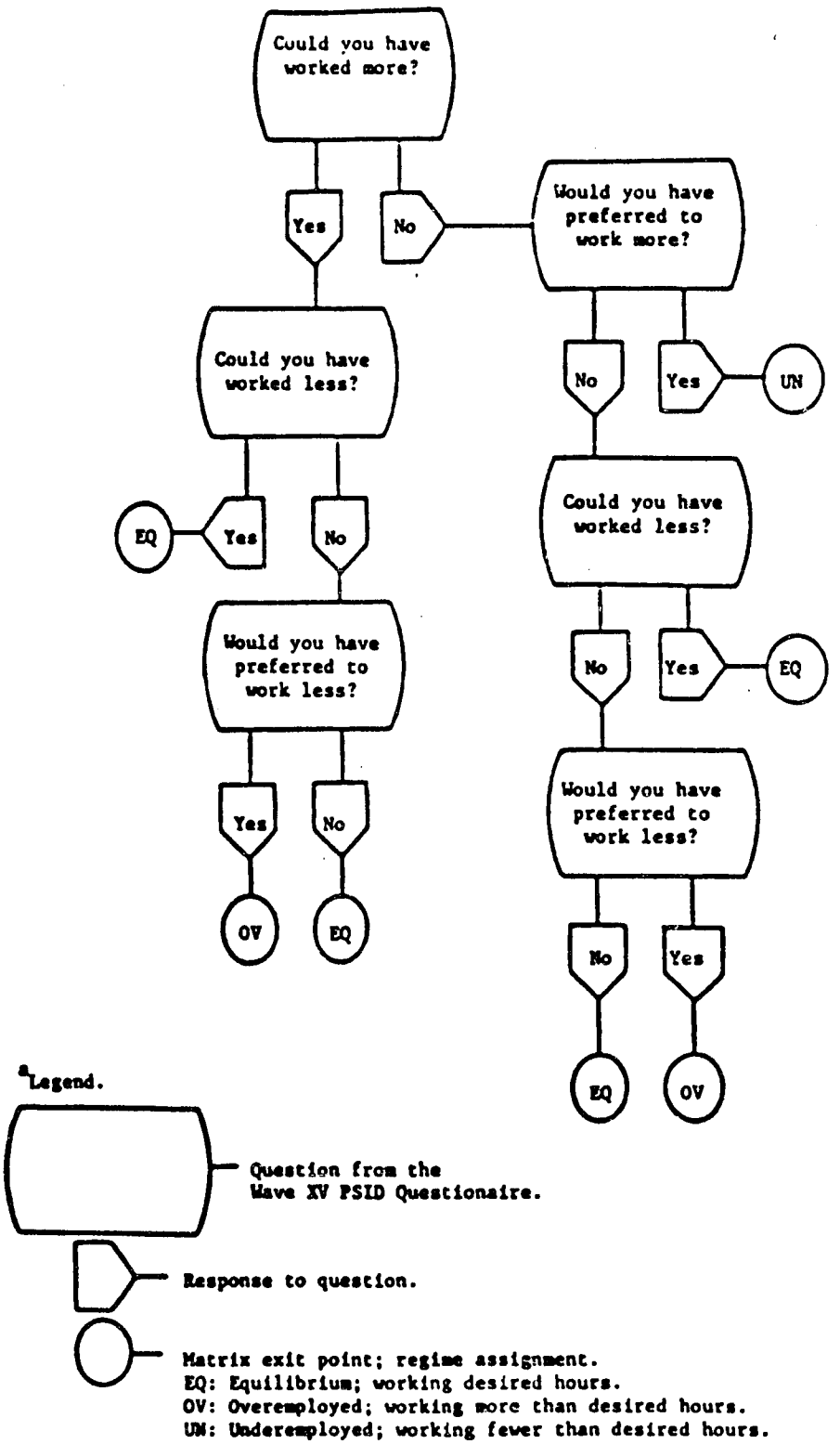

Figure 6. A Matrix for Respondent Constraint Regime Assignment[a]

The principle problems and steps taken to overcome these problems are briefly discussed here.

In many of the previous empirical studies of labor supply the wage and hours measures are definitionally related, the wage rate being defined as some measure of earnings divided by hours worked. Therefore, the wage rate is likely to be highly correlated with the error term in the labor supply equation. Fortunately, in the PSID separate questions are used to solicit information on wages and hours. While a proportional relationship between the wage and labor earnings still remains if the wage rate is constant throughout the year, this independent measure of wages is strictly preferable to one imputed from total earned income.

Since the individual is assumed to adjust his hours offered in response to changes in his net marginal wage rate, taxes must be explicitly considered. Hall (1973), Boskin (1973), Kurz et al. (1974), Hurd (1976), Rosen (1976), and Wales and Woodland (1979), have all addressed this issue, but in each of the above cases shortcomings remain. Since all data used in this study are for 1981, the hourly wage-rate measure used is one adjusted by the appropriate marginal tax rate. These tax rates are generated for each individual by a computer program run at the Survey Research Center (see

A Panel Study of Income Dynamics, Wave XIII, Institute for Social Research 1981, pp. 83-88).

The problem of unobserved wage rates for survey week non-workers has often been treated by simply estimating the labor supply equation on a truncated sample. Since this problem is a pervasive one in the analysis of female labor supply (see the papers in Smith 1980), the solution is found in that literature. Since usually the sample is not truncated but rather censored (information is available on most but not all variables for each observation), the method developed by Heckman (1974, 1976, 1979) to address exactly this problem, is appropriate. Fortunately, for the sample analyzed here the unobserved wage is not a serious problem. This is discussed below where the sample selection process is reviewed.

Non-wage Income

While the theoretical income variable in the labor supply equation is exogenous initial wealth, something like inherited wealth, most researchers have used a proxy defined as the current income flow from the stock of wealth. Since current wealth depends on past savings, and therefore past labor supply behavior, which is likely to be highly correlated with current labor supply behavior, positive correlation between hours of work and the usual income measure may dominate. The

problem is a particular concern in time series studies of labor supply where the availability of data on exogenous income is poor. Nonetheless, several researchers using cross section data (e.g., Hall 1973, who used the 1967 Survey of Economic Opportunity data, and Rosen 1976, and Cogan 1978, who both used the 1967 National Longitudinal Survey data) also have reported positive income effects on labor supply.

Greenberg and Hosek (1975), Kniesner (1976), and Lillard (1977), have addressed the endogeneity problem by excluding any measure of non-wage income from their labor supply equations. Such a procedure naturally leads to omitted variables bias and also precludes the estimation of income and substitution effects--the parameters of primary interest in most labor supply studies.

An instrumental variable has been used for non-wage income by DaVanzo et al. (1973) and Kurz et al. (1974), but this procedure is likely to introduce a severe multicollinearity problem since hours and non-wage income depend on the same variables.

Fortunately the data to be used here provides an independent estimate of the flow of returns which accrues during the period of analysis on the stock of assets held by the decision-making unit at the beginning of the period. Ignoring the tendency of persons who

respond to surveys to underreport income from non-labor sources, this measure will provide a good proxy for exogenous initial wealth. Separate responses are solicited for total household income (from all sources), and a respondent's labor income.

Other Variables

The empirical literature on labor supply which employs survey data is uniformly disappointing in one important respect. The proportion of variation in hours of work explained by the predictors in the labor supply equations estimated is very low. For example, in the studies based on the Survey of Economic Opportunity presented in the Cain and Watts (1973) volume, the coefficient of determination on the labor supply equations averages about 0.10.

Nearly every empirical labor supply equation reported in the literature (see Keeley 1981, for a summary) includes variables for one or more of the following: age, education, sex, race, and unionism. When certain issues are being investigated some of these variables should properly be included in the labor supply equation, even though none is suggested by neo-classical theory. It is likely that in other instances additional variables are included only to raise the overall significance of the statistical results. Indeed, as Heckman (1974) has argued, adding,

variables to a basic labor supply specification reduces the explanatory power of the variables of principal interest: the hourly wage rate and non-labor income.

All results in this study are based on empirical labor supply equations which include only variables suggested by the theory. The significant difference across the sexes in labor supply behavior, however, prompted a reconsideration of the basic results using samples stratified by sex. These results are also presented.

The Sample

As stated earlier, the sample analyzed in this study was selected from the 6,742 respondents to the Wave XV of the PSID survey to yield a group with characteristics which correspond to the model of individual consumer-worker behavior. From the original sample of 6,742 households, a subsample of 857 was used for analysis. The sample selection process is summarized in Table 3, and is discussed here.

To arrive at a sample of unattached individuals the sample was limited to unmarried persons (which reduced the sample to 2,888), who lived alone (this reduced the sample to 1,585), and had no dependents (this reduced the sample to 1,319). The sample was reduced further due to labor force status considerations. Of the 1,319 single householders remaining in

Table 3. Sample Selection Process

Sample Selection Criterion	Remaining Sample Size
Full Sample: Wave XV of the PSID	6,742
Select if Not Married	2,888
Select if Household Size is One	1,585
Select if No Dependents	1,319
Select if Hours of Work are Positive*	859
Select if Wage Rate is Positive*	857
Final Sample Size	857

* The discussion in the text suggests that individuals eliminated from the sample by this selection criterion are permanently out of the labor force. Most are either retired or permanently disabled.

the sample, 462 were observed as having a zero hourly wage. Annual hours of work were also reported as zero for all but two of these individuals (positive hours for these two may have been due to a coding error). The methods developed by Heckman (1974, 1976, 1979) for application to female labor supply seem natural here; however, of the 460 respondents with zero hours and wages 438 (205 retired, 96 permanently disabled, 4 students, and 133 others), or 95.2 percent, were out of the labor force in some permanent sense. The decision was made to restrict analysis to the 857 with positive hours and wages out of the subsample of 1,319.

A description of the characteristics of the sample analyzed is contained in Table 4. In the sample the average single householder worked 1675.27 hours in 1981 for an average net wage of $4.84 per hour and received an average $1709.57 in income from non-labor sources. Average gross total income was $11,830.54 for these individuals, and 47 percent of the sample was male. Compared to 1981 national figures, a disproportionately large percentage (39.7 percent) are members of racial minorities (probably due to the origin of the PSID in the SEO sample). The average age of respondents in the subsample was 35.26 years, the average level of educational attainment was 12.5 years, and 14 percent of the sample were union members in 1981.

Table 4. Characteristics of the Subsample of 857 Single Householders Selected from the Wave XV of the PSID.

Variable	Mean	Minimum	Maximum	Description
Hours	1675.27	8.00	5606.00	Hours Worked in 1981
Net Wage	4.84	0.14	32.38	Net Hourly Wage Rate
Net Non-labor Income	1709.57	0.00	29640.00	Net Property Income
Tax Rate	0.21	0.00	0.68	Marginal Tax Rate
Sex	0.47	0.00	1.00	Male = 1 Female = 0
Age	35.26	17.00	82.00	Age in Years
Education	12.50	0.00	17.00	Years of Schooling
Race	0.60	0.00	1.00	White =1 Else = 0
Union	0.14	0.00	1.00	Member = 1 Else = 0

The analysis is conducted on a sample from a small proportion of the total population, so the potential for generalizing the results to national levels is limited. However, in all respects except race and sex, the sample mirrors the growing national population of single householders reasonably well. Money Income of Households, Families, and Persons in the United States: 1981 (U.S. Department of Commerce 1983) reports that out of a total of 83.527 million households in the United States, 19.354 million or 23.2 percent were composed of a single person in 1981. While only 13.2 percent of these were minority householders and 38.7 percent were male, the average gross total income for these single person households was $12,774. The sample mean values for age, years of schooling, and extent of unionism compare favorably with the general working age population.

CHAPTER 6

EMPIRICAL RESULTS FROM ESTIMATING VARIOUS LABOR SUPPLY FUNCTIONS

Estimating labor supply has been a growth industry in labor economics for the past twenty-five years. The results of this research have been used to evaluate the effects of macroeconomic and manpower policies and programs ranging from federal income tax reform to national incomes policy. The important findings of this work are neatly summarized in Cain and Watts (1973), Keeley (1981), and Killingsworth (1982). Discussion of the present findings is undertaken in light of these earlier results, and is divided into two parts. First, the utility function parameter estimates are given, then income and substitution effects are presented and compared to earlier findings.

Utility Function Parameter Estimates

In most empirical labor supply studies utility function parameter estimates go unreported, either because the labor supply specification estimated is not derived from an explicit (direct or indirect) utility function, or because interest is only in income and

substitution effects. For the purpose of evaluating direct closed form compensation formulae similar to equation (27), however, knowledge of utility function parameter estimates is essential.

Tobit maximum likelihood (ML) and ordinary least squares (OLS) parameter estimates are presented in the next several pages in tables 5 through 10 for estimations performed on the total sample (n=857) and separate male (n=406) and female (n=451) sub-samples, for the Cobb-Douglas (CD), Stone-Geary (SG), and Constant Elasticity of Substitution (CES) functional forms. Results from maximum likelihood estimation of the Stone-Geary Generalized Constant Elasticity of Substitution (SG-CES) specification are presented in Table 11; unfortunately, this highly non-linear form is not amenable to OLS estimation.

Since the "second-generation" techniques have come into popular use it has been customary to report a comparison of the results of applying these methods to estimates generated using the traditional OLS approach. The added value, won at the cost of much time and effort, has often been questioned. As Killingsworth (1982, p. 179) states,

> [I]n <u>principle</u>, estimates of labor supply parameters based on second-generation methodology are preferable to OLS estimates, since the latter may suffer from one or more forms of bias. But <u>in practice</u>, it is not obvious that different estimation techniques must necessarily

> yield substantially different results. If biases in OLS estimates are of a relatively minor magnitude, then, as a practical matter, there is not much reason to abandon OLS estimation, even if its theoretical purity leaves something to be desired. On the other hand, if the magnitude of OLS biases is substantial, then the case for alternative estimation techniques is considerably stronger.

Comparing the least squares and maximum likelihood results for the CD (Tables 5 and 6) and the SG (Tables 7 and 8) is direct, as both forms are linear in the parameters. In the CD case ML estimation results in significantly reduced standard errors and dramatically different parameter estimates compared with OLS. Furthermore, the function fits the total, male, and female samples equally well, when estimated by ML, but when the CD form is estimated on the male sample by OLS the leisure budget share parameter α is negative and insignificant.

