NBER WORKING PAPER SERIES

TAXES AND LABOR SUPPLY

Jerry A. Hausman

Working Paper No. 1102

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge MA 02138

March 1983

Taxes and Labor Supply

ABSTRACT

Over 75% of Federal tax revenue is raised through the income tax and FICA taxes. The potential effects on labor supply and economic welfare are important because of the large and increasing reliance on direct taxation. Over the past few years significant legislative changes have occurred with respect to taxation of labor: the 25% tax cuts, indexation, the tax credit for working spouses, and likely increases in FICA taxation. I review recent econometric work which measures the effect of taxes on labor supply and which analyzes the likely effects of tax law changes on labor supply and economic welfare.

Sections 1 and 2 develop the theory and econometric techniques for models of labor supply with taxes. Section 3 discusses the various tax systems in the U.S. In Section 4, I present empirical estimates for husbands' and wives' labor supply functions. The economic cost of the tax system is also estimated. In Section 5 the individual questionnaire data for high income individuals is reviewed. Lastly, in Section 6 evidence from the negative income tax experiments and for social security beneficiaries is considered. These latter groups face extremely high marginal tax rates so that evidence beyond that contained in other surveys of labor supply is provided.

Jerry A. Hausman
Department of Economics
Massachusetts Institute of Technology
E52-271A
Cambridge, Massachusetts 02139

(617) 253-3644

Introduction

The effect of taxes on labor supply introduces interesting questions in economic theory, econometrics, and public finance. Since the greatest share of federal tax revenue, approximately 50 percent in 1980, is raised by the individual income tax, we are certainly interested in its effects on economic activity. The federal income tax is based on the notion of 'ability to pay'; and its progressive structure has received wide acceptance. The income tax has not been thought to induce large economic distortions so that it has been generally accepted as probably the best way to raise revenue where an unequal distribution of income exists. At the same time we finance social security by FICA which is a proportional tax with an upper limit. As both the tax rate and limit have grown rapidly in recent years, FICA taxes have become the subject of much controversy. In 1980 FICA taxes represented 28% of total Federal tax revenue. In Table 1 the income tax and payroll tax revenues are given for the period 1960-1980. It is interesting to note over that same period while the marginal income tax rate of the median taxpayer remained constant, the FICA tax rate more than doubled. At the same time the earnings limit rose about 220% in constant dollars. Over the same 20 year period the corporate income tax has decreased from 24% to 13% of Federal tax revenues. Likewise, excise taxes have decreased from 13% to 5%. Thus, taxes on labor supply currently amount to about 3/4 of Federal taxes raised.[1] Their potential effects on labor supply and

---

[1] Of course, not all income tax revenue is a tax on labor supply because of the taxation of capital income which was about 12% of adjusted gross income in 1980. Also, a portion of the incidence of FICA taxes fall on the employer although the amount is likely to be small.

TABLE 1

Revenues from Income and Payroll Taxes (billions)

Year	Income Tax Revenues	Payroll Tax[1] Revenues	Income Tax % of Federal Revenues	Payroll Tax % of Federal Revenues	Median Marginal Tax Rate[2]	Tax Rate for Payroll Tax	Earnings Limit for Payroll Tax
1960	$ 40.7	$ 11.3	45%	12%	20%	3.0%	$ 4800
1965	48.8	17.6	43	15	20	3.625	4800
1970	90.4	39.5	47	21	20	4.8	7800
1975	122.4	75.6	45	28	20	5.85	14100
1980	244.1	139.3	49	28	20	6.05	25900

1 Includes old-age, survivors, disability, hospital insurance, and railroad retirement taxes.
2 From Steverle and Hartzmark (1981) with interpolation to have years match up.

welfare are important because of the large and increasing reliance on direct taxation.

To measure empirically the effect of taxes on labor supply, problems in economic theory and econometrics need to be treated. First, the effect of progressive taxation is to create a convex, nonlinear budget set where the net, after tax wage depends on hours worked. Since most of consumer theory is based on constant market prices which are independent of quantity purchased, theoretical notions such as the Slutsky equation need to be modified to assess the effect of a change in the tax rate. Theoretical problems increase in complexity when we realize that other provisions of the tax code such as the earned income credit, the standard deduction, and FICA together with transfer programs such as AFDC create important nonconvexities in the budget set. Then certain portions of the budget set cannot correspond to utility maximizing points. Little definite knowledge can be gained by a theoretical analysis of the effect of taxation. In fact, we cannot usually tell whether an increase in tax rates will increase or decrease hours worked. Nor can we decide how an increase in exemptions or other similar changes will effect hours worked. Thus, only empirical investigation can determine the sign and magnitude of the effect of taxation.

Appropriate econometric techniques to measure the effect of taxation also need to treat the nonlinearity of the budget sets which taxation creates. Other problems such as components of the stochastic specification, limited dependent variables, and unobserved wages for nonworkers arise. Econometric procedures to handle these problems, many of which have only recently been developed, have been used to estimate labor supply functions. We review these results and discuss the

possible effects on labor supply of various tax reform proposals which have been enacted or have been discussed in the U.S.

The other important aspect of the taxation of labor supply is the effect on economic welfare. If Hicksian deadweight loss (excess burden) is accepted as the appropriate efficiency measure of the distortion created by taxation, we know that the deadweight loss is proportional to the square of the tax rate.[1] The ratio of deadweight loss to tax revenue raised rises approximately with the tax rate. In Table 1 it can be seen that the marginal tax rate for the median taxpayer is 26% while the top marginal tax rate on labor supply is 50%. If compensated labor supply elasticities are non-zero, even though small, the deadweight loss from the income tax is likely to be substantial. The important redistributive aspect of the income tax must not be lost sight of, but the cost of the current means of doing so is an important consideration. Again, we will consider various tax reform proposals and their possible effect on economic welfare.

The plan of the paper is as follows. Section 1 considers the theory of labor supply with taxes. The effect of the nonlinearity of the budget sets complicates the analysis so few definite conclusions can be reached. In Section 2 we develop an econometric model of labor supply so that the problems created by convex and nonconvex budget sets can be solved. Section 3 discusses the various tax systems in the United States. The federal income tax, FICA tax, and state income taxes all are used to develop the appropriate budget sets. We also discuss AFDC, social security benefits, and a negative income tax to determine how they affect labor supply budget sets. In Section 4 we present empirical estimates for husbands and wives labor supply functions. We also calculate

---

[1] See Auerbach (this volume) for a discussion of appropriate welfare measures in the presence of taxation.

the economic cost of the tax system for certain individuals. Because of small numbers in cross section samples, and mesurement problems, high income individuals are difficult to treat within the context of a labor supply model. Thus, in Section 5 we review the individual questionnaire data for high income people. It is interesting to note that it agrees broadly with the econometric evidence. In Section 6 we review the evidence from the negative income tax experiments and from samples of social security beneficiaries. These individuals face extremely high marginal tax rates so that interesting evidence of the effect of taxes is produced in these situations.

1.   The Theory of Labor Supply with Taxes

In a world without taxes, the theory of labor supply is characterized by the same conditions which characterize the theory of consumer demand. That is, the Slutsky conditions completely exhaust the theoretical restrictions on consumer response to a price change. Thus, in most previous work on the effect of taxation on labor supply, the authors consider taxes as lowering the net, after tax wage. Using the Slutsky equation

$$(1.1) \qquad \frac{dh}{dw} = \frac{\partial h}{\partial w} \bigg|_{u=\bar{u}} + h \frac{\partial h}{\partial y}$$

we decompose the change in hours into the substitution effect and the income effect. Since labor is supplied while leisure is demanded, the sign of the substitution effect is positive, while the sign of the income effect is negative if leisure is a normal good. We can conclude that the sign of the sum of the effects is indeterminate. It might then be considered the goal of empirical analysis to determine the sign and magnitude of the effect of taxation.

'However, this approach is seriously misleading in all cases except one. Consider the two good diagram of Figure 1.1. The composite good is used as numeraire so consumption is measured on the vertical axis with hours supplied on the horizontal axis. Non-labor income is denoted by y. The original pre-tax market wage is w and preferred hours of labor are h*. The effect of a proportional tax is then to lower the net, after tax wage to $w_t = w(1-t)$. Depending on the individual's preferences, desired hours of work, h* can either
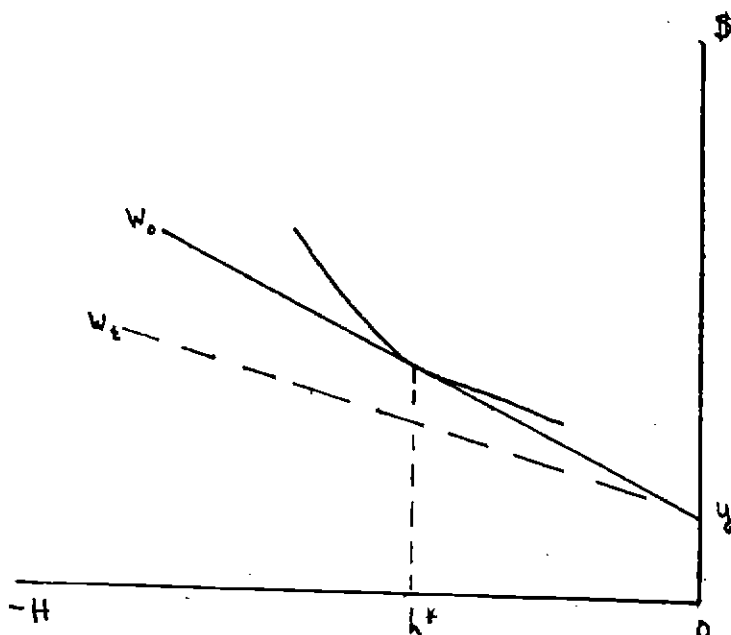
Figure 1.1

increase or decrease according to equation (1.1). Thus, in the case of
proportional taxation, the traditional analysis is correct. But, only for
proportional taxes is the analysis so simple. What makes the proportional tax
case so special is that non-labor income y is unaffected by the tax which is
implicitly assumed to be only a tax on labor income. If y were also subject to
taxation at rate t, we would have to take account of another income effect which
would cause h* to rise. Equation (1.1) would then need to be modified to account
for taxation of y to

$$(1.2) \qquad \frac{dh}{dt} = \frac{\partial h}{\partial w}\bigg|_{u=\bar{u}} \frac{dw}{dt} + h\frac{\partial h}{\partial y} + \frac{\partial h}{\partial y}\frac{dy}{dt}$$

When we consider the effect of taxation, the income and substitution effect of a
change in the wage as well as the change in non-labor income must be accounted
for. This equation becomes the key device in analyzing the effect of taxation on

desired hours of work. The total effect of taxation is still indeterminate but a complication has been added since changes in both w and y must be considered. In cases of progressive taxation or government tax and transfer programs, both w and y are affected. The traditional analysis has neglected to account for the effect on y of the tax system. We now consider how the analysis changes when non-proportional tax systems are considered.