Interestingly, when the CD homotheticity restriction is relaxed by adding translation parameters (to arrive at the Stone-Geary form), the α estimates remain virtually unchanged when estimated by OLS, but change dramatically when estimated by ML. The ML estimates of the SG α parameters differ little from the OLS in magnitude and significance; however, there is a marked difference in the estimates of the γ parameters. While the negative α for males in the SG case will make it impossible to compute closed form direct

Table 5. Maximum Likelihood Cobb-Douglas Budget Share Estimates by Sex.[a]

Sample	Total	Male	Female
α	.5689 (86.96)	.5631 (59.18)	.5740 (64.60)
σ	1073.2 (32.48)	991.6 (21.35)	1132.5 (24.60)
lnL	-911.04	-385.54	-522.50

[a] T = 5840, asymptotic t-statistics in parentheses.

α = [wL/(wT + I)] = The share of full income devoted to leisure.

σ = The standard error of the Tobit regression equation.

L = The value of the likelihood function at optimum.

Table 6. Ordinary Least Squares Cobb-Douglas Budget Share Estimates by Sex.[a]

Sample	Total	Male	Female
α	.092 (4.14)	-.005 (0.11)	.105 (4.52)
R^2	.02	.01	.04

[a] T = 5840, t-statistics in parentheses.

α = [wL/(wT + I)] = The share of full income devoted to leisure.

Table 7. Maximum Likelihood Estimates of Stone-Geary Utility Function Parameters.[a]

Sample	Total	Male	Female
α	.101 (3.88)	-.036 (0.55)	.156 (5.42)
γ_1	3553.83 (40.88)	3676.24 (22.75)	3836.20 (39.09)
γ_2	662.28 (0.93)	2290.71 (0.54)	5811.89 (4.54)
σ	799.4 (32.14)	900.7 (27.50)	735.2 (24.20)
lnL	-771.23	-342.20	-400.32

[a] T = 5840, asymptotic t-statistics in parentheses.

α = The marginal share of full income devoted to leisure.

γ_1 = The time origin translation parameter.

γ_2 = The income origin translation parameter.

σ = The standard error of the Tobit regression equation.

L = The value of the likelihood function at optimum.

Table 8. Ordinary Least Squares Estimates of Stone-Geary Utility Function Parameters by Sex.[a]

Sample	Total	Male	Female
α	.091 (4.01)	-.018 (0.35)	.133 (5.29)
γ_1	3941.74	4068.29	4063.32
γ_2	-208.46	6315.33	-3458.65
R^2	.02	.01	.04

[a] T = 5840, t-statistics in parentheses. Estimates for γ_1 and γ_2 are imputed from regression results, no t-statistics directly apply.

α = The marginal share of full income devoted to leisure.

γ_1 = The time origin translation parameter.

γ_2 = The income origin translation parameter.

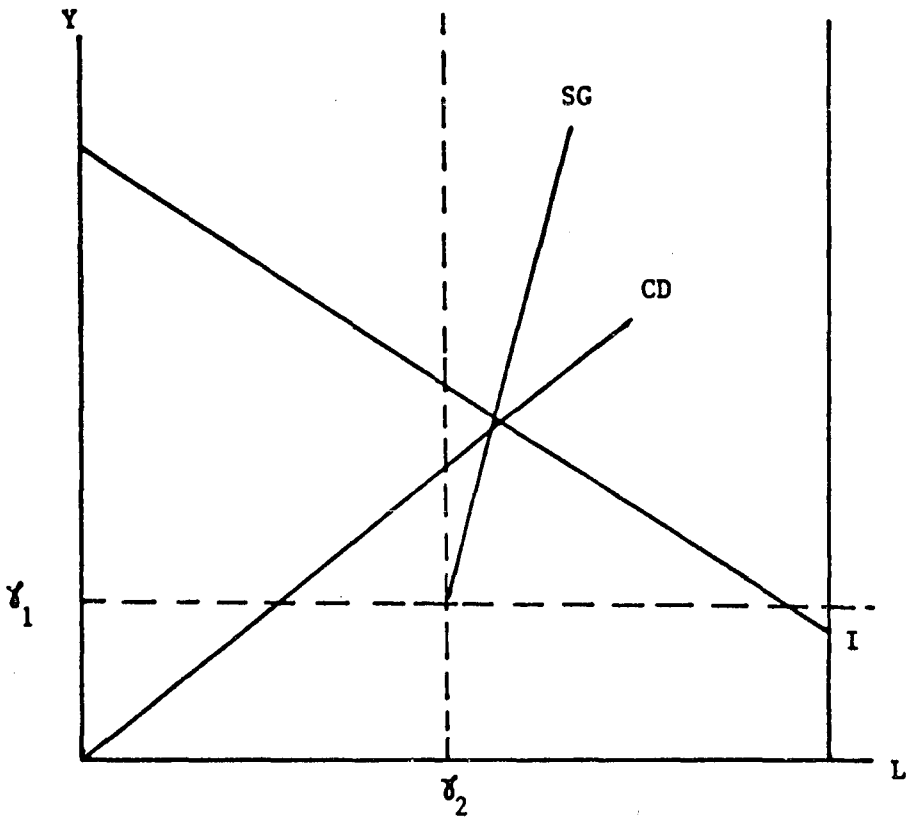

Figure 7. The effect on the Income Consumption Curve of going from the Cobb-Douglas to the Stone-Geary Labor Supply Form.

compensation estimates, the fact that α is insignificant and γ_1 (subsistence level of leisure) is lower for males is consistent with the general finding in the literature that "male labor supply is considerably less sensitive to wage rates, property income, and the like than female labor supply" (Killingsworth 1982, p. 185).

The change in the ML estimates of the parameter α when going from CD to SG is easily understood by reference to Figure 7 on the previous page. While the SG form preserves the linear Engle curves of the CD, the CD income consumption curve (ICC) is obviously flatter than is the ICC for the SG case since the latter emanates from the origin translation vector (γ_1 = 3553.83 hours, γ_2 = \$662.28).

Comparison of results from ML (Table 9) and OLS (Table 10) estimation of the CES parameters is less direct. Due to the fact that the CES labor supply function (48) is non-linear in the parameters it may not be directly estimated by OLS. Interest by econometricians in the CES form as an empirical tool was high during the 1960s, however, because by appropriate transformation of the first order conditions the CES parameters may be estimated by OLS.

For the CES utility function (47) it is the case that:

$$MRS_{LY} = [(1 - \alpha)/\alpha][Y/L]^{(1 + \rho)}, \qquad (52)$$

and at equilibrium:

$$w = [(1 - \alpha)/\alpha][Y/L]^{(1 + \rho)}, \tag{53}$$

since Y is the numéraire. Rearranging

$$[Y/L] = [w\{\alpha/(1 - \alpha)\}]^{\sigma} \tag{54}$$

and taking logs yields:

$$\ln[Y/L] = A + \sigma \ln(w), \tag{55}$$

where $A = \ln\{[\alpha/(1 - \alpha)]^{\sigma}\}$, $Y = wH + I$, and $L = T - H$. And (55) may obviously be estimated by OLS. Ignoring for a moment the problems associated with the fact that reported hours do not necessarily equal desired hours, denoting $\exp(A) = [\alpha/(1 - \alpha)]^{\sigma}$ by a, and taking expectations, it can be seen that $E(a) = E(\exp(A)) \neq \exp(E(A))$, so that the least squares estimator for α is biased, $\alpha = [(a^{1/\sigma})/(1 + a^{1/\sigma})]$.

It is impossible to directly compare the ML and OLS results in this case as different parameters are estimated, furthermore the direction of any bias is unclear. It should be noted that while the R^2 values for the CD and SG OLS results reported in Tables 6 and 8 are of the typical magnitude for cross section studies of labor supply, the R^2 values reported in Table 10 are not comparable as it is an equilibrium condition, not a labor supply function, which is estimated here.

Table 9. Maximum Likelihood Estimates of Constant Elasticity of Substitution Utility Function Parameters by Sex.[a]

Sample	Total	Male	Female
ρ	.9735 (5.60)	.4099 (3.15)	1.8380 (4.05)
δ	1.4614 (15.11)	1.1770 (9.61)	1.6706 (12.67)
α	.3211	.4427	.1892
σ_{LY}	.5067	.7093	.3524
σ	968.5 (33.00)	955.3 (21.35)	925.8 (24.66)
lnL	-845.08	-374.42	-485.06

[a] T = 5840, asymptotic t-statistics in parentheses. Relying on the invariance property of Maximum Likelihood estimation, estimates of the utility function parameters α and σ_{LY} were imputed from estimates of δ and ρ. Therefore t-values associated with α and σ_{LY} are not reported. The following formulae were employed:

$\delta = [(1 - \alpha)/\alpha]^{\sigma}$

$\alpha = [(\delta)**(-1/\sigma_{LY})]/[1 + \{(\delta)**(-1/\sigma_{LY})\}]$,

$\sigma_{LY} = [1/(1 + \rho)]$

σ = The standard error of the Tobit regression equation.

L = The value of the likelihood function at optimum.

Table 10. Ordinary Least Squares Estimates of Constant Elasticity of Substitution Utility Function Parameters by Sex.[a]

Sample	Total	Male	Female
A	-.453 (7.0)	-.682 (6.6)	-.210 (2.6)
σ_{LY}	.781 (18.6)	.938 (14.4)	.608 (11.5)
α	.641	.674	.585
ρ	.280	.066	.645
R^2	.29	.34	.23

[a] T = 5840, t-statistics in parentheses.

$\alpha = [\{a^{**}(1/\sigma_{LY})\}/\{1 + a^{**}(1/\sigma_{LY})\}]$,

$a = \exp(A)$,

$\rho = (1 - \sigma_{LY})/\sigma_{LY}$.

Estimates of the possibilities for substitution between leisure and market goods, $\hat{\sigma}_{LY} \simeq .5$, are observed to be significantly less than unity. By removing the Cobb-Douglas straightjacket of unitary elasticity of substitution, estimates of α are observed to fall although not to the level observed in the SG case.

Utility function parameter estimates for the Stone-Geary Generalized Constant Elasticity of Substitution (SG-CES) utility function are presented in Table 11. For this most general form considered, relaxation of homotheticity by inclusion of translation parameters results in near zero α parameter estimates for the total and male samples due to huge income translation (γ_2) and negative leisure translation (γ_1) parameter estimates. Predicted hours are reasonable for each of the three different samples (total, male, and female), and parameter estimates are statistically significant except for the female case, but results for this functional form are mostly disappointing. While it is feasible to compute substitution effects and elasticities, and therefore determine triangle approximation values for constraint compensation, it is impossible to evaluate the direct closed form compensation formula, as the γ_2 estimates are not consistent with concavity of the utility function.

Table 11. Maximum Likelihood Estimates of Stone-Geary Generalized Constant Elasticity of Substitution Utility Function Parameters by Sex.[a]

Sample	Total	Male	Female
ρ	19.53 (4.31)	30.24 (2.49)	0.28 (0.72)
δ	15.30 (4.48)	23.44 (2.54)	0.79 (2.28)
γ_1	-1351.10 (25.69)	-2199.67 (35.93)	28.01 (0.03)
γ_2	73582.17 (4.26)	130444.98 (2.44)	-57.51 (0.06)
α	2.02×10^{-24}	2.16×10^{-46}	.57
σ_{LY}	.05	.03	.78
σ	790.7 (32.28)	808.2 (21.46)	1152.3 (1.31)
lnL	-758.38	-399.44	-510.77

[a] T = 5840, asymptotic t-statistics in parentheses. Relying on the ML invariance property, estimates of the utility function parameters α and σ_{LY} were imputed from estimates of δ and ρ. Therefore t-values associated with α and σ_{LY} are not reported.

$\delta = [(1 - \alpha)/\alpha]^{\sigma}$

$\alpha = [\delta^{**}(-1/\sigma_{LY})]/[1+\{\delta^{**}(-1/\sigma_{LY})\}]$, $\sigma_{LY} = [1/(1+\rho)]$

σ = The standard error of the Tobit regression.

L = The value of the likelihood function at optimum.

In Table 12, on the next page, results of maximum likelihood estimation of the four different labor supply specifications on the total sample of 857 are given. Earlier, in the course of presenting results, an informal comparison of results across specifications was undertaken. However, since the forms estimated are generalizations of one another, direct tests of the underlying structure of preferences for the simple labor-leisure choice model may be performed.

Denoting a k dimensional parameter vector by Θ_k, the maximum value of the likelihood function (36) with respect to Θ_k may be written: max $L(\Theta_k)$. The appropriate test is based on the statistic

$$\lambda = \max L(\Theta_{k-r}) \; / \; \max L(\Theta_k) \qquad (56)$$

where r is the number of parameter restrictions imposed under the null hypothesis. Intuitively, if the null hypothesis were true then the maximum value of the restricted likelihood function should be about equal to the unrestricted maximum value, so that λ should be at or near one. And if the null hypothesis were false, λ should be close to zero.

Wilks (1962, p. 420) demonstrates that when the sample size is large $-2\ln\lambda$, "converges in probability to a random variable having the chi-square distribution" with $(k - r)$ degrees of freedom, and this leads to a

Table 12. A Comparison of Maximum Likelihood Utility Function Parameter Estimates for Various Functional Forms on the Total Sample .[a]

Form	CD	SG	CES	SG-CES
α	.569 (87.0)	.101 (3.9)	.321	.000
γ_1	0*	3553.8 (40.9)	0*	-1351.1 (25.7)
γ_2	0*	662.3 (0.9)	0*	73582.2
ρ	0*	0*	.974 (5.6)	19.5 (4.3)
σ_{LY}	1*	1*	.507	.1
σ	1073.2	799.4	968.5	790.7
lnL	-911.0	-771.2	-845.1	-758.4

* Implicitly restricted parameter values.

[a] T = 5840, asymptotic t-statistics in parentheses. Relying on the invariance property of Maximum Likelihood estimation, estimates of various utility function parameters were imputed from estimates of other parameters. (Consult the previous tables for the relevant formulae.) Therefore t-values for some parameters are not reported.

σ = The standard error of the Tobit regression equation.

L = The value of the likelihood function at optimum.

formal test. The compound hypothesis likelihood ratio test which applies in this case amounts to rejecting the null hypothesis whenever $-2\ln\lambda$ is greater than a critical value, which is a function of the degrees of freedom and the significance level, previously determined from the chi-square distribution.