Let us first analyze the simplest case, that of a progressive tax on labor income so that the marginal tax rate is non-decreasing. In figure 1.2 three marginal tax rates are considered, t_1, t_2, t_3, which lead to three after-tax net wages, w_1, w_2, w_3, where $w_i = w(1-t_i)$. H_1 and H_2 correspond to kink point hours which occur at the intersection of two tax brackets. But an important addition to the diagram are the "virtual" incomes y_2 and y_3, which follow from extension of a given budget segment to the vertical axis. They are denoted as virtual income because if
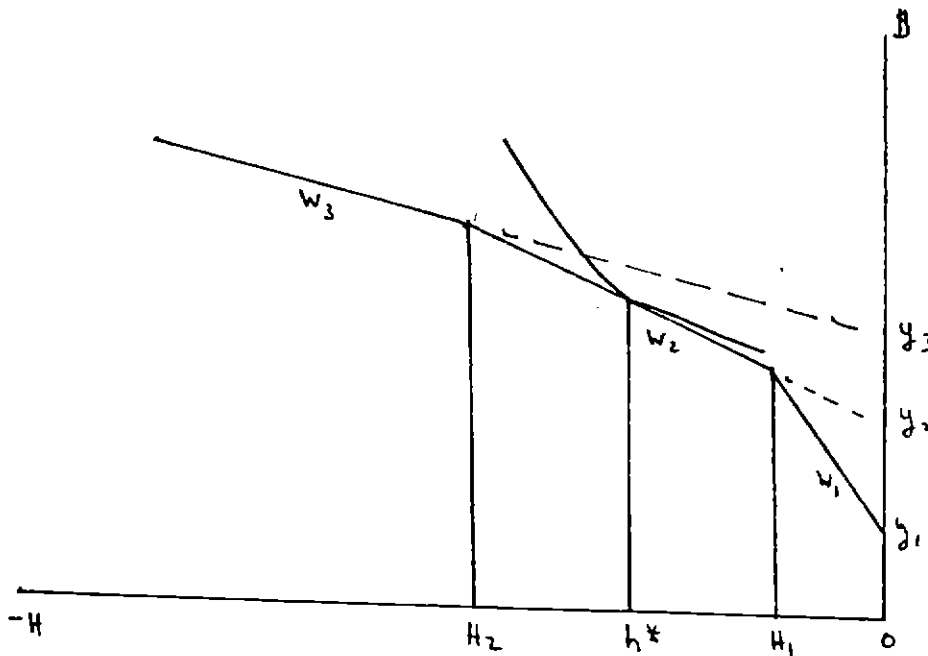

Figure 1.2

the individual faced the linear budget set $B_2 = (w_2, y_2)$, he would still choose hours of work h* as in Figure 1.2. In assessing the effect of taxation on labor supply, two questions arise. How does h* in Figure 1.2 differ from the no-tax situation of Figure 1.1? And how is h* in Figure 1.2 affected by a change in the market wage w or the tax rates, t_i?

To consider the first question in Figure 1.3 we combine Figures 1.1 and 1.2. We see that no general effect can be identified. If the individual's h* falls on the first budget segment $B_1 = (w_1, y_1)$ we are back in the case of Figure 1.1 with offsetting income and substitition effects. Alternatively, if h* falls on either B_2 or B_3 then the net wage is lower than w which leads to an income and
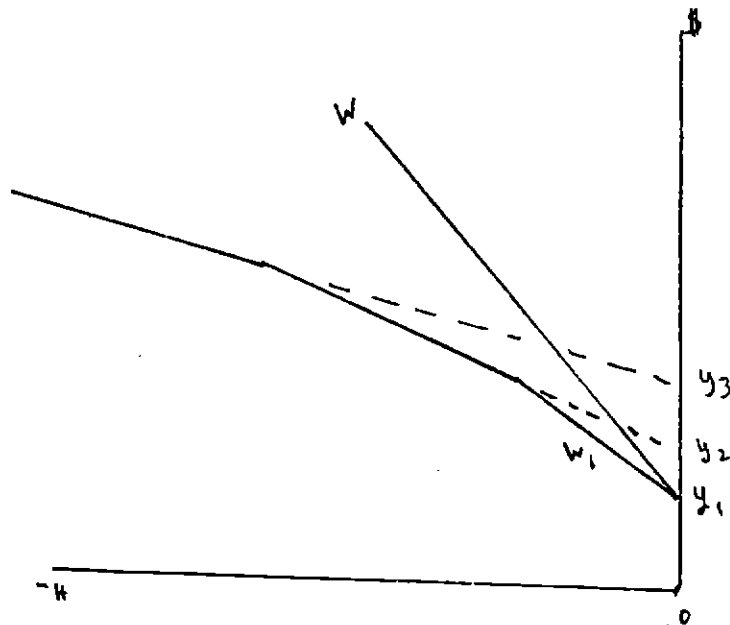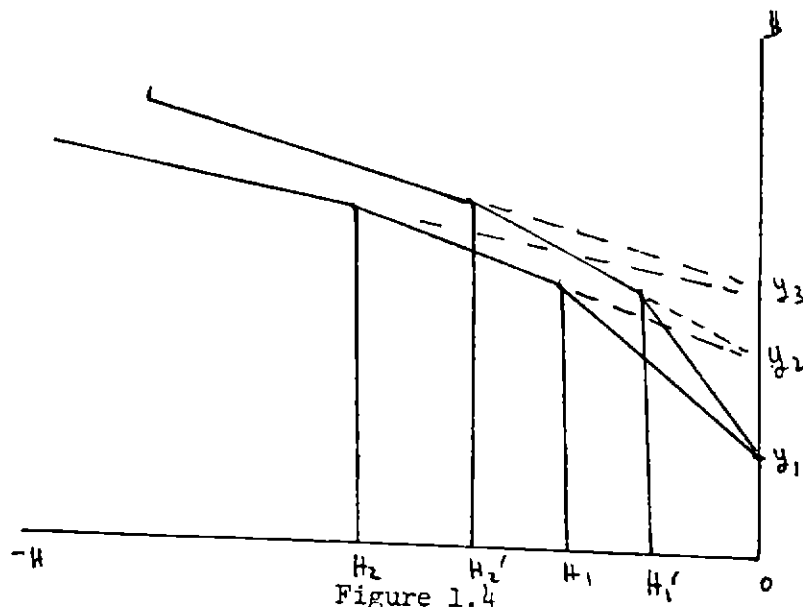

Figure 1.3

substitution effect, while virtual income y_2 or y_3 exceeds y_1 and a further income effect from equation (1.1) is created which would reduce labor supply.[1]

One result which does follow is that on the budget segment B_2 or B_3 labor supply is _less_ than it would be if the analysis were based on (w_2, y_1) or (w_3, y_1); that is, if the effect of the virtual income were ignored.

To answer the second question we initially consider an increase in the market wage from w to w'. In Figure 1.4 we see that this wage change leads to a clockwise rotation of the budget set. The effect of the rotation is to raise the w_i, but it also leaves the virtual incomes unchanged. For instance, the virtual income y_2 is $y_2 = E_1 \left(\frac{t_2 - t_1}{1 - t_1}\right) - y_1 \left(\frac{1 - t_2}{1 - t_1}\right)$ where E_1 is the earnings limit for the first tax bracket. Thus, the virtual incomes depend only on the tax system and nonlabor income, y_1. Therefore, so long as the individual's preferred hours of work h* remain on the same budget segment B_i, the effect of a wage change can be analyzed using the traditional local analysis which is contained in the Slutsky

Figure 1.4

eqn (1.2).

The effect of a change in a tax rate t_i depends on which t_i changes. To take the simplest case, suppose t_3 rises so that in Figure 1.2 the w_3 segment rotates counterclockwise. The virtual income y_3 also rises. We have the same effect as before where the change in wage alone induces both an income and substitution effect and the change in virtual income induces more labor supply from equation (1.2). It is important to note that a person whose preferred hours were previously on the third budget segment B_3 so that $h^* > H_2$ may now shift down to the second budget segment B_3 so that $H_1 < h^* < H_2$ if the substitution effect is large enough. Individuals whose preferred hours were less than H_2 before the change will not be affected. However, if the tax rate were to decrease we could again have people shifting from the second segment to the third segment because of the substitution effect. For these cases, we need "global" information on the individual's preferences, since the local information in the Slutsky equation is not sufficient to analyze the possible changes. Now if either t_1 or t_2 were to change, the situation is more complicated since all later budget segments are also affected. However, the later budget segments are affected only by a change in their virtual income since the net wage remains the same. Thus, if t_1 rises, for those individuals with $h^* > H_1$, the effect of the tax change is to cause their preferred hours to rise. For people dwhose $h^* < H_1$ initially only w_1 changes (although y_1 may change also) so that the Slutsky equation can be used. Lastly suppose one of the tax bracket limits E_i changes. If E_i is lowered, all virtual incomes on later budget segments fall. Therefore if initially $h^* > H_1$ we have a similar qualitative effect to a rise in t_1. Preferred hours of work will rise. For an individual whose initial $h^* < H_1$ but with E_1' have $H' < h^*$ the analysis is more complicated. They may switch to B_2

with its lower net wage, and higher virtual income or they may decrease their desired hours of work so that $h^* < H_1'$ and they remain on the first segment.

From the analysis of the progressive tax case we see that very few general propositions can be deduced about the effect of taxes on labor supply. The piecewise linear progressive tax system is defined by a sequence of budget segments $B_i = (w_i, y_i)$ of net wages and virtual incomes for the individual over a set of hours (H_i, H_{i+1}). Some limited results are possible for changes in t_i and E_i for individuals whose initial hours of work are on a subsequent budget segment B_{i+j}, $j > 0$. But to assess the effect of taxation adequately we really need to know the individual's preferences or equivalently, his utility function. We will show how knowledge of his utility function arises in the process of estimating his labor supply function so that numerical computations of the effect of taxation can be carried out.