Considering the CD form as a restricted version of SG and CES, in both cases the null hypothesis of CD form can be rejected at the one percent level of significance. That is to say, both the particular CD type of homotheticity, and unitary elasticity of substitution between leisure and income may be rejected on the basis of this evidence. Similarly, viewing the SG and CES as different restricted forms of the SG-CES, both are rejected at the one percent level of significance. These results suggest that a more flexible form, one with more parameters, tends to fit microeconomic labor supply data better.

Wage and Income Elasticities

Estimates of the structural Cournot wage effect, income effect, substitution effect, and associated elasticities are presented for the total, male, and female samples in tables 13 through 16 for each of the four functional forms. While complete results are given in these tables, this discussion focuses principally on the elasticity results, which due to their dimensionless

Table 13. Cobb-Douglas Partial Effect and Elasticity Estimates Implied by Maximum Likelihood Parameter Estimates by Sex.

Sample	Total[a]	Male[b]	Female[c]
H[d]	2316.68	2411.62	2227.93
$(\partial H/\partial w)$[e]	41.52	28.03	55.18
$(\partial H/\partial I)$[f]	-0.12	-0.11	-0.12
S[g]	313.82	300.17	326.70
$(\eta_{H.w})$[h]	0.09	0.06	0.12
$(\eta_{H.I})$[i]	-0.09	-0.06	-0.12
$(\eta^{S}_{H.w})$[j]	0.66	0.62	0.69

[a] Sample means: $\bar{w} = 4.84$, $\bar{I} = 1709.57$, $(I/w) = 504.25$.

[b] Sample means: $\bar{w} = 4.99$, $\bar{I} = 1239.50$, $(I/w) = 333.36$.

[c] Sample means: $\bar{w} = 4.71$, $\bar{I} = 2132.74$, $(I/w) = 658.08$.

[d] $H = H(\bar{w},\bar{I};\hat{\alpha}) = (1 - \hat{\alpha})T - \hat{\alpha}(I/w)$; $T = 5840$.

[e] $(\partial H/\partial w)$ = Cournot wage effect = $[(\hat{\alpha}\bar{I})/(\bar{w}^2)]$

[f] $(\partial H/\partial I)$ = pure income effect = $-\hat{\alpha}/\bar{w}$

[g] S = substitution effect = $(\partial H/\partial w) - H(\partial H/\partial I)$

[h] $(\eta_{H.w})$ = wage elasticity = $(\partial H/\partial w)(\bar{w}/H)$

[i] $(\eta_{H.I})$ = income elasticity = $(\partial H/\partial I)(\bar{I}/H)$

[j] $(\eta^{S}_{H.w})$ = substitution elasticity
$= (\eta_{H.w}) - (\bar{w}H/\bar{I})(\eta_{H.I})$

Table 14. Stone-Geary Partial Effect and Elasticity Estimates Implied by Maximum Likelihood Parameter Estimates by Sex.

Sample	Total[a]	Male[b]	Female[c]
H[d]	2039.46	2225.70	1880.78
$(\partial H/\partial w)$[e]	4.52	1.52	-25.87
$(\partial H/\partial I)$[f]	-0.02	0.01	-0.03
S[g]	47.07	-14.53	36.42
$(\eta_{H.w})$[h]	0.01	0.00	-0.06
$(\eta_{H.I})$[i]	-0.02	-0.00	-0.04
$(\eta^{S}_{H.w})$[j]	0.11	-0.03	0.09

[a] Sample means: $\bar{w} = 4.84$, $\bar{I} = 1709.57$, $(\bar{I/w}) = 504.25$.

[b] Sample means: $\bar{w} = 4.99$, $\bar{I} = 1239.50$, $(\bar{I/w}) = 333.36$.

[c] Sample means: $\bar{w} = 4.71$, $\bar{I} = 2132.74$, $(\bar{I/w}) = 658.08$.

[d] $H = H(\bar{w},\bar{I},\hat{\alpha},\hat{\gamma}_1,\hat{\gamma}_2) = (1-\hat{\alpha})(T-\hat{\gamma}_1) - \hat{\alpha}(\bar{I/w}) + \hat{\alpha}\hat{\gamma}_2(\bar{1/w})$; $T = 5840$.

[e] $(\partial H/\partial w)$ = Cournot wage effect = $[\hat{\alpha}(\bar{I} - \hat{\gamma}_2)]/(\bar{w}^2)$

[f] $(\partial H/\partial I)$ = pure income effect = $-\alpha/\bar{w}$

[g] S = substitution effect = $(\partial H/\partial w) - H(\partial H/\partial I)$

[h] $(\eta_{H.w})$ = wage elasticity = $(\partial H/\partial w)(\bar{w}/H)$

[i] $(\eta_{H.I})$ = income elasticity = $(\partial H/\partial I)(\bar{I}/H)$

[j] $(\eta^{S}_{H.w})$ = substitution elasticity
$= (\eta_{H.w}) - (\bar{w}H/\bar{I})(\eta_{H.I})$

Table 15. Constant Elasticity of Substitution Partial Effect and Elasticity Estimates Implied by Maximum Likelihood Parameter Estimates by Sex.

Sample	Total[a]	Male[b]	Female[c]
H[d]	2134.47	2336.08	1937.11
$(\partial H/\partial w)$[e]	-108.03	-58.01	-144.19
$(\partial H/\partial I)$[f]	-0.12	-0.12	-0.13
S[g]	148.11	222.32	107.63
$(\eta_{H.w})$[h]	-0.24	-0.12	-0.35
$(\eta_{H.I})$[i]	-0.10	-0.06	-0.14
$(\eta^{S}_{H.w})$[j]	0.34	0.47	0.26

[a] Sample means: $\bar{w} = 4.84$, $\bar{I} = 1709.57$, $(\bar{I}/\bar{w}) = 504.25$.

[b] Sample means: $\bar{w} = 4.99$, $\bar{I} = 1239.50$, $(\bar{I}/\bar{w}) = 333.36$.

[c] Sample means: $\bar{w} = 4.71$, $\bar{I} = 2132.74$, $(\bar{I}/\bar{w}) = 658.08$.

[d] $H = H(\bar{w},\bar{I})$; $T = 5840$.

[e] $(\partial H/\partial w)$ = Cournot wage effect

[f] $(\partial H/\partial I)$ = pure income effect

[g] S = substitution effect = $(\partial H/\partial w) - H(\partial H/\partial I)$

[h] $(\eta_{H.w})$ = wage elasticity = $(\partial H/\partial w)(\bar{w}/H)$

[i] $(\eta_{H.I})$ = income elasticity = $(\partial H/\partial I)(\bar{I}/H)$

[j] $(\eta^{S}_{H.w})$ = substitution elasticity

$= (\eta_{H.w}) - (\bar{w}H/\bar{I})(\eta_{H.I})$

Table 16. Stone-Geary Generalized Constant Elasticity of Substitution Partial Effect and Elasticity Estimates Implied by Maximum Likelihood Parameter Estimates by Sex.

Sample	Total[a]	Male[b]	Female[c]
H[d]	2037.13	2248.77	1811.26
$(\partial H/\partial w)$[e]	-55.25	-44.90	75.32
$(\partial H/\partial I)$[f]	-0.05	-0.03	-0.14
S[g]	46.61	22.56	328.90
$(\eta_{H.w})$[h]	-0.13	-0.10	0.20
$(\eta_{H.I})$[i]	-0.04	-0.02	-0.16
$(\eta^{S}_{H.w})$[j]	0.11	0.05	0.86

[a] Sample means: $\bar{w} = 4.84$, $\bar{I} = 1709.57$, $(\bar{I}/\bar{w}) = 504.25$.

[b] Sample means: $\bar{w} = 4.99$, $\bar{I} = 1239.50$, $(\bar{I}/\bar{w}) = 333.36$.

[c] Sample means: $\bar{w} = 4.71$, $\bar{I} = 2132.74$, $(\bar{I}/\bar{w}) = 658.08$.

[d] $H = H(\bar{w},\bar{I})$; $T = 5840$.

[e] $(\partial H/\partial w)$ = Cournot wage effect

[f] $(\partial H/\partial I)$ = pure income effect

[g] S = substitution effect = $(\partial H/\partial w) - H(\partial H/\partial I)$

[h] $(\eta_{H.w})$ = wage elasticity = $(\partial H/\partial w)(\bar{w}/H)$

[i] $(\eta_{H.I})$ = income elasticity = $(\partial H/\partial I)(\bar{I}/H)$

[j] $(\eta^{S}_{H.w})$ = substitution elasticity

$= (\eta_{H.w}) - (\bar{w}H/\bar{I})(\eta_{H.I})$

nature are comparable to elasticity estimates found in previous studies of labor supply which use different samples and variable definitions.

The results presented here for males are broadly consistent with the results of other "second-generation" research on labor supply. The literature reports estimates of the "Cournot" or gross wage elasticity for men which range from -0.20 to 0.14. Estimates reported in Tables 13 through 16 range from -0.12 in the CES case to 0.06 for the CD case. Females selected into this sample, like the males, are unattached single householders, so that while in each case the gross absolute wage elasticities for this group are at least double the observed values for the men, it is not surprising that the magnitudes are somewhat less than the typical 0.60 or more observed for women in the general population.

As mentioned earlier since $\partial H/\partial w = \hat{\alpha}\bar{I}/w^2$ for the CD case, gross wage effects are necessarily positive (provided that the unconstrained estimate of α is positive). This results in the CD gross wage elasticity being positive and the largest among the four cases. For all other forms, estimates of $\eta_{H.w}$ are significantly smaller and/or negative. The only exception is the SG-CES case when estimated on the female sample.

With few exceptions, income elasticities on labor supply reported in the literature are negative and

typically in the range minus one to zero. The present findings are uniformly consistent with this. As would be expected, inclusion of subsistence parameters in the SG and SG-CES forms reduces the estimated income sensitivity of labor supply. Also consistent with the literature is the finding that female labor supply is twice as responsive to income change as is male labor supply.

For purposes of computing Harberger triangle compensation estimates, substitution effect and elasticity estimates are of paramount importance. In every case except one (the statistically insignificant SG male case), results for these parameters are consistent with the implication of consumer demand theory that the substitution effect on labor supply is positive. Furthermore, all results found are in the range of those reported in the literature (-0.40 to 2.00). The "most reasonable" results on this count are found for the CES case. The positive $\eta_{H.w}$ for the CD case, reinforced by the finding that leisure is normal, results in unusually large compensated wage effects and elasticities. And the small income effects in the SG and SG-CES cases only weakly offset the "backward bending" uncompensated labor supply curves; the net result is very small substitution effect and elasticity estimates.

For a quick comparison of all results, partial effect and elasticity estimates implied by maximum likelihood estimation on the total sample for each of the various functional forms are collected together and presented on the last page of this chapter in Table 17. The averages of these four sets of results are presented in the right-hand column of this table. Certain compensation results based on these averages will be presented in the next chapter.

Table 17. A Comparison of Partial Effect and Elasticity Estimates Implied by Maximum Likelihood Estimation of Various Functional Forms on the Total Sample.[a]

Form	CD	SG	CES	SG-CES	Means
H[b]	2316.7	2039.5	2134.5	2037.1	2131.9
$(\partial H/\partial w)$[c]	41.5	4.5	-108.0	-55.3	-29.3
$(\partial H/\partial I)$[d]	-0.12	-0.02	-0.12	-0.05	-0.08
S[e]	313.8	47.1	148.1	46.6	138.9
$(\eta_{H.w})$[f]	0.09	0.01	-0.24	-0.13	-0.07
$(\eta_{H.I})$[g]	-0.09	-0.02	-0.10	-0.04	-0.06
$(\eta^{S}_{H.w})$[h]	0.66	0.11	0.34	0.11	0.31

[a] Sample means: $\bar{w} = 4.84$, $\bar{I} = 1709.57$, $(\bar{I/w}) = 504.25$.

[b] $H = H(\bar{w},\bar{I};\hat{\beta})$; $T = 5840$.

[c] $(\partial H/\partial w)$ = Cournot wage effect

[d] $(\partial H/\partial I)$ = pure income effect

[e] S = substitution effect = $(\partial H/\partial w) - H(\partial H/\partial I)$

[f] $(\eta_{H.w})$ = wage elasticity = $(\partial H/\partial w)(\bar{w}/H)$

[g] $(\eta_{H.I})$ = income elasticity = $(\partial H/\partial I)(\bar{I}/H)$

[h] $(\eta^{S}_{H.w})$ = substitution elasticity

$= (\eta_{H.w}) - (\bar{w}H/\bar{I})(\eta_{H.I})$

CHAPTER 7

COMPENSATION ESTIMATES AND SIMULATIONS

Three sets of compensation results are presented in this chapter. Results based on the Harberger triangle approximation are essentially simulation results where, given the parameter estimates, substitution effects and substitution elasticities are determined and used to estimate appropriate dollar and replacement rate compensation measures for various hypothetical degrees of labor market constraint. Direct closed form compensation formulae provide a vehicle for determining actual dollar compensation for constrained individuals (both underemployed and overemployed) in the sample, as well as for performing simulations. Simulations for benefit payments under three separate state Unemployment Insurance (UI) programs, representative of the three different payment schemes employed across the states, are presented, along with direct compensation simulations. Results of these state simulations are also evaluated relative to the triangle approximation results. Information for assessing the criterion for adequacy "one-half for four fifths" relative to the

findings of the triangle approximation and direct approaches to estimating compensation is also presented in the tables of simulation results.

Harberger Triangle Compensation Results

Ashenfelter (1980, p. 553) asserts that "[t]he majority of completed unemployment spells in the U.S. in the typical post-war year undoubtedly satisfy the constraint $D \leq .15$," that is, spells of unemployment are mostly less than fifteen percent of the year. Ashenfelter makes this point since his results (based on ML estimates of LES parameters using time series data) suggest that when the duration of a spell of unemployment is at or above 15% of the year the "appropriate value" of the replacement ratio $C^* = C/w_g d\underline{H}$ exceeds unity. Citing the obvious value of added leisure time, he rejects estimates of C^* greater than one as implausible and chooses to not report them. The sensitivity of C and C^* estimates to estimates of the compensated wage effect was mentioned in the previous chapter and is obvious from (17). Ashenfelter's findings result from unusually small substitution effect estimates. Differentiating C twice with respect to $d\underline{H}$, the Harberger triangle approximation to "appropriate" dollar compensation is found to be increasing at an increasing rate in the degree of constraint; a similar operation shows C^* to be increasing in a linear fashion with $d\underline{H}$.