When we do not have a progressive tax system, matters become more complex since the budget set is no longer convex.[2] Non-convex budget sets arise from the presence of government transfer programs. The three most important programs of this type are AFDC, Social Security benefits, and a negative income tax (NIT) program. In Figures 1.5 and 1.6 we show the two most common tyupes of non-convex
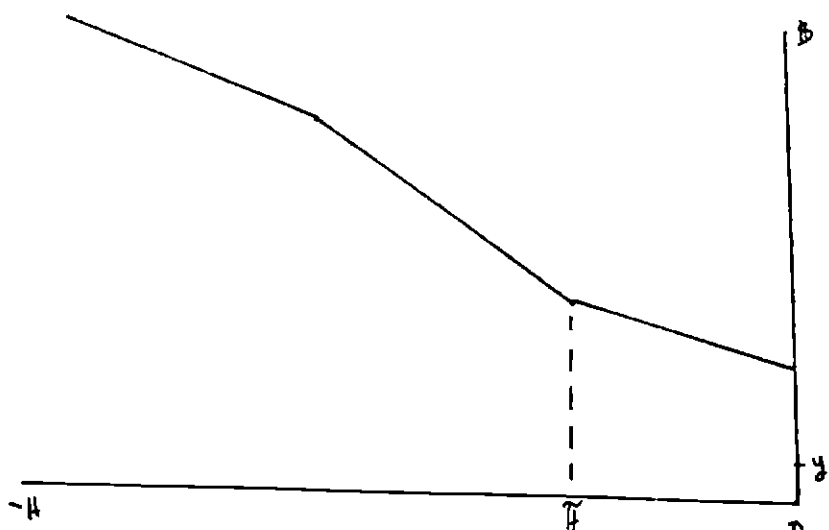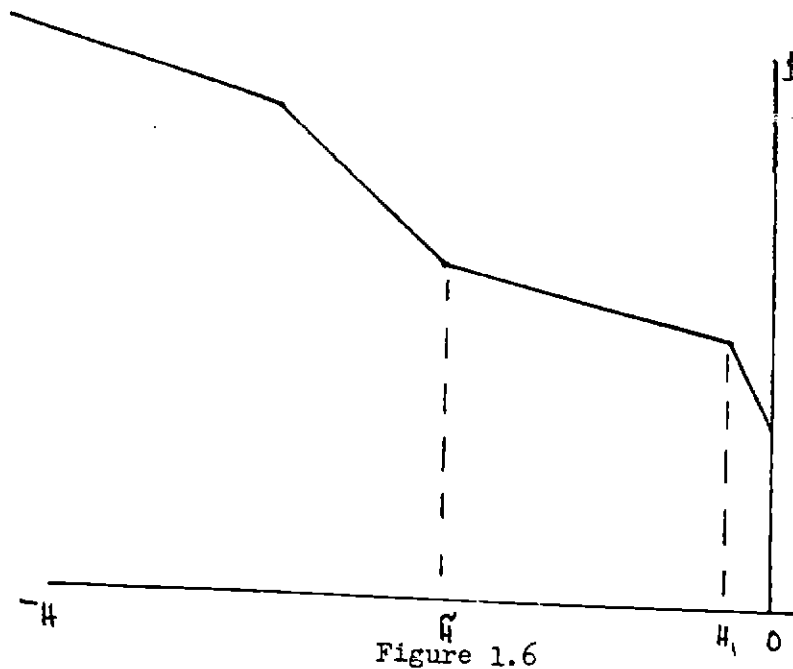

Figure 1.5

Figure 1.6

budget sets.[3]   In the first type of budget set used in the NIT experiments,

and in the majority of AFDC programs, non-labor income is raised by the amount of

the government transfer. The individual then faces a high marginal tax rate,

usually .4 or higher, until he reaches H, the breakeven point at which all

benefits have been taxed away. Beyond the breakeven point, the individual

rejoins the federal tax system, here taken to be convex. Figure 1.6 has one

additional complication which arises as an earnings disregard in Social Security

benefits or as a maximum payment amount in some AFDC programs.[4]   Hours up to H_1

are taxed only at FICA rates where H_1 is determined by E_1. Beyond this point,

the individual faces the high marginal rates until breakeven hours are again

reached. On a priori grounds, almost nothing can be said about the effect of

taxation in the non-convex budget case. The added complication arises from the

possibility of multiple tangencies between indifference curves and the budget

set.

Figures 1.7 and 1.8 demonstrate two cases of multiple tangencies although actual cases may be even more complex due to the possibility of skipping entire budget segments. The possibility exists of having multiple optima as in
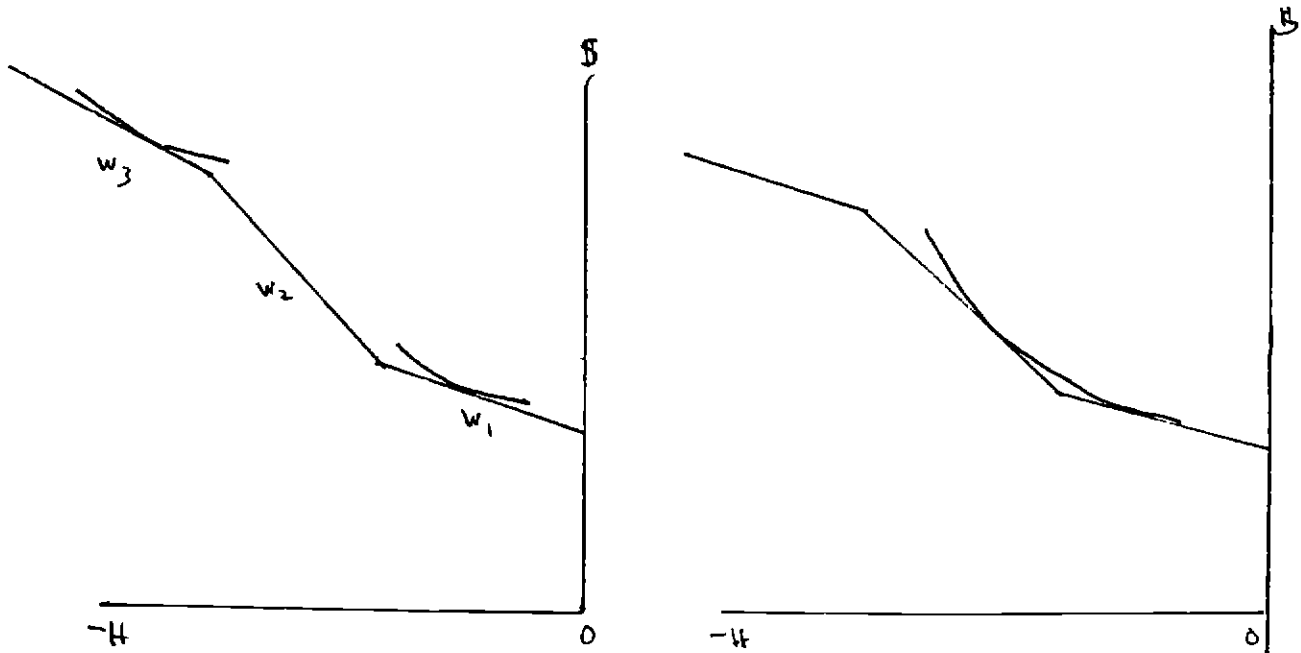
Figure 1.7

Figure 1.8

Figure 1.7 because $w_1 < w_3$ while $y_2 < y_3$. In the convex case this possibility does not arise because as w_i falls y_i is rising. To determine the global optimum we need to have knowledge of the utility function. Figure 1.8 demonstrates the case of a joint tangency the possibility of which arises with each non-convex segment. Small changes in the wage or any parameter of the tax system can then lead to large changes in desired hours of work.

In the convex budget case, we must always have a tangency which is unique and which represents the global optimum if desired hours are positive. For if we

had two tangencies we could connect the two points, and the connecting lines which would lie inside the original budget set would represent preferred points by the assumed concavity of preferences.[5] Furthermore, the effect of h* of a change in the market wage, taxes, or the earnings limits is "smooth" in an appropriate mathematical sense that the change is continuous and differentiable. For the non-convex case, this reasoning no longer follows since the line connecting the multiple tangencies no longer lies within the budget set. Thus, multiple tangencies may occur. Likewise, the effect of changes in the budget set are no longer smooth, since a small change may cause a jump in desired hours from an initial tangency to the neighborhood of another initial tangency. Thus, it seems that no general propositions hold. The extended Slutsky equation (1.2) is not usable since the possibility of a jump from one budget segment to another is always present.

We briefly consider the cases where we could say something definite in the convex case: a rise in t_1 or a drop in E_1 for individuals not on the first segment. For individuals who remain on the convex budget segments like w_2 and w_3 in Figure 1.7 virtual incomes again fall while w_i remains constant so that the local efect is again a rise in desired hours of work. But one cannot rule out the possibility of a non-local jump down to the first segment or even withdrawal from the labor force entirely. Similar possibilities exist if E_1 is decreased. Thus, the analysis of the non-convex case cannot proceed without knowledge about the form of the individual's utility function.

Important potential shortcomings exist in this theory of labor supply which we now discuss briefly. Future work on an econometric models will need to incorporate these problems into the theory and estimation. First, individuals

may face quantity restrictions in labor supply. That is, h^* may not be possible for systematic reasons. Certainly "involuntary" unemployment falls into this category. In principle, even if quantity restrictions exist we can estimate the underlying demand function or preference structure and analyze the effect of taxes. But a more difficult problem is to ascertain if individuals are actually constrained. Endless debates on the possibility of involuntary unemployment highlight this problem. Furthermore, survey questions on the ability of a person to work more hours are very untrustworthy. To date, only limited progress has been made on this problem.[7] Better data seems to be required to put quantity constraints into an empirical model in a totally satisfactory manner.

This type of labor supply theory also does not adequately treat the type of jobs people take or their intensity of work while on the job.[8] An effect of taxes is to make nonpecuniary rewards more attractive so that a measure of earnings may seriously misrepresent the preference comparisons being made among jobs. Academics need hardly be reminded of this fact in the present world of falling real academic wages. Yet it is doubtful that this problem will ever be completely solved. "Perks" from a job could be evaluated monetarily and included in earnings. But we cannot hope to measure adequately certain types of non-monetary rewards to jobs.

A last consideration is intertemporal aspects of the model. We have considered a static world devoid of human capital considerations and intertemporal factors such as savings. But intertemporal issues may be quite important for new entrants into the labor market and for individuals close to retirement. The eighty-hour weeks put in by young lawyers will be rewarded in the not-too-distant future so that current compensation is an inadequate measure

of earnings. Furthermore, ussues of on-the-job training may be important. To date, research on issues of intertemporal labor supply have indicated only limited empirical importance of this problem.[9] But further empirical research based on less restrictive models may find a more important role for intertemporal considerations.

In this section we have considered from a theoretical point of view the effect of taxes on labor supply. The Slutsky equation which has been traditionally used to analyze the problem is inadequate except for the case of a proportional tax. Progressive taxation results in a convex budget constraint which leads to a multiplicity of net wages and virtual incomes. We see that except for a few cases the effect of a change in the tax rate cannot be determined on a priori grounds even if reasonable assumptions are made such as leisure being a normal good. Government tax and transfer programs result in non-convex budget sets which are even more difficult to analyze theoretically. Thus, we now turn to the econometrics of the problem so that models can be estimated. From the estimated models we can assess the effect of taxation. However, as with all models we discuss certain aspects of the problem which have not been included. The results should be interpreted with this limitations in mind.

NOTES

[1] It may well be this latter income effect which creates the appearance of a backward bending labor supply curve which has been found in many empirical studies. The important point here is that no only do we have a income effect from the change in wage, but virtual income also rises due to the effect of the tax system.

[2] As we will discuss subsequently, even the federal tax system is not truly convex because of the effect of Social Security payments, the earned income credit, and the standard deduction. However, it may well be the case that treating taxes in a convex budget set is a sufficiently good approximation for empirical work.

[3] A non-convexity may also arise, not from the tax system, but due to fixed costs to working, e.g., Hausman (1980). We will discuss fixed costs in the next section.

[4] See Hanoch and Honig (1978) for a theoretical analysis of the Social Security case. Burtless and Moffitt (1982) discuss the Social Security budget set within a model of labor supply and retirement. See also Blinder, Gordon, and Wise (1980) for a treatment of intertemporal considerations.

[5] See Hausman (1979) for further analysis and implications of this case.

[6] The necessity of paying benefits, except for Social Security payments, is not a sufficient reason when total compensation is taken into account. Of course, most studies use the gross wage and neglect benefits due to lack of data.

[7] Ham (1982) has introduced quantity constraints into a labor supply model without taxes. See Deaton (1981) and Deaton and Muellbauer (1981) for further research on quantity restrictions. Brown et al. (1982) have attempted to incorporate quantity restrictions in a short term labor supply model which does incorporate taxation.

[8] To the extent that wages reflect intensity of work, this problem may not be too serious. However, for many jobs wages may be only loosely related to current effort with longer-run goals important. We discuss this issue subsequently. See Rosen (1980) for a discussion of these problems.

[9] MacCurdy (1981) has estimated an intertemporal model of labor supply. However, he did not consider the effect of taxation within the model.

2. Tax Systems

In the previous section we have discussed the theory of labor supply with taxes. We will now describe the type of tax systems which exist in the United States. To give a historical perspective on the problem, we will outline the evolution of the income tax rate over the century. We will also provide data on actual marginal tax rates since 1960 when the data becomes available. We shall discuss federal and state income taxes first. It turns out that even though the basic federal income tax is progressive, the resulting budget set that an individual faces is not convex. FICA payments, the standard deduction, and the earned income credit all introduce nonconvexities. These additions to the basic progressive tax system will be explained. Next we discuss AFDC tax systems for each state. Lastly we briefly discuss tax systems for social security beneficiaries and negative income tax (NIT) recipients. All of these tax systems have very large nonconvexities togewther with quite high marginal tax rates.

We first outline the basic federal income tax system in 1980 by 12 brackets.[1] The first bracket is $1,000 wide with succeeding brackets falling at intervals of $4,000. Since we are interested in the effect of taxes on labor supply, we consider only taxes on earned income. Table 3.1 lists the brackets along with the marginal tax rates and average tax rates at the midpoint of the bracket. It is interesting to note that the average tax rate remains significantly below the marginal tax rate until quite high levels of earned income are reached. Thus a theory which stated that individuals react to average after tax income when making marginal decisions might come up with rather different results. However, the theory of individual behavior with respect to

Table 2.1

Basic Federal Tax Rates for 1980 on Earned Income for Married Couples[2]

Taxable Income	Marginal Rate	Average Rate at Midpoint
0-2,000	.14	.14
2,000-4,000	.16	.147
4,000-8,000	.18	.160
8,000-12,000	.21	.174
12,000-16,000	.24	.189
16,000-20,000	.28	.204
20,000-24,000	.32	.222
24,000-32,000	.37	.250
32,000-42,000	.43	.287
42,000-56,000	.49	.331
56,000+	.50	--

progressive taxation contains both the marginal net wage and the appropriate virtual income which reflects average tax rates up to the current tax bracket. In a certain sense, the entire characteristics of the tax system are accounted for in this way.

In determining taxable income personal exemptions need to be accounted for. An exemption of $1000 per person was allowed in 1980. The standard deduction, or zero bracket amount, was $3,400 for married couples in 1980. Itemized deductions in excess of $3,400 could also be subtracted from gross income. They were approximately 9% of adjusted gross income in 1980. The standard deduction i.e., no itemized deductions, was used on approximately 70% of all tax returns in 1980.

Next, the earned income credit grants a credit of 10% below $5,000 of gross income. From $6,000 to $10,000 the credit is reduced by 12.5% so that the brerakeven point is reached at $10,000 when the credit has been completely exhausted. A nonconvexity is created at $10,000 because the tax rate falls by the 12.5 payment when the breakeven point is reached. Lastly FICA contributions were 6.05% up to a limit of $25,900 in 1980. Thus, in the appropriate bracket when the FICA limit is reached, the marginal tax rate falls from about .38 to about .32 which also creates a nonconvexity.[3] We provide some historical data on tax rates and actual marginal rates to provide a historical perspective on the income tax system.[4]

In Table 2.2 we provide a summary of marginal tax rates for the period 1950-1984, according to current legislation.[5] These rates are for single taxpayers with no exemptions or deductions accounted for. We also give the CPI and median family income so that valid comparisons across different yours can be made. First, note that the tax system between 1950 and 1980 was only imperfectly indexed for inflation. The median income faced a marginal tax rate of 22% in 1950, but multiplied by the change in the CPI, this amount faced a mrginal rate of 26% in 1980. Similarly $10,000 of earned income in 1950 had a marginal tax rate of 38% in 1950, but adjusted for inflation, this marginal tax rate increased to 43% in 1980. Similar increases in marginal tax rates occurred over the periods 1960-1980 and 1970-1980. Of course, this imperfect indexation corresponds to greater progressivity which may have been the intent of Congress over the period. However, note that under the tax reform of 1981, marginal rates will drop substantially by 1984 due to the 25% tax reduction, with the exact amount depending on inflation over the 1982-1984 period. Much of the 'bracket

creep' of the past decade will be eliminated. Under current legislation, the tax system will then be indexed after 1984. Another interesting finding which emerges from Table 2.2 is the significantly higher marginal tax rates faced by the median earner over the period. Besides the effect of inflation and imperfect indexation, real wage growth also led to higher marginal taxes. Lastly, note the remarkable decline in maximum taxes or earned income which arose with the Tax Reform Act of 1969. To determine the effect of these tax changes we now consider the actual marginal rates faced by given segments of the population.

We now present marginal tax rates from a sample of returns in Table 2.3 calculated by Steverle and Hartzmark (1981) in a very useful paper. Of course, the tax rates correspond to total income rather than just labor income which was considered in Table 2.2. The significant rise in the progressivity of the

Table 2.2

Federal Income Tax: Selected Marginal Rates

Taxable Income (1000's)	1950 $(1.0,3.3)$[3]	1960 $(1.23,5.6)$	1970[1] $(1.61,9.8)$	1980 $(3.42,21.0)$	1984[2]
2-4	22	22	19	16	12
6-8	30	30	26	21	16
10-12	38	38	33	26	20
16-18	50	50	43	40	30
20-22	56	56	49	43	23
26-32	62	62	54	50*	38
38-44	69	69	59	50	42
50-60	75	75	64	50	46
60-70	78	78	66	50	48
70-80	81	81	68	50	48
80-90	84	84	70	50	49
90-100	87	87	71	50	50
100-150	89	89	72	50	50
150-200	90	90	72	50	50

Table 2.2 (Continued)

[1] Includes 2.5% surtax.
[2] The 1984 rates reflect the entire 25% tax reduction passed by Congress in 1981. The tax will then be indexed.
*Maximum tax on earned (labor) income was 50% beginning in 1972 under the Tax Reform Act of 1969.
[3] First entry is CPI in 1950 dollars and second entry is median family income in thousands of current dollars.

----

income tax in the 1960-1980 period is evident in Table 2.3. Note that for those

Table 2.3

Marginal Rates of Taxation on Personal Income

| Percentile of Returns | Marginal Rates | | | | Average Marginal Tax Rates | | |
	1961	1969*	1974	1979	Year	Rate	Payroll Tax Included
1%	.00	.00	.00	.00	1950	15.2	--
5%	.00	.00	.00	.00	1955	16.3	--
10%	.00	.00	.00	.00	1960	16.4	19.4
25%	.18	.15	.15	.14	1965	14.0	17.6
50%	.18	.23	.20	.20	1970	17.2	22.0
75%	.22	.25	.22	.24	1975	17.4	23.3
90%	.22	.28	.28	.32			
95%	.26	.32	.32	.38			
99%	.38	.47	.47	.50			

*Includes an approximation for surtax changed in 1969.
**From Seater (1982).

----

households which paid tax, the marginal rate was between .18 and .26 up through

the 95% percentile. In fact 59% of all taxpayers who had a non zero marginal

rate, had a rate of 18%. While the marginal rate for the median return increased

by 10% between 1961 and 1979, the difference in rates on the interquantile range

increased by 33%. This considerable increase in the progressivity of the

marginal tax rates will significantly decrease by the tax legislation changes of 1981.

Another historical comparison of marginal tax rates is provided by Seater (1982) who based his estimates on the Statistics of Income rather than a sample of individual returns. Except for the years 1964-67 when the Kennedy cut lowered tax rates the movement of the average marginal tax rate has increased over the period 1950-1980. When the effects of the payroll tax are included the increase is from an average marginal tax rate of about 15% in 1950 to an average rate of over 23% in 1975 which is an increase of 43% in the 25 year period. Therefore, the increases in the payroll tax over the period have a large effect on the marginal tax rates.

State income taxes (including the District of Columbia) should also be briefly mentioned. In 1980 nine states did not tax earned income but the other 42 states have either progressive of proportional tax systems. Sixteen states permit deduction of federal income taxes. Among the states with progressive tax systems Delaware has the highest overall marginal tax rate of 19.8%. However, at $15,000 after personal exemptions the marginal rate in California is 10%, in Hawaii it is 10%, in Minnesota it is 14%, in New York state it is 10%, in Oregon the marginal tax rate is 10% above $15,000, and in Wisconsin the marginal rate is 11.4% at $15,000. Nebraska, Rhode Island and Vermont are the only states which take a constant percentage from the federal taxes paid. Rhode Island takes the highest proportion, 17%. Among states with proportional rates after personal exemptions Illinois has a rate of 2.5%, Massachusetts has a rate of 5.4% and Indiana and Pennsylvania have rates of 2%. State governments have increasingly turned to direct taxation as a source of revenue over the past 20 years.