Harberger triangle compensation estimates, determined by evaluating C and C^* for degrees of unemployment in 5% (2 week) increments from five to fifty percent (26 weeks) of the work year, are reported on the next few pages in Tables 18 to 21. These figures are based on substitution effect estimates found for all four functional forms estimated on the total, male, and female samples. While some results are outside the bounds of what seems reasonable, all are reported.

Results for the CD and CES cases estimated on all samples fall in the reasonable range. The SG and SG-CES results for the total sample are reasonable for $D \leq .2$, but they are uniformly unacceptable when based on parameters estimated on the male subsample. Negative C and C^* results for the SG male case are a direct result of the negative leisure budget share which resulted, in this case, from unconstrained maximum likelihood estimation.

In all cases the male and female subsample compensation estimates bracket those for the total sample, a result of the substitution effect estimates. In the CD and SG-CES cases the intuitive result (based on the relatively stronger attachment to the labor force by men), that compensation figures for males exceed those for females, obtains. While results for the SG case based on the male sample make subsample results

Table 18. Cobb-Douglas Harberger Triangle Compensation Results by Degree of Constraint and Sex.

Sample	Total		Male		Female	
	C	C^*	C	C^*	C	C^*
Degree						
D = .05	21.4	.04	24.2	.04	18.0	.04
D = .10	85.5	.08	96.9	.08	76.0	.07
D = .15	192.4	.11	218.0	.12	170.9	.11
D = .20	342.0	.15	378.5	.10	303.9	.15
D = .25	534.4	.19	605.5	.20	474.8	.18
D = .30	769.6	.23	871.9	.24	683.7	.22
D = .35	1047.5	.27	1186.7	.28	930.6	.25
D = .40	1368.2	.30	1550.0	.32	1215.5	.29
D = .45	1731.6	.34	1961.8	.36	1538.3	.33
D = .50	2137.8	.38	2421.9	.40	1899.2	.36

Degree = $D = d\underline{H} \,/\, H(\bar{w},\bar{I};\ \hat{\beta}_{ML})$

$C = C(\underline{H},w,V) \simeq (1/2)(d\underline{H})^2/S_{H.w}$ = dollar compensation amount

$C^* = C/wd\underline{H} = (1/2)(d\underline{H}/H(w,I))/\eta^S_{H.w} = (1/2)D/\eta^S_{H.w}$

= optimal replacement ratio

Table 19. Stone-Geary Harberger Triangle Compensation Results by Degree of Constraint and Sex.

Sample	Total		Male		Female	
	C	C^*	C	C^*	C	C^*
Degree						
D = .05	110.5	.23	-426.2	-0.83	121.4	.28
D = .10	441.8	.46	-1704.7	-1.67	485.6	.56
D = .15	999.1	.68	-3835.5	-2.5	1092.7	.83
D = .20	1767.3	.91	-6818.6	-3.33	1942.5	1.11
D = .25	2761.4	1.14	-10654.1	-4.17	3035.2	1.39
D = .30	3976.5	1.36	-15341.9	-5.00	4370.7	1.67
D = .35	5412.4	1.59	-20882.1	-5.83	5949.0	1.94
D = .40	7069.3	1.82	-27274.6	-6.67	7770.1	2.22
D = .45	8947.1	2.05	-34519.4	-7.50	9834.0	2.50
D = .50	11045.8	2.27	-42616.5	-8.33	12140.8	2.78

Degree = $D = d\underline{H} \,/\, H(\bar{w},\bar{I};\ \hat{\beta}_{ML})$

$C = C(\underline{H},w,V) \simeq (1/2)(d\underline{H})^2/S_{H.w}$ = dollar compensation amount

$C^* = C/wd\underline{H} = (1/2)(d\underline{H}/H(w,I))/\eta^S_{H.w} = (1/2)D/\eta^S_{H.w}$

= optimal replacement ratio

Table 20. Constant Elasticity of Substitution Harberger Triangle Compensation Results by Degree of Constraint and Sex.

Sample	Total		Male		Female	
	C	C^*	C	C^*	C	C^*
Degree						
D = .05	38.5	.07	30.7	.05	43.6	.10
D = .10	153.8	.15	122.7	.11	174.3	.19
D = .15	346.1	.22	276.2	.16	392.2	.29
D = .20	615.2	.29	490.9	.21	697.3	.39
D = .25	961.3	.37	767.1	.27	1089.5	.48
D = .30	1384.2	.44	1105.1	.32	1568.9	.58
D = .35	1884.1	.51	1503.5	.37	2135.4	.67
D = .40	2460.9	.59	1963.8	.43	2789.1	.77
D = .45	3114.5	.66	2485.4	.48	3530.0	.87
D = .50	3845.1	.74	3069.6	.53	4358.0	.96

Degree = $D = d\underline{H} / H(\bar{w},\bar{I};\ \hat{\beta}_{ML})$

$C = C(\underline{H},w,V) \simeq (1/2)(d\underline{H})^2/S_{H.w}$ = dollar compensation amount

$C^* = C/wd\underline{H} = (1/2)(d\underline{H}/H(w,I))/\eta^S_{H.w} = (1/2)D/\eta^S_{H.w}$

= optimal replacement ratio

Table 21. Stone-Geary Generalized Constant Elasticity of Substitution Harberger Triangle Compensation Results by Degree of Constraint and Sex.

Sample	Total		Male		Female	
	C	C^*	C	C^*	C	C^*
Degree						
D = .05	111.3	.23	280.2	0.50	12.5	.03
D = .10	445.2	.46	1120.8	1.00	49.9	.06
D = .15	1001.6	.68	2521.8	1.50	112.2	.09
D = .20	1780.7	.91	4483.1	2.00	199.5	.12
D = .25	2782.3	1.14	7004.9	2.50	311.7	.15
D = .30	4006.6	1.36	10087.0	3.00	448.9	.17
D = .35	5453.4	1.59	13729.6	3.50	610.9	.20
D = .40	7122.8	1.82	17932.5	4.00	798.0	.23
D = .45	9014.7	2.05	22695.8	4.50	1009.9	.26
D = .50	11129.3	2.27	28019.5	5.00	1246.8	.29

Degree = $D = d\underline{H} \,/\, H(\bar{w},\bar{I};\ \hat{\beta}_{ML})$

$C = C(\underline{H},w,V) \simeq (1/2)(d\underline{H})^2/S_{H.w}$ = dollar compensation amount

$C^* = C/wd\underline{H} = (1/2)(d\underline{H}/H(w,I))/\eta^S_{H.w} = (1/2)D/\eta^S_{H.w}$

= optimal replacement ratio

comparison uninteresting for that case, the CES results are surprising. The fact that male triangle compensation estimates are below those for females, given the same degree of labor market constraint in the CES case, is obviously a result of anomalous substitution effect estimates.

Concordance between findings for dollar compensation amounts, actual amounts, and the criterion of one-half wage replacement, is discussed at the end of this chapter after state program simulation results are given.

Direct Closed Form Compensation Estimates

In the 1982 Employment and Training Report of the President the U.S. Department of Labor reported that for the year 1981 (the year to which Wave XV of the PSID data relates) exactly half of all spells of unemployment experienced had a duration of twelve percent of the work year (six weeks) or less, while 27.6% were longer than 30% of the year, and 14% were of sufficient length (27 weeks) to completely exhaust UI benefits for an individual meeting the requirements for maximum benefit duration in any state of the union.

The Labor Department figures refer only to actual separation from work. In the present analysis the magnitude of the shortfall from desired hours, a more general concept which also covers underemployment

(working fewer than desired hours with no separation from work), is used to measure the degree of labor market constraint. Underemployment is measured here by the deviation of reported hours from "desired" hours, desired hours being estimated by evaluating empirical labor supply functions at individual characteristics. This estimate of underemployment obviously varies across functional forms for any given sample.

In the sample of 857 analyzed, 328 are classified as having experienced some type of underemployment, while 32 indicated that they were overemployed (see Figure 6 on page 72 for the constraint regime assignment matrix). On pages 117 to 120 in Tables 23 through 26 average direct compensation results, and associated measures, for the total, male, and female samples are reported for the four forms estimated. In each case averages are based only on observations where there is consistency between constraint regime classification and the estimate of the direction of constraint; such consistency obtains at an average rate of about eighty percent across specifications. The degree of concordance is indicated by the sample sizes reported in each table. Rather than add further clutter to the present discourse, closed form direct compensation formulae for the four forms investigated here are stated in Table 22. Each expression stated there is derived in

Table 22. Closed Form Direct Compensation Formulae.[a]

Cobb-Douglas

$$\tilde{c}_1 = -I - w\underline{H} + (1-\alpha)\{wT + I\} \times \left(\frac{\alpha\{wT + I\}}{w(T - \underline{H})}\right)^{(\alpha/(1-\alpha))}$$

Stone-Geary

$$\tilde{c}_2 = \gamma_2 - I - w\underline{H} + (1-\alpha)\{w(T - \gamma_1) + (I - \gamma_2)\} \times \left(\frac{\alpha\{w(T - \gamma_1) + (I - \gamma_2)\}}{w(T - \underline{H} - \gamma_1)}\right)^{(\alpha/(1-\alpha))}$$

Constant Elasticity of Substitution

$$\tilde{c}_3 = \{(\alpha/(1-\alpha))[(T - H^*)^{-\rho} - (T - \underline{H})^{-\rho}] + (wH^* + I)^{-\rho}\}^{(-1/\rho)} - (w\underline{H} + I)$$

Stone-Geary Generalized Constant Elasticity of Substitution

$$\tilde{c}_4 = \{(\alpha/(1-\alpha))[(T - \gamma_1 - H^*)^{-\rho} - (T - \gamma_1 - \underline{H})^{-\rho}] + (wH^* + I - \gamma_2)^{-\rho}\}^{(-1/\rho)} - (w\underline{H} + I - \gamma_2)$$

[a] The above four equations are closed form solutions for labor market constraint compensation. They are derived in the same fashion as (25) in Chapter 3 of the text. H^* is to be represented by (48) and (51) in the equations for $\tilde{c}_3$ and $\tilde{c}_4$ respectively.

Table 23. Cobb-Douglas Average Direct Underemployment Compensation Results by Sex.

Sample	Total	Male	Female
$\tilde{c}_1$	1260.34	1458.76	1068.15
w	4.38	4.66	4.08
w_g	5.58	6.01	5.09
I	1036.64	799.81	1296.78
UI	269.71	274.67	266.21
$w_g d\underline{H}$	4994.21	5711.84	4289.03
$\tilde{c}_1/w_g d\underline{H}$	.19	.21	.18
$UI/w_g d\underline{H}$	.07	.06	.10
H^a	1433.70	1411.05	1455.29
$d\underline{H}$	929.61	1021.89	839.50
Sample Size	276	147	128

$\tilde{c}_1$ = Average CD direct compensation estimate.

w = Average net hourly wage rate.

w_g = Average gross hourly wage rate.

I = Average net yearly non-labor income.

UI = Average UI benefits received in 1981.

$w_g d\underline{H}$ = Average lost income.

$\tilde{c}/w_g d\underline{H}$ = Average "full" replacement ratio.

$UI/w_g d\underline{H}$ = Average actual UI replacement ratio.

H^a = Average actual annual hours of work.

$d\underline{H}$ = Average deviation of actual from desired hours.

Table 24. Stone-Geary Average Direct Underemployment Compensation Results by Sex.

Sample	Total	Male	Female
$\tilde{c}_2$	1893.10	*	1488.62
w	4.33	4.63	3.90
w_g	5.44	5.78	4.89
I	1246.30	1164.66	1451.36
UI	296.09	278.76	292.96
$w_g d\underline{H}$	3579.04	3725.72	2525.73
$\tilde{c}_2/w_g d\underline{H}$	.42	*	.44
$UI/w_g d\underline{H}$	.12	.06	.34
H^a	1333.75	1386.52	1281.34
$d\underline{H}$	708.38	841.02	653.93
Sample Size	251	148	102

$\tilde{c}_2$ = Average SG direct compensation estimate.

w = Average net hourly wage rate.

w_g = Average gross hourly wage rate.

I = Average net yearly non-labor income.

UI = Average UI benefits received in 1981.

$w_g d\underline{H}$ = Average lost income.

$\tilde{c}/w_g d\underline{H}$ = Average "full" replacement ratio.

$UI/w_g d\underline{H}$ = Average actual UI replacement ratio.

H^a = Average actual annual hours of work.

$d\underline{H}$ = Average deviation of actual from desired hours.

Table 25. CES Average Direct Underemployment Compensation Results by Sex.

Sample	Total	Male	Female
$\check{c}_3$	1620.53	1643.76	585.35
w	4.08	4.57	3.78
w_g	5.02	5.88	4.56
I	890.85	679.37	1064.28
UI	261.58	272.81	244.42
$w_g d\underline{H}$	4181.44	5085.34	3430.78
$\check{c}_3/w_g d\underline{H}$	.31	.41	.30
$UI/w_g d\underline{H}$	.14	.08	.19
H^a	1411.68	1427.23	1429.40
$d\underline{H}$	999.63	1055.29	898.97
Sample Size	265	148	123

$\check{c}_3$ = Average CES direct compensation estimate.

w = Average net hourly wage rate.

w_g = Average gross hourly wage rate.

I = Average net yearly non-labor income.

UI = Average UI benefits received in 1981.

$w_g d\underline{H}$ = Average lost income.

$\check{c}/w_g d\underline{H}$ = Average "full" replacement ratio.

$UI/w_g d\underline{H}$ = Average actual UI replacement ratio.

H^a = Average actual annual hours of work.

$d\underline{H}$ = Average deviation of actual from desired hours.

Table 26. SG-CES Average Direct Underemployment Compensation Results by Sex.

Sample	Total	Male	Female
$\tilde{c}_4$	*	*	950.46
w	4.43	*	3.95
w_g	5.10	*	4.62
I	1198.01	*	950.46
UI	290.31	*	244.38
$w_g d\underline{H}$	3367.44	*	2957.99
$\tilde{c}_4/w_g d\underline{H}$	*	*	.18
$UI/w_g d\underline{H}$	.12	*	.09
H^a	1352.51	*	1365.96
$d\underline{H}$	736.93	*	657.59
Sample Size	256	*	110

$\tilde{c}_4$ = Average SG-CES direct compensation estimate.

w = Average net hourly wage rate.

w_g = Average gross hourly wage rate.

I = Average net yearly non-labor income.

UI = Average UI benefits received in 1981.

$w_g d\underline{H}$ = Average lost income.

$\tilde{c}/w_g d\underline{H}$ = Average "full" replacement ratio.