Beside the operation of the Federal tax system, another potentially more important influence on labor supply of female heads of household is the AFDC tax and transfer system. It has often been contended that AFDC presents a significant disincentive to labor supply, and its replacement by NIT could significantly decrease the work disincentive. The basic design of AFDC programs is a transfer payment which depends on family size accompanied by a tax rate of 67% until the breakeven point is reached and the person returns to the federal tax system. A sizeable nonconvexity is created because at the breakeven point the marginal tax rate decreases from .67 to approximately .16. Thus, the potential discincentive effect is quite large.[6] States differ in the size of the transfer payment and also in the exact operation of the AFDC tax system. The majority of the states permit $30 of earned income per month before starting to levy the .67 tax. Thus, in Figure 2.1 we show the basic outline of the AFDC budget set. Breakeven hours $\tilde{H}$ may not be reached even by women who work full time at the level of wages which AFDC recipients typically receive.
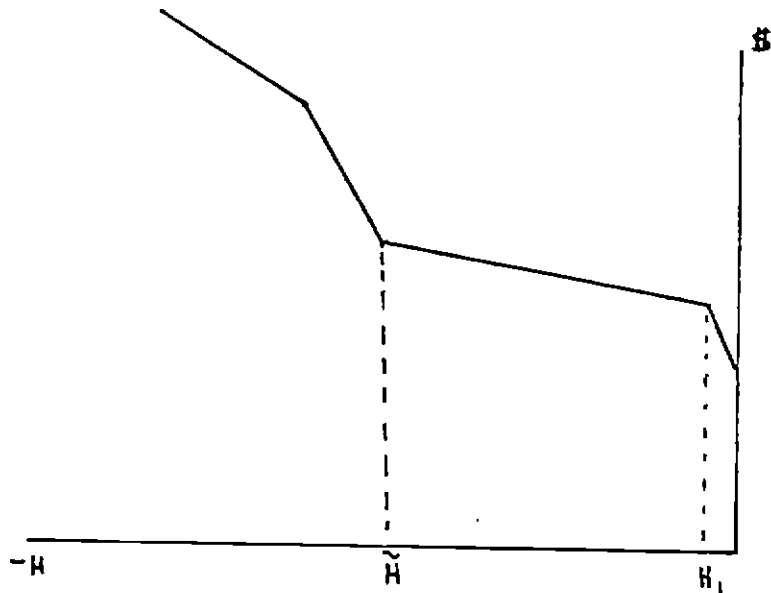

Figure 2.1

The workings of NIT tax systems resemble AFDC as in Figure 2.1 although no earnings disregard exists. Major differences are eligibility, since all families would qualify, and benefit and tax parameters. The NIT guarantee is a function of the povery limit which depends on family size and the local cost of living. The guarantee has been set at between .75 and 1.25 times the poverty limit in the NIT experiments. For instance in Indiana .75 times the poverty limit was 28% higher than the AFDC payment for non-labor force participation for a family of four. Thus the NIT guarantee is typically more generous than the AFDC payment. The marginal tax rate up to breakeven hours is also lowered from .67 to a value between .4 and .6. The budget set has the nonconvex form of Figure 2.2 where beyond breakeven hours, $\tilde{H}$, the individual returns to the federal tax system. At breakeven hours the marginal tax rate falls from .4 and .7 to around .25 when federal taxes and FICA are accounted for. For male heads of households with good jobs on the less generous plans of a low guarantee and high tax rate, breakeven
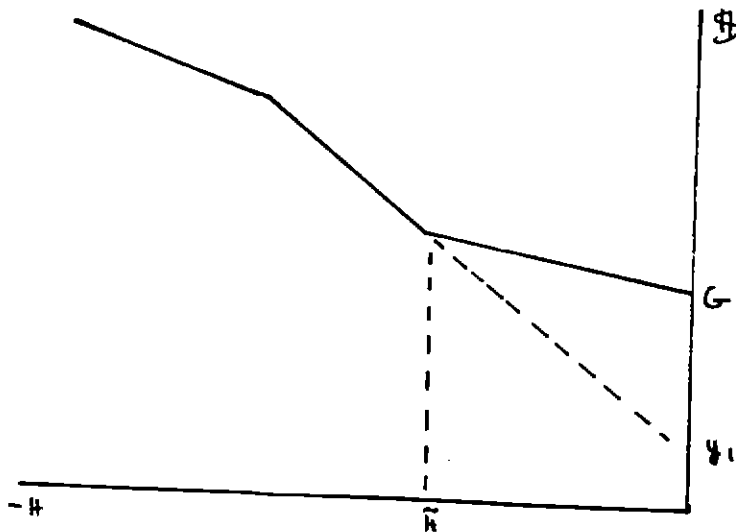

Figure 2.2

hours will be reached at about 120 hours per month of work. For males on very generous plans or those with low wages, breakeven costs will not be reached even for high hours of work. Likewise, for female heads of household the majority will not reach breakeven hours because of their relatively low wages. Thus the position of the first tax segment and the nonconvexity created at $\tilde{H}$ hours may have a significant influence on labor supply decisions.

The last tax system we consider is the operation of the social security earnings test for individuals between 62 and 70 years old who are receiving. social security benefits. The budget set has exactly the same form as the operation of AFDC in Figure 2.1. A level of benefits and family composition. An 'earnings disregard' then exists up to an amount which determines H_1 hours. Beyond H_1 hours earnings are taxed at a rate of .5 until breakeven hours $\tilde{H}$ are reached. Thus, we again seem to have a possibly large disincentive to working.[7]

But, this diagram leaves out a potentially important effect which Blinder, Gordon, and Wise (1980) point out. The effect is that current earnings will replace lower previous earnings which are used to compute average monthly earnings which the benefit level is partly based on. Especially with the low levels of previous FICA amounts, current earnings could replace the $3,600 level in force from 1951-1954 and for about 20% of near retirement workers replace previous zero FICA earnings years. Thus, if individuals understand the admittedly extremely complex social security benefit formulas, the work disincentives can be greatly diminished. Blinder, Gordon, and Wise actually give an example where the earnings test is more than compensated for as a work incentive exists. Thus, empirical studies which use historical data may have

great difficulty in adequately representing the correct budget set. The indexing provision of the 1977 Social Security Amendments greatly lowers the quantitative significance of earnings replacement. However, the disincentives effect of the earnings test is still diminished. The intertemporal aspects of the interaction of social security and the retirement decision probably require a more complex model than our essentially one period representation of the budget set. While the problem is quite difficult to represent in a model, social security may have a significant effect on retirement.[8]

In this section we have discussed the effect of Federal and state tax systems on the budget set. While federal tax rates are uniformly progressive, nonconvexities still exist in the budget set due to the presence of the standard deduction, earned income credit, and FICA contributions. State income tax and AFDC programs are also discussed. Next the NIT tax system and its relation to AFDC is considered. Lastly, the budget set for the social security earnings test and the complex intertemporal aspects of retirement are outlined. In this last area further work seems required to extend the labor supply model to account for intertemporal decisions.

NOTES

[1] Here we discuss our procedure for joint returns. We followed similar procedures for single persons and heads of households but do not report the details here.

[2] Tables exclude the zero bracket amount for the standard deduction.

[3] However, empirical work by Hausman (1981a) did not indicate that the nonconvexities created by the earned income credit and FICA had an important influence on the econometric estimates.

[4] Tax law changes in 1981 provide for exclusion from taxation of 10% of the secondary worker's earnings up to $30,000 beginning in 1983. This change greatly increase the neutrality of the tax system towards married persons.

[5] The tax rates are taken from Tax Foundation (1981).

[6] Under current legislation in certain cases the tax rate is 100%. An important distinction exists between the statutory tax rate and the effective tax rate because of various allowable deductions. Moffitt (1981) estimates the effective AFDC tax rates over a sample of recipients.

[7] If the individual is eligible to receive benefits but continues working without receiving benefits, his future benefits are increased by an approximately actuarily fair amount between the ages of 62 and 65. The adjustment for ages 65-70 is considerably less.

[8] The Blinder et al. conclusions have been challenged by Burkhauser and Turner (1981); a reply is given by Blinder et al. (1981). For empirical estimates of the effect of social security or retirement see Gordon and Blinder (1980), Boskin and Hurd (1982), Burtless and Moffitt (1982) and Diamond and Hausman (1982). These results are reviewed in the last section of the paper.

3. The Econometrics of Labor Supply with Taxes

The essential feature which distinguishes econometric models of labor supply with taxes from traditional demand models is the non-constancy of the net, after tax wage.[1] Except for the case of a proportional tax system, the net wage depends on hours worked because of the operation of the tax system. Also the marginal net wage depends on the specific budget segment that the individual's indifference curve is tangent to. Thus, econometric techniques need to be devised which can treat the nonlinearity of the budget set. However, it is important to note at the outset that a simultaneous equation problem does not really exist, even though the net wage received depends on hours worked.[1a] Given a market wage which is constant over hours worked and a tax system which is given exogenously by the government, the nonlinear budget set faced by the individual in deciding on his preferred hours of work is determined exogenously to his choice.[2] An econometric model needs to take the exogenous nonlinear budget set and to explain the individual choice of desired hours. We first describe such a model for convex and nonconvex budget sets. As expected, the convex case is simpler to deal with. We then consider other issues of model specification such as variation in tastes, fixed costs to working, and quantity constraints on available labor supply.

Econometric estimation is quite straightforward in the case of a convex budget set. Since a unique tangency or a corner solution at zero hours will determine desired hours of work, we need only determine where the tangency occurs. To do so we begin with a slight generalization of the usual type of labor supply specification

(3.1) $h = \tilde{g}(w,y,z,\beta) + \varepsilon = h^* + \varepsilon$

where w is a vector of net wages, y is a vector of virtual income, z are individual socioeconomic variables, β is the unknown vector of coefficients assumed fixed over the population, and ε is a stochastic term which represents the divergence between desired hours h^* and actual hours. The typical specification that has been used in $\tilde{g}(\ )$ is linear or log linear and scalar w and y corresponding to the market wage and nonlabor income. The stochastic term is assumed to have classical properties so that no quantity constraints on hours worked exist. However, $0 < h < \overline{H}$ where H is a physical maximum to hours worked. We also assume that when the β's are estimated that the Slutsky conditions are satisfied so that $\tilde{g}(\ )$ arises from concave preferences.