$UI/w_g d\underline{H}$ = Average actual UI replacement ratio.

H^a = Average actual annual hours of work.

$d\underline{H}$ = Average deviation of actual from desired hours.

a fashion similar to equation (27), the closed form solution for lump sum compensation, $\tilde{c}$, for the Linear Expenditure System example given in Chapter 3.

For the sample of 857, taken as a whole, the average duration of work separation was two weeks. Among the 328 classified as underemployed, the figure rises to nearly one month. And considering the more liberal definition used here, it can be seen from Tables 22 through 25 that underemployment for those classified as underemployed averages about 37% of the desired work year. This definition of lost work opportunities makes conventional replacement rates (e.g., $UI/w_g d\underline{H}$ = [UI payment/lost income]) look grossly inadequate, and dramatically lower than the traditional WRR reported in Table 1. On the other hand, appropriate replacement ratios also appear to average less than the one-half wage replacement ratio deemed necessary by so many commentators. Average values of $\tilde{c}/w_g d\underline{H}$ range from a low of .19 to a high of .42 when estimated on the total sample. These results suggest that appropriate compensation averages are significantly less than one-half the gross wage loss associated with underemployment.

From a quick glance at Tables 23 to 26 it is obvious that introduction of subsistence parameters causes some problems in evaluating closed form compensation formulae. This is a particular problem for results

based on the male subsample. The equations for $\tilde{c}_2$ and $\tilde{c}_3$ in Table 22 reveal that when the α parameter estimate is negative or the γ_2 parameter estimate exceeds the sum of labor and non-labor income for an individual, the compensation formulae may not be evaluated. The appropriateness of the SG and SG-CES specifications for estimating labor market constraint compensation is called into question. Judgement is reserved on this matter until the simulations presented in the next section are reviewed.

Differentiating each compensation formula in Table 22 with respect to H reveals that it is in general impossible to determine how a change in hours of work affects utility based compensation. Some insight into this is found from the simulations presented next. It is similarly impossible to sign the derivatives of $\tilde{c}$ with respect to the wage rate and non-labor income; however, information provided for the total, male, and female samples in the preceding tables suggests that $\tilde{c}$ increases with rises in the wage rate and decreases with rises in non-labor income.

Thus far little has been said about applying the methodology introduced to the case of overemployment. While the Harberger triangle results reported in Tables 18 to 21 may be regarded as approximate compensation measures for absolute deviations from desired hours of

work, explicit overemployment compensation estimates may be computed for a given sample using the direct compensation formulae.

Thirty-two respondents in the sample analyzed reported being constrained to work more than their desired hours. Because of the even smaller sub-samples in which overemployment is predicted, the average overemployment compensation estimates presented on the next page in Table 27 are not reported by sex; instead, a listing of overemployment compensation estimates for all four functional forms is presented for comparison.

The magnitudes of the compensation estimates vary widely across the four specifications. This is largely a result of the various degrees of overemployment estimated in the different cases. Again, the results change substantially when the homotheticity restriction is relaxed. The "subsistence" parameters introduced in the SG and SG-CES cases result in a larger share of the discretionary budget, or "supernumerary income," being devoted to market goods at the expense of leisure, and overemployment appears to be less of a problem.

The estimated degree of overemployment experienced by individuals selected into this group ranges from ten to forty-three percent of annual hours of work. Clearly, these individuals earn more labor income

Table 27. Average Direct Overemployment Compensation Results for Various Functional Forms.

Form	CD	SG	CES	SG-CES
$\tilde{c}$	1032.94	301.38	4065.51	*
O	.43	.10	.41	.16
w	5.41	5.70	6.67	6.63
w_g	7.83	8.50	10.16	10.03
I	8964.97	2563.55	3515.70	2553.28
H^a	2319.80	2230.44	2209.46	2174.44
$d\underline{H}$	680.69	205.51	435.00	274.48
$w_g d\underline{H}$	5361.89	1615.06	3781.49	2453.63
$\frac{w_g d\underline{H}}{\tilde{c} + w_g d\underline{H}}$	.86	.82	.79	*
Sample Size	5	13	13	18

$\tilde{c}$ = Average utility based direct compensation estimate.

O = $d\underline{H}/H(\bar{w},\bar{I};\ \hat{\beta}_{ML})$ = Average degree of over employment.

w = Average net hourly wage rate.

I = Average net yearly non-labor income.

H^a = Average actual annual hours of work.

$d\underline{H}$ = Average deviation of actual from desired hours.

$w_g d\underline{H}$ = Average gross "excess" labor earnings.

$(w_g d\underline{H}/(\tilde{c} + w_g d\underline{H}))$ = Gross labor earnings as a proportion of "full compensation".

than if they were to work "desired" hours, but the theory suggests that labor earnings are inadequate compensation for this excessive market work. In this case $\check{c}$ is the lump sum payment over and above labor earnings which would make the individual indifferent between working desired hours and the constrained number of hours.

The overemployment analogue to underemployment lost earnings is "excess labor earnings," meaning earnings due to excessive work, not excessive earnings for given work. For the three forms where solutions may be found, excess labor earnings are deficient by an average eighteen percent. These results may have some implications for overtime premium wage rates.

State UI Program, Direct, and One-Half Wage Replacement Simulations

Under all state Unemployment Insurance (UI) laws, a claimant's benefit rights depend on four principle factors: "the amount of employment and wages required to qualify an individual for benefits, the period for earning such wages, the method of computing the weekly benefit amount, and the method of determining the length of time for which benefits may be paid" (U.S. Department of Labor 1982, p. 3-1). While the level of wages and period of employment for qualification differ greatly across the states, there exist only three basic

schemes for determining a UI claimant's weekly benefit amount. They are referred to as the Average-weekly-wage (AWW), High-quarter (HQ), and Annual-wage (AW) formulae.

In Tables 29 through 37 the results of simple simulations, performed under the assumption of qualification for the maximum benefit payment period, are presented for state programs representative of each of the three benefit schemes: Michigan provisions are used to perform Average-weekly-wage simulations (AWW-MI), California laws provide the parameters to do High-quarter simulations (HQ-CA), and Oregon's scheme is used to generate Annual-wage simulations (AW-OR). The particulars of the four categories of benefit rights provisions in each of these states is summarized on the next page, in Table 28. In the third section of this table the examples highlight the distinguishing characteristics of the three general benefit schemes. Under each scheme a formula is employed which yields a weekly benefit amount (WBA) which is equal to about one-half of gross lost wages. Under the Michigan plan seventy percent of the net AWW is paid; in California a fraction between 1/24 and 1/31 of the HQ earnings is the WBA (the fraction $\{1/[(24 + 31)/2]\}$ is used in the California simulations); and in Oregon the WBA is 1.25 percent of annual income.

Table 28. Benefit Rights Provisions in the State UI Laws of Michigan, California, and Oregon for the year 1981.[a]

	Michigan Average-weekly-wage (AWW)	California High-quarter (HQ)	Oregon Annual-wage (AW)
Base Period (BP)	52 weeks preceeding BY	4 Quarters 4-7 Mos. before BY	1st 4 of last 5 Quarters
Benefit Year (BY)	year starting week of claim	year starting week of claim	year starting week of claim
To Qualify:			
Earnings	18x20xmin wage	$1200 in BP	$1000 in BP
Employment	18 weeks in BP	NS	18 weeks in BP
Weekly Benefit Amount (WBA)	.7xNet AWW	1/24 to 1/31 of HQ earnings	.0125xAW
Min-Max WBA	$41-$182	$30-$136	$41-$158
To Qualify for Max WBA	NS	$4,641 in HQ	$12,600 in Year
Duration:			
Max:			
Weeks	26	26	26
Dollars	$4,732	$3,536	$4,108
Min:			
Weeks	13	12	20
Dollars	NS	$375	$333

[a] Source: U.S. Department of Labor 1982, "Comparison of State Unemployment Insurance Laws", Manpower Administration, Unemployment Insurance Service, January.

NS: Not specified in the particular state law.

Four simple SPSS^X programs, one for each of the functional forms estimated, were used to perform these simulations, and these are listed in Appendix A, so that the details might be obvious. The programs differ only in the statements for computing predicted hours and the compensation amount.

Two tables are presented for the results of each of the CD, SG, and CES forms. In each case the first one is based on the total sample mean values for the gross wage rate (GWAGE), $\bar{w}_g$ = \$6.51, non-labor income (NLINC), $\bar{I}$ = \$1709.57, and income tax rate (TAXR), $\bar{t}$ = .205. And the second is based on mean values of the same variables for the underemployed groups reported in the compensation Tables 23, 24, and 25. In the SG-CES case the formula for $\tilde{c}_4$ is undefined at the estimated parameter values, but rather than report no results for this case, three tables are presented. While values for $\tilde{c}_4$ cannot be computed, the empirical labor supply function may still be evaluated and state program simulations performed. Results of this type are presented in Tables 35 and 36, and in Table 37 a complete set of simulation results for the SG-CES are reported for parameter estimates on the female sample. Even though results for estimation of the SG-CES labor supply form are statistically unreliable in this case, the compensation results are separately interesting.

On each of the following nine pages, six columns of figures are tabulated. In the first column of each table the hypothetical number of weeks of unemployment (WEEKSU), which ranges from one to twenty-seven and then thirty and increments of five weeks up to fifty, is listed. The second, third, and fourth columns report the cumulative benefit payments which would be received by a qualified claimant with the various weeks of unemployment, and gross hourly wage in Michigan, California, and Oregon, respectively. Column five in each table reports a dollar amount which equals half of the total gross wages lost, for various weeks of unemployment, by a mean individual with the particular preference structure and wage rate for which the results are tabulated. And the far right column in each of the tables is the "appropriate" or criterion compensation amount implied by the closed form direct compensation formulae $\tilde{c}_1$ to $\tilde{c}_4$ in Table 22.

In Michigan there is no waiting period before benefit payments begin. However, in California and Oregon the benefit payment is zero during the first full week of unemployment, with this waiting period acting as a type of coinsurance. The one-week waiting period was required in all but eleven states in 1981. In all states, once benefit payments commence, total benefits increase in a linear fashion, with a fixed benefit

Table 29. CD Simulation Results at Sample Means[a]

WEEKSU	AWW-MI	HQ-CA	AW-OR	HALFWAGE	CD
1.00	185.60	0.00	0.00	151.66	3.66
2.00	371.20	136.00	158.00	303.33	14.43
3.00	556.80	272.00	316.00	454.99	32.00
4.00	742.40	408.00	474.00	606.65	56.10
5.00	928.00	544.00	632.00	758.32	86.45
6.00	1113.60	680.00	790.00	909.98	122.80
7.00	1299.20	816.00	948.00	1061.65	164.91
8.00	1484.80	952.00	1106.00	1213.31	212.55
9.00	1670.40	1088.00	1264.00	1364.97	265.51
10.00	1856.00	1224.00	1422.00	1516.64	323.56
11.00	2041.60	1360.00	1580.00	1668.30	386.53
12.00	2227.20	1496.00	1738.00	1819.96	454.22
13.00	2412.80	1632.00	1896.00	1971.63	526.46
14.00	2598.40	1768.00	2054.00	2123.29	603.07
15.00	2784.00	1904.00	2212.00	2274.96	683.91
16.00	2969.60	2040.00	2370.00	2426.62	768.80
17.00	3155.20	2176.00	2528.00	2578.28	857.62
18.00	3340.80	2312.00	2686.00	2729.95	950.21
19.00	3526.40	2448.00	2844.00	2881.61	1046.45
20.00	3712.00	2584.00	3002.00	3033.27	1146.21
21.00	3897.60	2720.00	3160.00	3184.94	1249.37
22.00	4083.20	2856.00	3318.00	3336.60	1355.82
23.00	4268.80	2992.00	3476.00	3488.26	1465.43
24.00	4454.40	3128.00	3634.00	3639.93	1578.11
25.00	4640.00	3264.00	3792.00	3791.59	1693.76
26.00	4732.00	3400.00	3950.00	3943.26	1812.27
27.00	4732.00	3536.00	4108.00	4094.92	1933.56
30.00	4732.00	3536.00	4108.00	4549.91	2313.21
35.00	4732.00	3536.00	4108.00	5308.23	2993.83
40.00	4732.00	3536.00	4108.00	6066.55	3726.88
45.00	4732.00	3536.00	4108.00	6824.87	4505.19
50.00	4732.00	3536.00	4108.00	7583.18	5322.79

[a] These results were generated using mean values of the marginal tax rate (t = .205), the gross wage rate (w_g = \$6.51), and non-labor income (I = \$1709.57) from the total sample of 857 used for the basic estimation.
WEEKSU = Annual number of weeks unemployed.
AWW-MI = Compensation payable in Michigan.
HQ-CA = Compensation payable in California.
AW-OR = Compensation payable in Oregon.
HALFWAGE = Half of lost gross wages.
CD = "Appropriate" Cobb-Douglas compensation.

Table 30. CD Simulation Results at CD Subsample Means[a]

WEEKSU	AWW-MI	HQ-CA	AW-OR	HALFWAGE	CD
1.00	185.60	0.00	0.00	133.32	3.51
2.00	371.20	126.05	158.00	266.64	13.84
3.00	556.80	252.10	316.00	399.96	30.68
4.00	742.40	378.14	474.00	533.28	53.76
5.00	928.00	504.19	632.00	666.60	82.80
6.00	1113.60	630.24	790.00	799.92	117.54
7.00	1299.20	756.29	948.00	933.24	157.77
8.00	1484.80	882.33	1106.00	1066.56	203.23
9.00	1670.40	1008.38	1264.00	1199.88	253.73
10.00	1856.00	1134.43	1422.00	1333.20	309.06
11.00	2041.60	1260.48	1580.00	1466.52	369.03
12.00	2227.20	1386.52	1738.00	1599.84	433.44
13.00	2412.80	1512.57	1896.00	1733.15	502.14
14.00	2598.40	1638.62	2054.00	1866.47	574.96
15.00	2784.00	1764.67	2212.00	1999.79	651.73
16.00	2969.60	1890.71	2370.00	2133.11	732.32
17.00	3155.20	2016.76	2528.00	2266.43	816.57
18.00	3340.80	2142.81	2686.00	2399.75	904.36
19.00	3526.40	2268.86	2844.00	2533.07	995.55
20.00	3712.00	2394.91	3002.00	2666.39	1090.03
21.00	3897.60	2520.95	3160.00	2799.71	1187.67
22.00	4083.20	2647.00	3318.00	2933.03	1288.37
23.00	4268.80	2773.05	3476.00	3066.35	1392.01
24.00	4454.40	2899.10	3634.00	3199.67	1498.51
25.00	4640.00	3025.14	3792.00	3332.99	1607.75
26.00	4732.00	3151.19	3950.00	3466.31	1719.65
27.00	4732.00	3277.24	4108.00	3599.63	1834.12
30.00	4732.00	3277.24	4108.00	3999.59	2192.10
35.00	4732.00	3277.24	4108.00	4666.19	2832.82
40.00	4732.00	3277.24	4108.00	5332.78	3521.65
45.00	4732.00	3277.24	4108.00	5999.38	4251.81
50.00	4732.00	3277.24	4108.00	6665.98	5017.72

[a] These results were generated using mean values of the marginal tax rate (t = .168), the gross wage rate (w_g = \$5.58), and non-labor income (I = \$1036.64) from the sample of 276 underemployed reported on in Table 23.
WEEKSU = Annual number of weeks unemployed.
AWW-MI = Compensation payable in Michigan.
HQ-CA = Compensation payable in California.
AW-OR = Compensation payable in Oregon.
HALFWAGE = Half of lost gross wages.
CD = "Appropriate" Cobb-Douglas compensation.

Table 31. SG Simulation Results at Sample Means[a]

WEEKSU	AWW-MI	HQ-CA	AW-OR	HALFWAGE	SG
1.00	185.45	0.00	0.00	132.47	17.05
2.00	370.91	125.24	158.00	264.93	62.02
3.00	556.36	250.48	316.00	397.40	128.14
4.00	741.82	375.73	474.00	529.87	210.80
5.00	927.27	500.97	632.00	662.34	306.75
6.00	1112.73	626.21	790.00	794.80	413.58
7.00	1298.18	751.45	948.00	927.27	529.49
8.00	1483.63	876.69	1106.00	1059.74	653.08
9.00	1669.09	1001.93	1264.00	1192.21	783.25
10.00	1854.54	1127.18	1422.00	1324.67	919.10
11.00	2040.00	1252.42	1580.00	1457.14	1059.94
12.00	2225.45	1377.66	1738.00	1589.61	1205.15
13.00	2410.91	1502.90	1896.00	1722.08	1354.24
14.00	2596.36	1628.14	2054.00	1854.54	1506.81
15.00	2781.81	1753.39	2212.00	1987.01	1662.49
16.00	2967.27	1878.63	2370.00	2119.48	1820.99
17.00	3152.72	2003.87	2528.00	2251.94	1982.04
18.00	3338.18	2129.11	2686.00	2384.41	2145.41
19.00	3523.63	2254.35	2844.00	2516.88	2310.91
20.00	3709.09	2379.60	3002.00	2649.35	2478.35
21.00	3894.54	2504.84	3160.00	2781.81	2647.60
22.00	4079.99	2630.08	3318.00	2914.28	2818.51
23.00	4265.45	2755.32	3476.00	3046.75	2990.95
24.00	4450.90	2880.56	3634.00	3179.22	3164.82
25.00	4636.36	3005.80	3792.00	3311.68	3340.02
26.00	4732.00	3131.05	3950.00	3444.15	3516.47
27.00	4732.00	3256.29	4108.00	3576.62	3694.07
30.00	4732.00	3256.29	4108.00	3974.02	4233.17
35.00	4732.00	3256.29	4108.00	4636.36	5149.21
40.00	4732.00	3256.29	4108.00	5298.69	6082.64
45.00	4732.00	3256.29	4108.00	5961.03	7029.69
50.00	4732.00	3256.29	4108.00	6623.37	7987.68

[a] These results were generated using mean values of the marginal tax rate (t = .205), the gross wage rate (w_g = \$6.51), and non-labor income (I = \$1709.57) from the total sample of 857 used for the basic estimation.
WEEKSU = Annual number of weeks unemployed.
AWW-MI = Compensation payable in Michigan.
HQ-CA = Compensation payable in California.
AW-OR = Compensation payable in Oregon.
HALFWAGE = Half of lost gross wages.
SG = "Appropriate" Stone-Geary compensation.

Table 32. SG Simulation Results at SG Subsample Means[a]

WEEKSU	AWW-MI	HQ-CA	AW-OR	HALFWAGE	SG
1.00	155.55	0.00	0.00	111.11	15.63
2.00	311.10	105.05	138.88	222.21	56.73
3.00	466.65	210.09	277.77	333.32	116.95
4.00	622.20	315.14	416.65	444.43	192.05
5.00	777.75	420.19	555.53	555.53	279.02
6.00	933.30	525.23	694.42	666.64	375.69
7.00	1088.85	630.28	833.30	777.75	480.43
8.00	1244.40	735.33	972.18	888.85	591.96
9.00	1399.95	840.37	1111.07	999.96	709.30
10.00	1555.50	945.42	1249.95	1111.07	831.66
11.00	1711.04	1050.46	1388.84	1222.17	958.40
12.00	1866.59	1155.51	1527.72	1333.28	1088.98
13.00	2022.14	1260.56	1666.60	1444.39	1222.98
14.00	2177.69	1365.60	1805.49	1555.50	1360.01
15.00	2333.24	1470.65	1944.37	1666.60	1499.77
16.00	2488.79	1575.70	2083.25	1777.71	1641.99
17.00	2644.34	1680.74	2222.14	1888.82	1786.44
18.00	2799.89	1785.79	2361.02	1999.92	1932.91
19.00	2955.44	1890.84	2499.90	2111.03	2081.24
20.00	3110.99	1995.88	2638.79	2222.14	2231.27
21.00	3266.54	2100.93	2777.67	2333.24	2382.86
22.00	3422.09	2205.98	2916.55	2444.35	2535.90
23.00	3577.64	2311.02	3055.44	2555.46	2690.28
24.00	3733.19	2416.07	3194.32	2666.56	2845.89
25.00	3888.74	2521.11	3333.20	2777.67	3002.67
26.00	4044.29	2626.16	3472.09	2888.78	3160.52
27.00	4044.29	2731.21	3610.97	2999.88	3319.38
30.00	4044.29	2731.21	3610.97	3333.20	3801.40
35.00	4044.29	2731.21	3610.97	3888.74	4619.97
40.00	4044.29	2731.21	3610.97	4444.27	5453.59
45.00	4044.29	2731.21	3610.97	4999.81	6298.99
50.00	4044.29	2731.21	3610.97	5555.34	7153.83

[a] These results were generated using mean values of the marginal tax rate (t = .157), the gross wage rate (w_g = \$5.44), and non-labor income (I = \$1246.30) from the sample of 251 underemployed reported on in Table 24.
WEEKSU = Annual number of weeks unemployed.
AWW-MI = Compensation payable in Michigan.
HQ-CA = Compensation payable in California.
AW-OR = Compensation payable in Oregon.
HALFWAGE = Half of lost gross wages.
SG = "Appropriate" Stone-Geary compensation.

Table 33. CES Simulation Results at Sample Means[a]

WEEKSU	AWW-MI	HQ-CA	AW-OR	HALFWAGE	CES
1.00	185.60	0.00	0.00	136.66	5.94
2.00	371.20	129.21	158.00	273.33	23.15
3.00	556.80	258.42	316.00	409.99	50.73
4.00	742.40	387.63	474.00	546.66	87.91
5.00	928.00	516.84	632.00	683.32	133.97
6.00	1113.60	646.05	790.00	819.99	188.28
7.00	1299.20	775.26	948.00	956.65	250.25
8.00	1484.80	904.47	1106.00	1093.32	319.36
9.00	1670.40	1033.68	1264.00	1229.98	395.12
10.00	1856.00	1162.89	1422.00	1366.65	477.10
11.00	2041.60	1292.11	1580.00	1503.31	564.90
12.00	2227.20	1421.32	1738.00	1639.98	658.14
13.00	2412.80	1550.53	1896.00	1776.64	756.50
14.00	2598.40	1679.74	2054.00	1913.31	859.65
15.00	2784.00	1808.95	2212.00	2049.97	967.33
16.00	2969.60	1938.16	2370.00	2186.64	1079.26
17.00	3155.20	2067.37	2528.00	2323.30	1195.21
18.00	3340.80	2196.58	2686.00	2459.97	1314.94
19.00	3526.40	2325.79	2844.00	2596.63	1438.25
20.00	3712.00	2455.00	3002.00	2733.30	1564.94
21.00	3897.60	2584.21	3160.00	2869.96	1694.84
22.00	4083.20	2713.42	3318.00	3006.63	1827.78
23.00	4268.80	2842.63	3476.00	3143.29	1963.60
24.00	4454.40	2971.84	3634.00	3279.96	2102.16
25.00	4640.00	3101.05	3792.00	3416.62	2243.32
26.00	4732.00	3230.26	3950.00	3553.29	2386.96
27.00	4732.00	3359.47	4108.00	3689.95	2532.95
30.00	4732.00	3359.47	4108.00	4099.95	2983.98
35.00	4732.00	3359.47	4108.00	4783.27	3773.67
40.00	4732.00	3359.47	4108.00	5466.60	4602.65
45.00	4732.00	3359.47	4108.00	6149.92	5463.60
50.00	4732.00	3359.47	4108.00	6833.25	6350.91

[a] These results were generated using mean values of the marginal tax rate (t = .205), the gross wage rate (w_g = \$6.51), and non-labor income (I = \$1709.57) from the total sample of 857 used for the basic estimation.
WEEKSU = Annual number of weeks unemployed.
AWW-MI = Compensation payable in Michigan.
HQ-CA = Compensation payable in California.
AW-OR = Compensation payable in Oregon.
HALFWAGE = Half of lost gross wages.
CES = "Appropriate" CES compensation.

Table 34. CES Simulation Results at Subsample Means[a]

WEEKSU	AWW-MI	HQ-CA	AW-OR	HALFWAGE	CES
1.00	162.38	0.00	0.00	115.99	5.92
2.00	324.76	109.66	144.98	231.97	22.98
3.00	487.15	219.32	289.97	347.96	50.24
4.00	649.53	328.98	434.95	463.95	86.85
5.00	811.91	438.64	579.93	579.93	132.06
6.00	974.29	548.30	724.92	695.92	185.18
7.00	1136.67	657.96	869.90	811.91	245.63
8.00	1299.05	767.62	1014.89	927.90	312.84
9.00	1461.44	877.28	1159.87	1043.88	386.33
10.00	1623.82	986.94	1304.85	1159.87	465.65
11.00	1786.20	1096.60	1449.84	1275.86	550.40
12.00	1948.58	1206.26	1594.82	1391.84	640.21
13.00	2110.96	1315.92	1739.80	1507.83	734.73
14.00	2273.34	1425.58	1884.79	1623.82	833.67
15.00	2435.73	1535.25	2029.77	1739.80	936.75
16.00	2598.11	1644.91	2174.76	1855.79	1043.70
17.00	2760.49	1754.57	2319.74	1971.78	1154.29
18.00	2922.87	1864.23	2464.72	2087.76	1268.31
19.00	3085.25	1973.89	2609.71	2203.75	1385.55
20.00	3247.63	2083.55	2754.69	2319.74	1505.82
21.00	3410.02	2193.21	2899.67	2435.73	1628.96
22.00	3572.40	2302.87	3044.66	2551.71	1754.81
23.00	3734.78	2412.53	3189.64	2667.70	1883.22
24.00	3897.16	2522.19	3334.62	2783.69	2014.04
25.00	4059.54	2631.85	3479.61	2899.67	2147.17
26.00	4221.92	2741.51	3624.59	3015.66	2282.47
27.00	4221.92	2851.17	3769.58	3131.65	2419.84
30.00	4221.92	2851.17	3769.58	3479.61	2843.35
35.00	4221.92	2851.17	3769.58	4059.54	3582.13
40.00	4221.92	2851.17	3769.58	4639.48	4354.64
45.00	4221.92	2851.17	3769.58	5219.41	5154.33
50.00	4221.92	2851.17	3769.58	5799.35	5976.23

[a] These results were generated using mean values of the marginal tax rate (t = .153), the gross wage rate (w_g = \$5.02), and non-labor income (I = \$890.85) from the sample of 265 underemployed reported on in Table 25.
WEEKSU = Annual number of weeks unemployed.
AWW-MI = Compensation payable in Michigan.
HQ-CA = Compensation payable in California.
AW-OR = Compensation payable in Oregon.
HALFWAGE = Half of lost gross wages.
CES = "Appropriate" CES compensation.

Table 35. SG-CES Simulation Results at Sample Means[a]

WEEKSU	AWW-MI	HQ-CA	AW-OR	HALFWAGE	SGCES
1.00	183.97	0.00	0.00	131.40	*
2.00	367.93	124.24	158.00	262.81	*
3.00	551.90	248.47	316.00	394.21	*
4.00	735.87	372.71	474.00	525.62	*
5.00	919.83	496.95	632.00	657.02	*
6.00	1103.80	621.19	790.00	788.43	*
7.00	1287.77	745.42	948.00	919.83	*
8.00	1471.73	869.66	1106.00	1051.24	*
9.00	1655.70	993.90	1264.00	1182.64	*
10.00	1839.67	1118.14	1422.00	1314.05	*
11.00	2023.63	1242.37	1580.00	1445.45	*
12.00	2207.60	1366.61	1738.00	1576.86	*
13.00	2391.57	1490.85	1896.00	1708.26	*
14.00	2575.54	1615.09	2054.00	1839.67	*
15.00	2759.50	1739.32	2212.00	1971.07	*
16.00	2943.47	1863.56	2370.00	2102.48	*
17.00	3127.44	1987.80	2528.00	2233.88	*
18.00	3311.40	2112.03	2686.00	2365.29	*
19.00	3495.37	2236.27	2844.00	2496.69	*
20.00	3679.34	2360.51	3002.00	2628.10	*
21.00	3863.30	2484.75	3160.00	2759.50	*
22.00	4047.27	2608.98	3318.00	2890.91	*
23.00	4231.24	2733.22	3476.00	3022.31	*
24.00	4415.20	2857.46	3634.00	3153.72	*
25.00	4599.17	2981.70	3792.00	3285.12	*
26.00	4732.00	3105.93	3950.00	3416.53	*
27.00	4732.00	3230.17	4108.00	3547.93	*
30.00	4732.00	3230.17	4108.00	3942.15	*
35.00	4732.00	3230.17	4108.00	4599.17	*
40.00	4732.00	3230.17	4108.00	5256.19	*
45.00	4732.00	3230.17	4108.00	5913.22	*
50.00	4732.00	3230.17	4108.00	6570.24	*

[a] These results were generated using mean values of the marginal tax rate (t = .205), the gross wage rate (w_g = \$6.51), and non-labor income (I = \$1709.57) from the total sample of 857 used for the basic estimation.
WEEKSU = Annual number of weeks unemployed.
AWW-MI = Compensation payable in Michigan.
HQ-CA = Compensation payable in California.
AW-OR = Compensation payable in Oregon.
HALFWAGE = Half of lost gross wages.
SG-CES = "Appropriate" SG-CES compensation.