The problem to be solved is to find h^* when the individual is faced with the convex budget set, B_i for i=1,...,m.[3] To find h^* we take the specification of desired hours on a given budget segment B_i

(3.2) $h_i^* = g(w_i,y_i,z,\beta)$

Calculate h_i^* and if $0 < h_i^* < H_i$ where the H_i's are kink point hours in Figure 1.2 then h_i^* is feasible and represents the unique tangency of the indifference curves and the budget set. However, if h_i^* lies outside the interval $(0,H_i)$ it is not feasible so we move on to try the next budget segment. If $H_1 < h_2^* < H_2$ we again would have the unique optimum. If we have bracketed the kink point so that $h_i^* > H_1$ and $h_2^* < H_1$, then $h^* = H_1$ so that desired hours fall at the kink point. Otherwise we go on and calculate h_3^*. By trying out all the segments we will either find a tangency or find that $h_i^* < H_{i-1}$ for all i in which case $h^* = 0$ or $h_i^* > H_i^*$ for all i in which case $h^* = \overline{H}$. Then a nonlinear least squares procedure

or Tobit procedure to take account of minimum hours at zero should be used to compute the unknown β parameters. The statistical procedure would basically minimize the sum of $\sum_{j=1}^{N} (h_j - h_j^*)^2$ where j represents individuals in the sample.[4] Perhaps a better technique would be to use Tobit which enforces the constraint that $h_j > 0$.

The case of the nonconvex budget set as in Figure 1.5 or Figure 1.6 is more complicated because equation (2.2) can lead to more than one feasible tangency which leads to many potential h_i^*'s. How can we decide which of these feasible h_i^*'s is the global optimum? Burtless-Hausman (1978) initially demonstrated the technique of working backwards from the labor supply specification of equation (2.2) to the underlying preferences which can be represented by a utility function.[5] The basic idea to make use of Roy's identity which generated the labor supply function from the indirect utility function $v(w_i, y_i)$

$$(3.3) \qquad \frac{\partial v(w_i, y_i)}{\partial w_i} \; / \; \frac{\partial v(w_i, y_i)}{\partial y_i} = h_i^* = g(w_i, y_i, z, \beta)$$

along a given budget segment. So long as the Slutsky condition holds then $v(w_i, y_i)$ can always be recovered by solving the differential equation (2.3). In fact, $v(\ )$ often has a quite simple closed form for commonly used labor supply specifications. For the linear supply specification

$$(3.4) \qquad h_i^* = a w_i + \beta y_i + z\gamma$$

Hausman (1980) solved for the indirect utility function

$$(3.5) \qquad v(w_i, y_i) = e^{\beta w_i} \left(y + \frac{\alpha}{\beta} w - \frac{\alpha}{\beta^2} + \frac{z\gamma}{\beta} \right)$$

Given the indirect utility function, all of the feasible tangencies can be compared, and the tangency with highest utility is chosen as the preferred hours of work, h^*.[6] Then as with the convex budget set case, we can use either nonlinear least squares or a Tobit procedure to estimate the unknown coefficients. While using a specific parameterization of the utility function seems upsetting to some people, it should be realized that writing down a labor supply function as in equation (2.2) is equivalent to writing down a utility function under the assumption of utility maximization. To the extent that the labor supply specification yields a robust approximation to the data, the associated utility function will also provide a good approximation to the underlying preferences. The utility function allows us to make the global comparisons to determine the preferred hours of labor supply. The convex case needs only local comparisons, but the nonconvex case requires global comparisons because of the possibility of multiple tangencies of indifference curves with the budget set.

We next introduce the possibility of variation in tastes. In the labor supply specification of equation (2.1), all individuals are assumed to have identical β's so that the variation of observationally equivalent individuals must arise solely from ε. However, empirical studies seemed to do an inadequate job of explaining observed hours of work under the assumption of the representative individual. Burtless-Hausman (1978) allowed for variation in preferences by permitting β to be randomly distributed in the population. Their results indicated that variation in β seemed more important than variation in α.[8]

They also found that variation in β represented approximately 8 times as much of the unexplained variance as did variation in ε. Hausman (1981) also found parameter variation to be an important part of his econometric specification. Blomquist (1982) tests for and rejects the constant preference (no parameter variation) model. However, his results on terms of policy interest are quite similar whether or not preference variation is specified. An even more satisfactory procedure would be to allow all the taste coefficients to vary in the population. At present the requirement of evaluating multiple integrals over nonrectangular regions for the more general specification has led to use of the simple case of one or two taste coefficients varying. Further research is needed to determine whether this more complex specification would be an important improvement over current models. Hausman (1982) uses panel data to allow for general preference variation by conditioning on individual coefficients. Estimates of separate coefficients for each individual can be accomplished using the time series aspect of the data. The need for distributional assumptions or the varying parameter is also eliminated.

Another consideration which can have an important effect on the budget set for women's labor force participation is fixed costs to working. Transportation costs, the presence of young children, and search costs of finding a job all can lead to a fixed cost element in the labor supply decision. The basic effect of fixed costs is to introduce a nonconvexity in the budget set at the origin. Thus, even if the original budget is convex as in Figure 1.2 the presence of fixed costs leads to a minimum number of hours H_0, which depends on the wage, below which an individual will not choose to work. In Figure 3.1 nonlabor income is y_1 with the original convex budget set drawn by the dotted line. However,
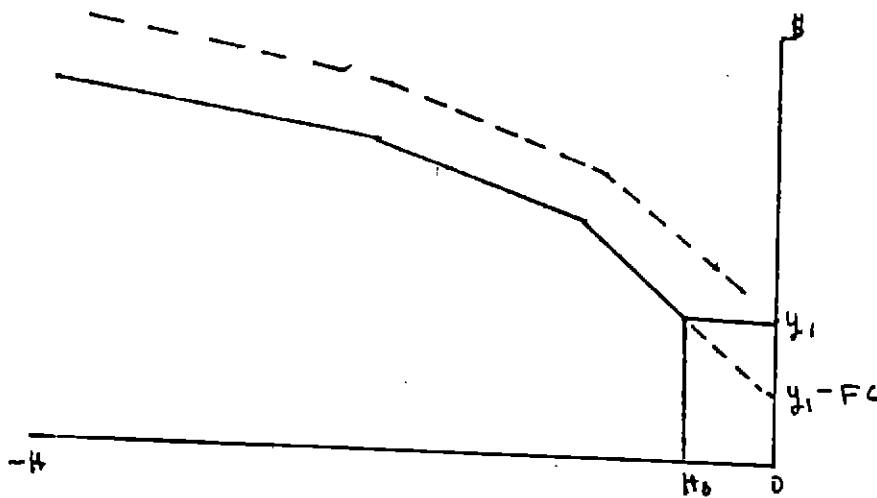
Figure 3.1

presence of fixed costs lowers the effective budget set to the point y_1 - FC. The individual would not choose to work less than H_0 hours because she would be better off at zero hours. This nonconvexity invalidates the simple reservation wage theory of labor force participation since hours also need to be accounted for. Hausman (1980),(1981) has found average fixed costs to be on the order of $100 per month. The importance of fixed costs could explain the often noted empirical fact that very few individuals are observed working less than ten or fifteen hours per week.[9]

We now turn to the question of quantity constraints which seems to enter labor supply models in two possible ways. The first type of quantity constraint might arise if an individual has the choice of working either full time, say 40 hours per week, or not working at all. We can still estimate the parameters of

his labor supply function by discrete choice models which allow a distribution of preferences, e.g., Hausman-Wise (1978), Zabalza et.al. (1980). For example, suppose we begin with the linear labor supply specification $h_i^* = aw_i + \alpha w_i + z\gamma$ along with the associated indirect utility function of equation (2.5). To compare indirect utility at zero and forty hours we need to specify w_i and y_i that would lead to the appropriate number of hours being chosen in an unconstrained setting.[10] But w_i and y_i can be solved for by using the desired hours supply equation and the linear equation through the point that gives net, after tax, earnings for that number of hours of work. For forty hours the equation is $E_{40} = w_i \cdot 40 + y_i$ where E_{40} arises from the budget set. We can solve the two equations in two unknowns for w_i and y_i and use the values for the required comparison so that α, β, and γ can be estimated. It turns out that this procedure is equivalent to solving for the direct utility function where only quantities appear so that quantity constraints enter in a straightforward manner. For instance, the direct utility function for our example is

$$(3.6) \quad u(h,x) = \frac{1}{\beta} (h - \frac{\alpha}{\beta}) \exp \left[1 - \gamma (x + \frac{z\gamma}{\beta} - \frac{\alpha}{\beta^2})) / \frac{\alpha}{\beta} - h)\right]$$

where x is consumption of the composite commodity. However, the direct utility function need not exist in closed form in which case the previous solution procedure can be used with the indirect utility function. Of course, specification of a direct utility function could be done ab initio, but it might not be easily combined with the labor supply functions of unconstrained individuals.

The other type of quantity constraints which people seem to have in mind is the choice among jobs, each of which comes with a distinct market wage and hours of work combination. However, if the individual takes a given job he is constrained to work the given number of hours which come with the job. Again a discrete choice framework seems apprpriate to model this situation. Use of either the indirect or direct utility function would allow the appropriate utility comparisons to be made. We would need to know the range of choices which a given individual faces. But the choice set might be either established by survey questions or estimated from a data set of choices of similar individuals. At this point we have strayed rather far from our original theory of flexible hours of work. In our empirical estimation we have not accounted for the possibility of quantity constraints. It seems unclear how important an empirical problem quantity constraints are. As we discuss later, even conditional on working in a given week the standard deviation of hours worked for prime age males is around 14 hours. Thus, the model of flexible labor supply with fixed costs may provide a reasonably good approximation, especially in the long run.[11]

A question of some interest might be what are the direction of biases in estimated labor supply models which do not account for taxes? Given the complexity of a model which incorporates taxes, the answer is not straightforward although a partial solution is possible. Consider the linear labor supply specification of equation (2.4). The net wage for individual i on budget segment j, w_{ij}, and the corresponding virtual income, y_{ij}, are determined simultaneously with the unknown coefficients α, β, and γ. Suppose that the market wage ω_i and observed non-labor income, x_i, are used instead. If x_i is measured subject to error, which it almost surely is in any survey, then the estimated coefficient

for β will be subject to errors in variables bias towards zero. As an approximation assume that the contribution of virtual income, βy_{ij}, is omitted so that it enters the stochastic disturbance. Since the net wage w_{ij} and virtual income y_{ij} are positively correlated due to progressive taxes and $\beta < 0$ if leisure is a normal good, the estimate of the wage coefficient will have a negative bias. In fact, empirical studies of males which do not account for taxes typically estimate α to be negative and substantial.[12] On the other hand, estimates which accoaunt for taxes, e.g., Burtless-Hausman (1978), Wales-Woodland (1979), Hausman (1981), Ashworth-Ulph (1981), Blomquist (1982), Hausman (1982), estimate α to be much nearer to zero. These latter studies also find considerably more evidence in support of economic theory than do studies which ignore taxes and after find compensated demand curves which slope in the wrong direction.