Table 36. SG-CES Simulation Results at SG-CES Means[a]

WEEKSU	AWW-MI	HQ-CA	AW-OR	HALFWAGE	SGCES
1.00	149.10	0.00	0.00	106.50	*
2.00	298.19	100.69	133.12	212.99	*
3.00	447.29	201.38	266.24	319.49	*
4.00	596.38	302.06	399.36	425.99	*
5.00	745.48	402.75	532.48	532.48	*
6.00	894.57	503.44	665.61	638.98	*
7.00	1043.67	604.13	798.73	745.48	*
8.00	1192.77	704.82	931.85	851.98	*
9.00	1341.86	805.50	1064.97	958.47	*
10.00	1490.96	906.19	1198.09	1064.97	*
11.00	1640.05	1006.88	1331.21	1171.47	*
12.00	1789.15	1107.57	1464.33	1277.96	*
13.00	1938.24	1208.26	1597.45	1384.46	*
14.00	2087.34	1308.94	1730.58	1490.96	*
15.00	2236.44	1409.63	1863.70	1597.45	*
16.00	2385.53	1510.32	1996.82	1703.95	*
17.00	2534.63	1611.01	2129.94	1810.45	*
18.00	2683.72	1711.70	2263.06	1916.94	*
19.00	2832.82	1812.38	2396.18	2023.44	*
20.00	2981.91	1913.07	2529.30	2129.94	*
21.00	3131.01	2013.76	2662.42	2236.44	*
22.00	3280.11	2114.45	2795.54	2342.93	*
23.00	3429.20	2215.14	2928.67	2449.43	*
24.00	3578.30	2315.82	3061.79	2555.93	*
25.00	3727.39	2416.51	3194.91	2662.42	*
26.00	3876.49	2517.20	3328.03	2768.92	*
27.00	3876.49	2617.89	3461.15	2875.42	*
30.00	3876.49	2617.89	3461.15	3194.91	*
35.00	3876.49	2617.89	3461.15	3727.39	*
40.00	3876.49	2617.89	3461.15	4259.88	*
45.00	3876.49	2617.89	3461.15	4792.36	*
50.00	3876.49	2617.89	3461.15	5324.85	*

[a] These results were generated using mean values of the marginal tax rate (t = .151), the gross wage rate (w_g = \$5.10), and non-labor income (I = \$1198.01) from the sample of XXX underemployed reported on in Table 26.
WEEKSU = Annual number of weeks unemployed.
AWW-MI = Compensation payable in Michigan.
HQ-CA = Compensation payable in California.
AW-OR = Compensation payable in Oregon.
HALFWAGE = Half of lost gross wages.
SG-CES = "Appropriate" SG-CES compensation.

Table 37. SG-CES Simulation Results at Female Means[a]

WEEKSU	AWW-MI	HQ-CA	AW-OR	HALFWAGE	SGCES
1.00	129.51	0.00	0.00	92.51	0.24
2.00	259.03	87.46	115.64	185.02	6.06
3.00	388.54	174.93	231.27	277.53	17.19
4.00	518.06	262.39	346.91	370.04	33.36
5.00	647.57	349.86	462.55	462.55	54.33
6.00	777.08	437.32	578.19	555.06	79.88
7.00	906.60	524.78	693.82	647.57	109.78
8.00	1036.11	612.25	809.46	740.08	143.84
9.00	1165.62	699.71	925.10	832.59	181.86
10.00	1295.14	787.17	1040.74	925.10	223.67
11.00	1424.65	874.64	1156.37	1017.61	269.10
12.00	1554.17	962.10	1272.01	1110.12	317.99
13.00	1683.68	1049.57	1387.65	1202.63	370.18
14.00	1813.19	1137.03	1503.28	1295.14	425.54
15.00	1942.71	1224.49	1618.92	1387.65	483.93
16.00	2072.22	1311.96	1734.56	1480.16	545.22
17.00	2201.73	1399.42	1850.20	1572.67	609.30
18.00	2331.25	1486.89	1965.83	1665.18	676.05
19.00	2460.76	1574.35	2081.47	1757.69	745.36
20.00	2590.28	1661.81	2197.11	1850.20	817.13
21.00	2719.79	1749.28	2312.75	1942.71	891.26
22.00	2849.30	1836.74	2428.38	2035.22	967.66
23.00	2978.82	1924.20	2544.02	2127.73	1046.25
24.00	3108.33	2011.67	2659.66	2220.24	1126.94
25.00	3237.84	2099.13	2775.29	2312.75	1209.64
26.00	3367.36	2186.60	2890.93	2405.26	1294.30
27.00	3367.36	2274.06	3006.57	2497.77	1380.82
30.00	3367.36	2274.06	3006.57	2775.29	1650.97
35.00	3367.36	2274.06	3006.57	3237.84	2132.89
40.00	3367.36	2274.06	3006.57	3700.39	2648.89
45.00	3367.36	2274.06	3006.57	4162.94	3193.76
50.00	3367.36	2274.06	3006.57	4625.49	3763.27

[a] These results were generated using mean values of the marginal tax rate (t = .145), the gross wage rate (w_g = \$4.62), and non-labor income (I = \$950.46) from the sample of 110 females reported on in Table 26.
WEEKSU = Annual number of weeks unemployed.
AWW-MI = Compensation payable in Michigan.
HQ-CA = Compensation payable in California.
AW-OR = Compensation payable in Oregon.
HALFWAGE = Half of lost gross wages.
SG-CES = "Appropriate" SG-CES compensation.

amount being paid each week, until there is either a return to work or eligibility is exhausted.

It is assumed in the simulations performed here that the stylized claimants considered all qualify for the maximum benefit period of twenty-six weeks. In the absence of economic conditions which trigger extended benefits, 26 weeks is the maximum benefit duration under most UI programs; the exceptions (maximum duration in weeks) are: Louisiana (28), Massachusetts (30), Pennsylvania (30), Puerto Rico (20), Utah (36), Virginia (28), Washington, D.C. (34), and West Virginia (28). As a consequence of the waiting period and the benefit maximums, the figures in columns two, three, and four of the simulation tables are constant for weeks of unemployment beyond twenty-seven.

Just as the UI benefit totals increase in a linear fashion, so do the totals for one-half gross wage replacement (HALFWAGE) reported in column five. The direct compensation simulation figures increase with the duration of unemployment, and they appear to do so at a decreasing rate. This uniform result is obviously due to the parameter values used in the simulations. Comparing these appropriate compensation amounts with the figures for the actual benefit payments which would be forthcoming in the various states, the general result for the group of single householders analyzed here is

that current UI programs overcompensate for wage loss in the early phase and, because of the maximum duration provisions, undercompensate for lengthy spells of unemployment.

The norm of benefit adequacy, "one-half wage replacement," is met in the Michigan and Oregon simulations, states with liberal benefit provisions, and nearly satisfied for the case of California. This finding is not surprising; Becker (1980) has documented the fact that single individuals with no dependents historically have been adequately compensated for lost earnings under state UI programs. In fact, compared with the direct compensation estimated, one-half wage replacement appears to be excessive.

Using the fact that five weeks of unemployment in a given year amounts to a duration of unemployment (D) of ten percent, for ten weeks D = .20, and so forth the Harberger triangle compensation estimates may be compared with the closed form estimates of "appropriate" compensation. Referring back to Tables 18 through 21 on pages 110 to 113, the agreement is found to be unusually good, especially for unemployment spells of the typically observed duration. For example, the difference at five weeks of unemployment in the CES case is 13 percent, and at ten weeks in the CD case the difference is only 5 percent.

CHAPTER 8

SUMMARY, POLICY IMPLICATIONS, AND CONCLUSIONS

Explicit parameterizations of labor supply have been specified and estimated on a sample of single unattached individuals using a generalized Tobit maximum likelihood method which is consistent under the assumption that employed hours are exogenous. Results of these estimations have been used to compute triangle approximation and direct closed form solutions for labor market constraint compensation. Underemployment compensation estimates are generated and compared to actual and hypothetical payments which would accrue under the UI systems of representative states. Certain compensation results for overemployment are also offered.

Where they are directly comparable, results from Tobit estimation of the basic labor supply relations are found to strictly dominate least squares results in terms of efficiency, that is to say the statistical significance of predictors is higher when estimated by maximum likelihood. As is usually the case in empirical labor supply analysis, the overall predictive power of

the models, as indicated by the R^2 of the ordinary least squares (OLS) results, is low. While there is no consensus in the literature on a statistic similar to R^2 for maximum likelihood models, a low overall predictive power for these models is also likely. This combination of significant predictors and poorly predicting models in labor supply analysis has been directly addressed by Killingsworth (1982, p. 20).

> In terms of econometrics, one can say that the simple model does assert that the relationships between labor supply and various variables measuring pecuniary factors (the wage rate, property income) will usually be "statistically significant" (subject to the exceptions just noted); but it does not assert that such pecuniary factors alone necessarily have a high "explanatory power"...In sum, the notion that the simple model treats suppliers of labor as persons who make decisions solely on the basis of pecuniary factors is a fundamental misconception.

While the OLS and Tobit parameter estimates differ dramatically in most cases, the latter are consistent with the bulk of recent empirical labor supply research, with the uncompensated wage effect averaging -29.3 hours, and the substitution elasticity found to average 0.31. All compensation results reported, therefore, rely on the Tobit parameter estimates. A corollary purpose of estimating the several labor supply specifications was the search for an appropriate structure of preferences to be used in modeling the labor-leisure choice problem. And while

empirical results were particularly disappointing for some functional forms, notably the linear expenditure form based on the Stone-Geary utility function, direct likelihood ratio tests yielded no preferred form.

Results on compensation amounts tend to support accepted standards of UI benefit adequacy. The Harberger triangle estimates accorded quite closely with the direct compensation estimates for cases where the duration of unemployment is at the level typically experienced by labor force members. For all levels of unemployment the direct compensation results suggested that "one-half gross wage replacement" would slightly overcompensate individuals from a utility based perspective. Referring again to the adequacy studies of the 1950s reviewed in Chapter 2, at that time UI was observed as providing slight overcompensation on average for individuals of the type considered in the present sample. If the utility based compensation estimates may be relied upon as mimicking the detailed adequacy studies of the fifties or the more recent studies such as that by Burgess and Kingston (1978a, 1978b), then the same conclusion obtains.

None of this is to suggest that the present UI system is overly generous. When evaluating the present results it must be borne in mind that the underlying model is one of individual behavior, and the entire

analysis was performed on a sample of single, unattached householders. While the analysis has provided reasonable guidelines for unemployment policy directed toward this group, it has also provided an agenda for future research in the area of household labor supply.