For labor supply estimates for wives, the husband's before tax income is often used for y_i in equation (2.4). Then two counteracting biases as present in estimates of the wage parameter α. If the wife's wage is positively correlated with husband's income then a negative bias of the estimate of α is created. However, the bias from the income term turns out to be positive so that the net effect cannot be determined. To the extent that husband's before tax income is fairly close to the wive's virtual income the effect of the bias should not be as imortant as in the husband's case. The empirical evidence to date supports this tentative conclusion.

In this section we have demonstrated how the nonlinearity of the budget set which taxes create can be accounted for in an econometric model. The labor supply (leisure demand) curves are still the focus of model specification. For the convex budget set case the only new complication is to search for the budget

segment on which h* falls. When the budget set is nonconvex, we need to solve for the indirect utility function which is associated with the labor supply specification. Then the multiple tangencies of the budget set and indifference curves can be compared to find the h* which corresponds to maximum utility. We also emphasized the potential importance of allowing for variation in preferences and fixed costs to working. Previous empirical studies indicate the potential importance of both considerations. Lastly, we discuss techniques to handle quantity constraints within the context of our approach. However, unless on a priori grounds we know who in the sample is quantity constrained, it is not clear that these procedures can be applied in a given sample.

NOTES

[1]   Nonconstant prices do exist in the demand for other goods, e.g., electricity with a declining block rate. A general treatment of econometric techniques for nonlinear budget sets is given by Hausman (1982).

[1a]   An initial work on introducing taxes into labor supply models, Hall (1973) used the observed after tax wage which creates simultaneous equation bias in the estimated coefficients. Wales (1973), Hausman and Wise (1976) and Rose (1976) introduced instrumental variable techniques to take account of this problem.

[2]   If the market wage depends on hours worked the same reasoning holds since the budget set is still exogenous.

[3]   The technique used here is more fully explained in Hausman (1979b). See also Hausman (1981) and Hausman (1982).

[4]   A potential problem does exist in the asymptotic expansions used to compute the standard errors of the coefficients.

[5]   Their work was done in the framework of labor supply and a composite consumption good. The technique can also be used in the many good case although it is more difficult to apply. Alternatiuvely, one can begin with a utility function specification and derive the labor supply function as Wales-Woodland (1979), Ashworth-Ulph (1981), and Ruffell (1981) did.

[6]   The indirect utility function can be used to evaluate tangencies on both budget segments and at kink points so that the direct utility function is unnecessary. See Hausman (1980) or Deaton-Muellbauer (1981) for techniques to be used here. As Figure 1.8 shows a tangency will not occur at a nonconvex kink point, but it may occur later on a convex portion of the budget set.

[7]   For many linear regression specifications where the effect of taxes are not accounted for, variations in preferences leads only to an efficiency issue for the econometric estimator. However, taxes create an essential nonlinearity in the problem so that variation in preferences can be quite important. A similar issue arises in the specification of discrete choice models, e.g., Hausman-Wise (1978). Greenberg and Kosters (1973) seemed to be the first paper that allowed for a dispersion of preferences to affect their model in an important way.

[8]   It is interesting to note that Greenberg-Kosters had a similar type of variation in preferences. However, they did not allow for the effect of taxes so that the results cannot be compared.

[9]   Similar results in a model without taxes were found ty Cogan (1981). Hanoch (1980) and Nakamura and Nakamura (1981) have also included fixed costs inb models of female labor supply.

[10]   Neary and Roberts (1980) and Deaton and Muellbauer (1980) discuss this technique in a general demand setting. However, they do not consider the effect of taxes.

[11] Ham (1981), in a model without taxes, attempts to provide evidence on quantity constraints by considering the response to a survey question on the possibility of additional work. Deaton (1981) considers quantity constraints by a rationing model of the consumption function.

[12] Heckman-Borjes (1979) present a range of estimates. Despite its title the paper should not be used for policy purposes since all the studies reviewed ignore taxes in their models of labor supply.

4.   Results

In this section we summarize the results of studies of labor supply which
take account of taxes. The effect of taxes on both labor supply and economic
welfare is considered. However, difficulties arise in providing convenient
summary measures for the effect of taxes. Elasticity measures for labor supply,
which are most often used as summary measures in demand studies, are not fully
adequate to assess the effect of taxation for the following reasons: (1)
Nonlinearity of the budget sets can lead to large changes in labor supply with
small changes in taxes. The nonconvexity of many of the budget sets leads to
this result. (2) About 1/2 of all women are not labor force participants.
Because of the non-tangency of their utility functions with the budget sets at
zero hours, small changes in taxes will not effect most non-workers. (3) When
taxes are changed both the change in the net after tax wages and the virtual
incomes must be taken account of. Equation (1.2) demonstrates the correct
relationship. (4) If variation in preferences are specified, e.g., Burtless-
Hausman (1978), Hausman (1981,1982), and Blomquist (1982), behavior of 'mean'
individual may differ from the mean population response.[1] This difference arises
from the nonlinearity of the budget set. To some extent problems which arise
with the first and last reason are decreased by aggregation from individual
responses to the population. However, the middle two problems remain..

A.   Prime Age Males: These individuals are usually taken to be from 25 to
either 35 or 60 years old. Labor force participation among this group is nearly
100%, especially when disabled individuals are not considered. Unemployment is
typically low among this group in a non-recession year. Most studies therefore

do not account specifically for unemployment or constraints on labor market activity.[2] An integration of behavior when unemployed and hours of work should be a goal of future research, but theoretical advances as well as better data would be required.[3] Another needed advance is an integrated model of family labor supply with taxesd to take account of wives labor market activity and its possible effect on husband's labor market behavior.[4]

The most natural interpretation of the labor supply results estimated on cross section data is an equilibrium model where actual hours differ from desired hours because of stochastic reasons. One should not maintain the incorrect image of the prime age male labor free uniformly at work for 40 hours per week and 2000 hours per year. On the company, significant variation exists in both normal hours per week and weeks worked per year. Hours per week of work, conditional on being employed, typically have a mean of about 42 hours with a standard deviation of 10-15 hours in typical cross section date.[5] Men presumably choose jobs which have the number of hours which most closely correspond to their desired hours taking account of over time and possible layoffs. However, for a significant proportion of the prime age male population, changes between employers is fairly rare, see Hall (1982). How much of the year to year variation in labor supply for this group arises from fluctuations in their market wage is problematical. Therefore, the models of labor supply and empirical results presented here are probably less relevant for short term labor supply response to business cycle conditions.

We consider from sets of results for prime age males: Wales-Woodland (1979), Ashworth and Ulph (1981), Hausman (1981), Blomquist (1982), and Hausman (1982).[6] The results are given in Table 4.1. First, note that the

TABLE 4.1

Prime Age Male Labor Supply Results

	Authors	Data	Model	Wage Elasticity	Income Elasticity
1.	Wales-Woodland	PSID	CES	.09**	-.11**
2.	Ashworth-Ulph	UK	Generalized CES	-.13	-.05
3.	Hausman*	PSID	Linear	.00	-.17
4.	Blomquist*	Sweden	Linear	.08	-.04
5.	Hausman*	PSID	Linear	.03	-.14

*Specification permits variation in preferences. Mean results are given.
**Results are approximate since means of data were not given.

uncompensated labor supply elasticity is much closer to zero than is typically

found in labor supply studies which ignore taxes. This result concurs with the

econometric bias arguments given in the last section. The next difference is

that the income elasticities vary from -.04 to -.17 which imply that leisure is a

normal good in contrast to many studies which ignore taxes and find the opposite

sign. Given the magnitude of virtual income with progressive taxation, the clear

implication is that taxes will affect the labor supply decision. The combination

of these two results leads to the last result, which is perhaps the most

satisfying. All five studies imply a positive compensated wage elasticity so

that the compensated labor supply curve is upward sloping. These results are in

stark contrast to models which ignore taxation, and very often estimate a

compensated elasticity of the wrong sign. This finding is difficult, if not

impossible, to justify even when more general models of labor supply are

considered. Since a non-negative compensated elasticity is the only implication

of economic theory for models of labor supply, it is satisfying to find that the

results become acceptable to the theory when the effect of taxes is taken into account.

We now turn to the effect of taxes on labor supply. As equations (1.1) and (1.2) demonstrate, the theoretical effect is indeterminate. Most models for prime age males which ignore taxes estimate a backward bending labor supply curve.[7]   Therefore, a reduction in tax rates which has recently occurred in the U.S. and U.K. would lead to a reduction in hours of work. A contrary view has been put forward by 'supply side' advocates in the U.S. who have argued that a reduction in tax rates will lead to such a large increase in labor supply that government revenue would actually increase.

We first present some results of Hausman (1981a,1981b) for the U.S. He found using 1975 data that compared to a no tax situation, desired labor supply was 8.2% lower because of the U.S. tax system, including FICA taxes and state income taxes. In Table 4.2 the results are given by wage quintiles from the PSID sample. In the second row the change from the no tax situation is given. Note that the effect of the progressiveness of the tax system is to cause high wage individuals to reduce their labor supply more from the no tax situation than do

TABLE 4.2

The Effect of Taxes on Prime Age Male Labor Supply in the U.S.

Market Wage	$3.15	$4.72	$5.87	$7.06	$10.01
Change in Labor Supply	-4.5%	-6.5%	-8.5%	-10.1%	-12.8%
10% Tax Cut	+ .4%	+ .5%	+ .9%	+ 1.7%	+1.47%
30% Tax Cut	+1.3%	+1.6%	+2.7%	+ 3.1%	+4.6%

low tax individuals. The higher marginal tax rates lead to higher virtual income and a greater reduction in desired labor supply. Of course, this pattern of labor supply has an adverse effect on tax revenues because of the higher tax rates that high income individuals pay tax at. In the second and third rows of Table 4.2 we present the expected change in labor supply for tax cuts of 10% and 30%. Note that desired labor supply increases with a tax reduction. We find the expected pattern that the effect on high wage individuals is greatest since the linear labor supply model used has an increasing elasticity with virtual income. The effect of a 30% tax cut is roughly three times as large as a 10% cut, but the ratios are not exact. However, neither of the two tax cuts is nearly self-financing as Hausman's (1981b) results indicate.