APPENDIX A

SPSS^X PROGRAMS FOR DIRECT COMPENSATION SIMULATIONS

```
TITLE  "Cobb-Douglas Compensation Simulations"
DATA LIST FREE /WEEKSU
CONDESCRIPTIVE WEEKSU
BEGIN DATA
0
1
2
.
.[Numbers 3 to 48 are omitted here to save space.]
.
49
50
END DATA

COMPUTE TAXR=.205
COMPUTE GWAGE=6.51
COMPUTE NLINC=1709.57

COMPUTE BMIN=42.50
COMPUTE BMAX=.58*320
COMPUTE DMIN=13
COMPUTE DMAX=26
COMPUTE DDMIN=375
COMPUTE DDMAX=4732
COMPUTE RATE=.70
COMPUTE NWAGE=GWAGE*(1-TAXR)
COMPUTE RWAGE=1/NWAGE
COMPUTE IOVERW=NLINC/NWAGE

COMPUTE A1=.62215806727
COMPUTE T=5840
COMPUTE ANHOURS=(T*(1-A1))-(A1*IOVERW)
COMPUTE HCD=ANHOURS
COMPUTE WKHOURS=ANHOURS/50
COMPUTE ANHOURS=ANHOURS-(WKHOURS*WEEKSU)
COMPUTE HALFWAGE=.5*NWAGE*(HCD-ANHOURS)
COMPUTE CD = -(NWAGE*ANHOURS+NLINC)+(((A1*(NWAGE*T+
 NLINC))/  (NWAGE*(T-ANHOURS)))**(A1/(1-A1)))*
 ((1-A1)*(NWAGE*T+NLINC))

COMPUTE WKWAGE=GWAGE*WKHOURS
COMPUTE UIPAY=RATE*WKWAGE
IF (UIPAY LT BMIN) UIPAY=BMIN
IF (UIPAY GT BMAX) UIPAY=BMAX
COMPUTE COMPWKS=WEEKSU
IF (WEEKSU GT DMAX) COMPWKS=DMAX
```

```
COMPUTE UIPAY=COMPWKS*UIPAY
IF (UIPAY GT DDMAX) UIPAY=DDMAX
COMPUTE MICHIGAN=UIPAY
COMPUTE BMIN=41
COMPUTE BMAX=158
COMPUTE DMIN=8
COMPUTE DMAX=26
COMPUTE DDMIN=333.34
COMPUTE DDMAX=4108
COMPUTE RATE= .0125

COMPUTE YEARINC=WKHOURS*50*GWAGE
COMPUTE UIPAY=RATE*YEARINC
IF (UIPAY LT BMIN) UIPAY=BMIN
IF (UIPAY GT BMAX) UIPAY=BMAX
COMPUTE COMPWKS=WEEKSU-1
IF (WEEKSU GT DMAX) COMPWKS=DMAX
COMPUTE UIPAY=COMPWKS*UIPAY
IF (UIPAY GT DDMAX) UIPAY=DDMAX
COMPUTE OREGON=UIPAY

COMPUTE BMIN=30
COMPUTE BMAX=136
COMPUTE DMIN=12
COMPUTE DMAX=26
COMPUTE DDMIN=375
COMPUTE DDMAX=3536
COMPUTE RATE= 1/((24+31)/2)

COMPUTE HQHOURS=13*WKHOURS
COMPUTE HQEARN=GWAGE*HQHOURS
COMPUTE UIPAY=RATE*HQEARN
IF (UIPAY LT BMIN) UIPAY=BMIN
IF (UIPAY GT BMAX) UIPAY=BMAX
COMPUTE COMPWKS=WEEKSU-1
IF (WEEKSU GT DMAX) COMPWKS=DMAX
COMPUTE UIPAY=COMPWKS*UIPAY
IF (UIPAY GT DDMAX) UIPAY=DDMAX
COMPUTE CALIF=UIPAY

COMPUTE WEEK=MICHIGAN
COMPUTE QUARTER=CALIF
COMPUTE YEAR=OREGON


REPORT  FORMAT=MARGINS(15,72)  LENGTH(1,59)  BRKSPACE(0)
LIST/
 STRING=LABOR(WEEKSU WEEK QUARTER YEAR HALFWAGE CD)/
 VARIABLES=WEEKSU WEEK QUARTER YEAR HALFWAGE CD/
 BREAK=(NOBREAK)/
FINISH
```

```
TITLE  "Stone-Geary Compensation Simulations"
DATA LIST FREE /WEEKSU
CONDESCRIPTIVE WEEKSU
BEGIN DATA
0
1
2
.
.
.
49
50
END DATA

COMPUTE TAXR=.205
COMPUTE GWAGE=6.51
COMPUTE NLINC=1709.57

COMPUTE BMIN=42.50
COMPUTE BMAX=.58*320
COMPUTE DMIN=13
COMPUTE DMAX=26
COMPUTE DDMIN=375
COMPUTE DDMAX=4732
COMPUTE RATE=.70

COMPUTE NWAGE=GWAGE*(1-TAXR)
COMPUTE RWAGE=1/NWAGE
COMPUTE IOVERW=NLINC/NWAGE
COMPUTE T=5840

COMPUTE A2=.14299354682
COMPUTE G12=3671.3470563
COMPUTE G22=-65.213337596
COMPUTE ANHOURS=((T-G12)*(1-A2))-(A2*IOVERW)+
 (A2*G22*RWAGE)
COMPUTE HSG=ANHOURS
COMPUTE WKHOURS=ANHOURS/50
COMPUTE ANHOURS=ANHOURS-(WKHOURS*WEEKSU)
COMPUTE HALFWAGE=.5*GWAGE*(HSG-ANHOURS)
COMPUTE SG = G22 - NLINC - (NWAGE * ANHOURS) + ((1 - A2)
 * ((NWAGE * (T - G12)) + (NLINC - G22))) *
 (((A2 * ((NWAGE * (T - G12)) +
 (NLINC - G22))) /
 (NWAGE * (T - G12 - ANHOURS))) **
 (A2/(1-A2)))

COMPUTE WKWAGE=GWAGE*WKHOURS
COMPUTE UIPAY=RATE*WKWAGE
IF (UIPAY LT BMIN) UIPAY=BMIN
IF (UIPAY GT BMAX) UIPAY=BMAX
COMPUTE COMPWKS=WEEKSU
```

```
IF (WEEKSU GT DMAX) COMPWKS=DMAX
COMPUTE UIPAY=COMPWKS*UIPAY
IF (UIPAY GT DDMAX) UIPAY=DDMAX
COMPUTE MICHIGAN=UIPAY

COMPUTE BMIN=41
COMPUTE BMAX=158
COMPUTE DMIN=8
COMPUTE DMAX=26
COMPUTE DDMIN=333.34
COMPUTE DDMAX=4108
COMPUTE RATE= .0125

COMPUTE YEARINC=WKHOURS*50*GWAGE
COMPUTE UIPAY=RATE*YEARINC
IF (UIPAY LT BMIN) UIPAY=BMIN
IF (UIPAY GT BMAX) UIPAY=BMAX
COMPUTE COMPWKS=WEEKSU-1
IF (WEEKSU GT DMAX) COMPWKS=DMAX
COMPUTE UIPAY=COMPWKS*UIPAY
IF (UIPAY GT DDMAX) UIPAY=DDMAX
COMPUTE OREGON=UIPAY

COMPUTE BMIN=30
COMPUTE BMAX=136
COMPUTE DMIN=12
COMPUTE DMAX=26
COMPUTE DDMIN=375
COMPUTE DDMAX=3536
COMPUTE RATE= 1/((24+31)/2)

COMPUTE HQHOURS=13*WKHOURS
COMPUTE HQEARN=GWAGE*HQHOURS
COMPUTE UIPAY=RATE*HQEARN
IF (UIPAY LT BMIN) UIPAY=BMIN
IF (UIPAY GT BMAX) UIPAY=BMAX
COMPUTE COMPWKS=WEEKSU-1
IF (WEEKSU GT DMAX) COMPWKS=DMAX
COMPUTE UIPAY=COMPWKS*UIPAY
IF (UIPAY GT DDMAX) UIPAY=DDMAX
COMPUTE CALIF=UIPAY

COMPUTE WEEK=MICHIGAN
COMPUTE QUARTER=CALIF
COMPUTE YEAR=OREGON

REPORT  FORMAT=MARGINS(15,72)  LENGTH(1,59)  BRKSPACE(0)
LIST/
 STRING=LABOR(WEEKSU WEEK QUARTER YEAR HALFWAGE SG)/
 VARIABLES=WEEKSU WEEK QUARTER YEAR HALFWAGE SG/
 BREAK=(NOBREAK)/
FINISH
```

```
TITLE  "CES Direct Compensation Simulations"
DATA LIST FREE /WEEKSU
CONDESCRIPTIVE WEEKSU
BEGIN DATA
0
1
2
.
.
49
50
END DATA

COMPUTE TAXR=.205
COMPUTE GWAGE=6.51
COMPUTE NLINC=1709.57

COMPUTE BMIN=42.50
COMPUTE BMAX=.58*320
COMPUTE DMIN=13
COMPUTE DMAX=26
COMPUTE DDMIN=375
COMPUTE DDMAX=4732
COMPUTE RATE=.70

COMPUTE NWAGE=GWAGE*(1-TAXR)
COMPUTE RWAGE=1/NWAGE
COMPUTE IOVERW=NLINC/NWAGE
COMPUTE T=5840

COMPUTE S3= .60149603697
COMPUTE RHO3=(1-S3)/S3
COMPUTE K3=1.0594588951
COMPUTE A3=(K3**(1/-S3))/(1+(K3**(1/-S3)))
COMPUTE ANHOURS=(K3*((nWAGE)**(S3))*T-NLINC)/(NWAGE +
 K3*((nWAGE)**(S3)))
COMPUTE HCES=ANHOURS
COMPUTE WKHOURS=ANHOURS/50
COMPUTE ANHOURS=ANHOURS-(WKHOURS*WEEKSU)
COMPUTE HALFWAGE=.5*NWAGE*(HCES-ANHOURS)
COMPUTE HALFWAGE=HALFWAGE
COMPUTE HALFGROS=.5*GWAGE*(HCES-ANHOURS)
COMPUTE CES = (((A3/(1-A3))*(((T-hces)**(-RHO3))-((T
 - anhours)**(-RHO3)))+((NWAGE*hces+NLINC)**(-RHO3)))
 **(-1/RHO3))-(NWAGE*ANHOURS+NLINC)

COMPUTE WKWAGE=GWAGE*WKHOURS
COMPUTE UIPAY=RATE*WKWAGE
IF (UIPAY LT BMIN) UIPAY=BMIN
IF (UIPAY GT BMAX) UIPAY=BMAX
COMPUTE COMPWKS=WEEKSU
IF (WEEKSU GT DMAX) COMPWKS=DMAX
```

```
COMPUTE UIPAY=COMPWKS*UIPAY
IF (UIPAY GT DDMAX) UIPAY=DDMAX
COMPUTE MICHIGAN=UIPAY

COMPUTE BMIN=41
COMPUTE BMAX=158
COMPUTE DMIN=8
COMPUTE DMAX=26
COMPUTE DDMIN=333.34
COMPUTE DDMAX=4108
COMPUTE RATE= .0125

COMPUTE YEARINC=WKHOURS*50*GWAGE
COMPUTE UIPAY=RATE*YEARINC
IF (UIPAY LT BMIN) UIPAY=BMIN
IF (UIPAY GT BMAX) UIPAY=BMAX
COMPUTE COMPWKS=WEEKSU-1
IF (WEEKSU GT DMAX) COMPWKS=DMAX
COMPUTE UIPAY=COMPWKS*UIPAY
IF (UIPAY GT DDMAX) UIPAY=DDMAX
COMPUTE OREGON=UIPAY

COMPUTE BMIN=30
COMPUTE BMAX=136
COMPUTE DMIN=12
COMPUTE DMAX=26
COMPUTE DDMIN=375
COMPUTE DDMAX=3536
COMPUTE RATE= 1/((24+31)/2)

COMPUTE HQHOURS=13*WKHOURS
COMPUTE HQEARN=GWAGE*HQHOURS
COMPUTE UIPAY=RATE*HQEARN
IF (UIPAY LT BMIN) UIPAY=BMIN
IF (UIPAY GT BMAX) UIPAY=BMAX
COMPUTE COMPWKS=WEEKSU-1
IF (WEEKSU GT DMAX) COMPWKS=DMAX
COMPUTE UIPAY=COMPWKS*UIPAY
IF (UIPAY GT DDMAX) UIPAY=DDMAX
COMPUTE CALIF=UIPAY

COMPUTE WEEK=MICHIGAN
COMPUTE QUARTER=CALIF
COMPUTE YEAR=OREGON
COMPUTE HALF=HALFWAGE

REPORT  FORMAT=MARGINS(15,72)  LENGTH(1,59)  BRKSPACE(0)
LIST/
 STRING=LABOR(WEEKSU WEEK QUARTER YEAR HALFWAGE CES)/
 VARIABLES=WEEKSU WEEK QUARTER YEAR HALFWAGE CES/
 BREAK=(NOBREAK)/
FINISH
```

```
TITLE "SG-CES Direct Compensation Simulations"
DATA LIST FREE /WEEKSU
CONDESCRIPTIVE WEEKSU
BEGIN DATA
0
1
2
.
49
50
END DATA

COMPUTE TAXR=.205
COMPUTE GWAGE=6.51
COMPUTE NLINC=1709.57

COMPUTE BMIN=42.50
COMPUTE BMAX=.58*320
COMPUTE DMIN=13
COMPUTE DMAX=26
COMPUTE DDMIN=375
COMPUTE DDMAX=4732
COMPUTE RATE=.70

COMPUTE NWAGE=GWAGE*(1-TAXR)
COMPUTE RWAGE=1/NWAGE
COMPUTE IOVERW=NLINC/NWAGE
COMPUTE T=5840

COMPUTE S4= .353387263
COMPUTE G14= 2885.9047619
COMPUTE G24= 7334.1883494
COMPUTE RHO4=(1-S4)/S4
COMPUTE K4=8.9249499881
COMPUTE A4=(K4**(1/-S4))/(1+(K4**(1/-S4)))
COMPUTE  ANHOURS=(K4*((nWAGE)**(S4))*(T-G14)-NLINC-G24)/
              (NWAGE + K4*((nWAGE)**(S4)))

COMPUTE HCESSG=ANHOURS
COMPUTE WKHOURS=ANHOURS/50
COMPUTE ANHOURS=ANHOURS-(WKHOURS*WEEKSU)
COMPUTE HALFWAGE=.5*GWAGE*(HCESSG-ANHOURS)

COMPUTE SGCES = (((A4/(1-A4))*(((T-hcessg-G14)**(-RHO4))
 -((T-anhours-G14)**(-RHO4)))+((NWAGE*hcessg+NLINC-G24)
 **(-RHO4)))**(-1/RHO4))-(NWAGE*ANHOURS+NLINC-G24)

COMPUTE WKWAGE=GWAGE*WKHOURS
COMPUTE UIPAY=RATE*WKWAGE
IF (UIPAY LT BMIN) UIPAY=BMIN
IF (UIPAY GT BMAX) UIPAY=BMAX
COMPUTE COMPWKS=WEEKSU
```

```
IF (WEEKSU GT DMAX) COMPWKS=DMAX
COMPUTE UIPAY=COMPWKS*UIPAY
IF (UIPAY GT DDMAX) UIPAY=DDMAX
COMPUTE MICHIGAN=UIPAY

COMPUTE BMIN=41
COMPUTE BMAX=158
COMPUTE DMIN=8
COMPUTE DMAX=26
COMPUTE DDMIN=333.34
COMPUTE DDMAX=4108
COMPUTE RATE= .0125

COMPUTE YEARINC=WKHOURS*50*GWAGE
COMPUTE UIPAY=RATE*YEARINC
IF (UIPAY LT BMIN) UIPAY=BMIN
IF (UIPAY GT BMAX) UIPAY=BMAX
COMPUTE COMPWKS=WEEKSU-1
IF (WEEKSU GT DMAX) COMPWKS=DMAX
COMPUTE UIPAY=COMPWKS*UIPAY
IF (UIPAY GT DDMAX) UIPAY=DDMAX
COMPUTE OREGON=UIPAY

COMPUTE BMIN=30
COMPUTE BMAX=136
COMPUTE DMIN=12
COMPUTE DMAX=26
COMPUTE DDMIN=375
COMPUTE DDMAX=3536
COMPUTE RATE= 1/((24+31)/2)

COMPUTE HQHOURS=13*WKHOURS
COMPUTE HQEARN=GWAGE*HQHOURS
COMPUTE UIPAY=RATE*HQEARN
IF (UIPAY LT BMIN) UIPAY=BMIN
IF (UIPAY GT BMAX) UIPAY=BMAX
COMPUTE COMPWKS=WEEKSU-1
IF (WEEKSU GT DMAX) COMPWKS=DMAX
COMPUTE UIPAY=COMPWKS*UIPAY
IF (UIPAY GT DDMAX) UIPAY=DDMAX
COMPUTE CALIF=UIPAY

COMPUTE WEEK=MICHIGAN
COMPUTE QUARTER=CALIF
COMPUTE YEAR=OREGON

REPORT  FORMAT=MARGINS(15,72)  LENGTH(1,59)  BRKSPACE(0)
LIST/
 STRING=LABOR(WEEKSU WEEK  QUARTER YEAR HALFWAGE SGCES)/
VARIABLES=WEEKSU WEEK QUARTER YEAR HALFWAGE SGCES/
 BREAK=(NOBREAK)/
FINISH
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