Lastly, we consider two types of radical tax reform. We consider a progressive linear income tax with all current deductions removed, e.g., interest deductability. Therefore, we have broadened the tax base considerably and then determined the tax rate which would raise the same amount of tax revenue as the current U.S. tax system using 1975 data. With a zero exemption level so that a flat tax results, the required tax rate is 14.6%. Desired labor supply for the prime age males rises about 8.1%. For a progressive tax with an exemption level of $4000 (1975 dollars), the required tax rate rises to 20%. Desired labor supply increases by about 7.7%. Therefore, a decrease in marginal tax rates does lead to an increase in desired labor supply of significant amounts although much of the progressivity of the tax system is lost with such a proposed tax reform.

Ashworth and Ulph (1981) also considered the effect of tax changes on labor supply. They considered changing the standard rate of tax in the U.K. from its present value of 30% to 4 other rates representing changes of plus or minus 7%

and 15%. The standard rate of tax is the marginal tax rate for almost 90% of prime age males in the U.K. In Table 4.3 the percentage change in labor supply is given for the entire sample as well as for each quintile of the income (not wage) distribution.[8]

TABLE 4.3

The Effect of Tax Rate Changes on Prime Age Male Labor Supply in the U.K.

Income	Quintile	1	2	3	4	5	Total
15%	Tax Cut	- .3%	+ .7%	+ .8%	+1.6%	+2.1%	+1.8%
7%	Tax Cut	- .1%	+ .3%	+ .3%	+ .9%	+ .9%	+ .8%
7%	Tax Rise	+ .1%	- .5%	-1.0%	- .9%	- .8%	-1.2%
15%	Tax Rise	+ .3%	-1.1%	-2.3%	-2.6%	-2.1%	-2.9%

Note the qualitative similarity between the Ashworth-Ulph results and the Hausman results. A much larger change in labor supply is forecast from the higher income quintiles. The magnitude of the predicted changes also do not differ too much, although Ashworth-Ulph find that the income effect dominates in the lowest quintile, leading to a small decrease in labor supply when taxes are lowered. The labor supply changes given in Table 4.3 are not sufficient to make a tax cut self-financing. The rise in labor supply would offset about 10% of the fall in revenues from the tax cut which is again fairly close to what Hausman (1981b) found.

The last set of results which we consider are Blomquist's (1982) estimates for Sweden. Using 1973 data, he calculates the effect of taxes on labor supply for the mean individual at wage rates of 10.0 skr, 20.3 skr, and 40.0 skr which correspond to a low wage, the average wage rate in the sample, and a higher wage

rate, respectively.

TABLE 4.4

The Effect of Taxes on Prime Age Males in Sweden

Market Wage (Skr)	10.0	20.3	40.0	Total Sample
Change in Labor Supply	-4.7%	-13.6%	-27.1%	-13.1%
Proportional Tax	-1.9%	+ 6.2%	+11.4%	+ 6.9%

In Table 4.4 the first row estimates the change in labor supply from the no tax situation. Note that the results are almost twice as large as the estimates for the U.S. in Table 4.2. Much of this difference arises from the considerably higher level of taxation in Sweden. In the second row of Table 4.4 an equal yield proportional tax is considered for each of the 'representative' males. The corresponding tax rates are 27.8%, 39.1%, and 47.8% respectively. For the entire sample the equal yield proportional tax is 34% with desired labor supply increasing 6.9% from its current level. Blomquists' estimates indicate a substantial effect of taxes on labor supply in Sweden.

B.   Economic Welfare: The welfare cost of the distortion created by the composition of a tax is measured by use of deadweight loss (excess burden). We briefly sketch the theory of the deadweight loss measure, and then we present estimates which arise from labor supply studies.[9] The first component of a welfare measure is the effect of the tax on individual utility. Here the measure long used by economists has been some form of consumers' surplus. Consumers' surplus corresponds to the concept of how much money each individual would need to be given, after imposition of the tax, to be made as well off as

he was in the no tax situation. Measurement of consumers' surplus often is done by the size of a trapezoid under the individual's demand curve or here it would be the labor supply curve. But Hausman (1981c) has demonstrated that in the case of labor supply this method is very inaccurate. Instead the theoretically correct notion of either the compensating variation or equivalent variation must be used.[10] These measures, set forth by Sir John Hicks, are probably best defined in terms of the expenditure function. The expenditure function determines the minimum amount of money an individual needs to attain a given level of utility at given levels of wagges and prices.[11] Its form is determined by either the direct utility function $U(H,Y)$ or the labor supply function. Consider the simple example of the wage tax for which the compensating variation equals

$$(4.1) \qquad C.V.(w,w',U) = e(w',U) - e(w,U)$$

Equation (4.1) states that the welfare loss to the individual, measured in dollars of the consumption good, equals the minimum amount of non-labor income needed to keep the individual at his original utility level U minus his non-labor income in the no tax situation, y. Since utility is kept at the pre-tax level U, the compensating variation arises solely from the subtitution effect in the Slutsky equation (1.1). The income effect is eliminated because the individual is kept on his initial indifference curve. In the more complicated case of progressive taxes, the only difference is that we use virtual non-labor incomes in equation (4.1) rather than actual non-labor income.[12]

We need one more ingredient to complete the measure of the welfare loss from taxation. The government has raised tax revenue, and we need to measure the

contribution to individual welfare which arises from the government spending the tax revenue. The assumption commonly used is that the government returns the tax
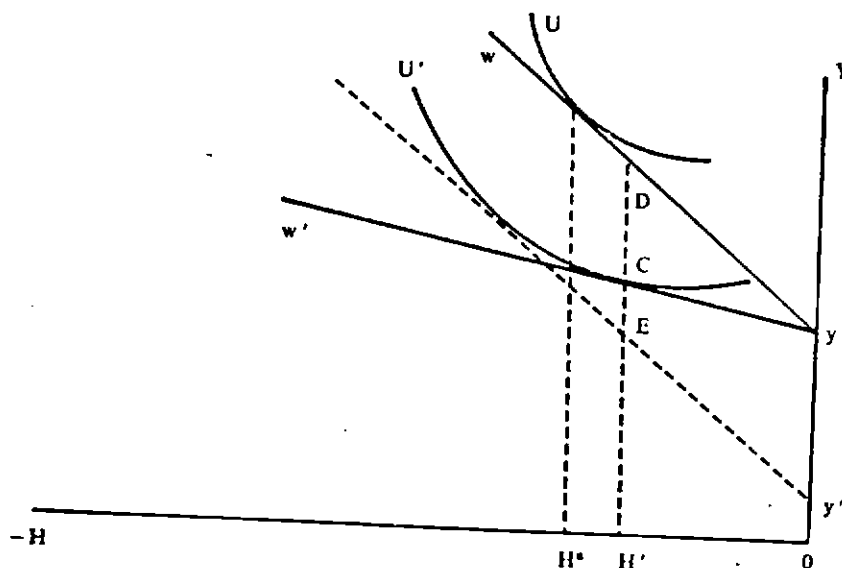

Figure 4.1

revenue to the individual via an income transfer. Here it would correspond to increasing the individual's non-labor income by the amount of tax revenue raised. Then the total economic cost of the tax is given by the deadweight loss (or excess burden) as

(4.2) $DWL(w,w',U) = C.V.(w,w',U) - T(w,w',U)$

$$= e(w',U) - e(w,U) - T(w,w',U)$$

Equation (4.2) states that the deadweight loss of a tax equals the amount the individual needs to be given to be as well off after the tax as he was before the tax minus the tax revenue raised $T(w,w',U)$.[13] Deadweight loss is greater than or equal to zero which makes sense given that we expect taxation always to have an economic cost. Of course, if no tax revenue is returned the compensating

variation gives the welfare loss to the individual. In Figure 4.1 the
compensating variation and deadweight loss are shown in terms of our simple wage
tax example of Figure 1.2. Here the effect of the tax is to reduce labor supply
from H* to H'. The compensating variation is measured by the line segment yy'.
We then decompose the compensating variation into its two parts. The line
segment CD measures tax revenue collected while the line CE measures the
deadweight loss of the tax. Since the taxpayer has been made worse off but no
one has benefited from the amount of the deadweight loss, it represents the
economic cost of raising the tax revenue.

In Table 4.5 we present Hausman's results from deadweight loss of taxation

TABLE 4.5

Deadweight Loss Estimates for Prime Age Male in the U.S.

Market Wage	$3.15	$4.72	$5.87	$7.06	$10.02	Total
DWL/Tax Revenue	9.4%	14.4%	19.0%	23.7%	39.5%	22.1%
10% Tax Cut	8.5%	13.3%	17.4%	21.8%	36.1%	19.0%
30% TAx Cut	6.8%	10.9%	14.5%	17.9%	29.5%	15.4%

of labor supply in the U.S. The first row gives the deadweight loss in each of
the wage quntiles. Note that the deadweight loss to tax revenue ratio rises
sharply because of the progressivity of the income tax. The 'triangle formula'
for deadweight loss demonstrates that the loss is proportional to the square of
the tax rate so that higher wage individuals face a higher economic distortion.
Overall, Hausman estimates the mean ratio of deadweight loss to tax revenue to be
22.1% which has important implications given the large proportion of the U.S. tax
revenues which are raised via the income tax. The next two rows of Table 4.5
calculate the deadweight loss under two tax cut proposals to given

an indication of the size of the marginal change. Lastly, we consider the deadweight loss under an equal yield proportional tax. With no exemption and a tax rate of 14.6% the deadweight loss to tax revenue ratio decline to 7.1%. A progressive linear income tax of 20.7% with an exemption level of $4000 leads to a ratio of 14.5%. Both sets of calculations indicate the size of the welfare cost which arises from the progressivity of the U.S. tax system.

Blomquist (1982) does similar deadweight loss calculations for Sweden. For the average individual in his sample who earns 20.3 Skr he calculates the deadweight loss to tax ratio to be 14%. The marginal tax rate faced by this individual is 62%. An equal yield proportional tax would be 39% and the deadweight loss to tax ratio would decline to 5.5%. Over the entire sample Blomquist calculates that the deadweight loss ratio is 19%. An equal yield proportional tax of 33.7% would lower the ratio to 4%.

Increased attention in the U.S. and European nations has focused on the incentive effects of the tax systems. Most of the attention has been on output effects. The labor supply results for prime age males reviewed here do demonstrate that income taxes reduce desired labor supply. The answer to the question of whether taxes increase or decrease desired labor supply is what most policy makers worry about. Yet, the deadweight loss effects may be more important from an economists' viewpoint. Since deadweight loss is a measure of the economic cost or efficiency effect of the income tax, it provides the appropriate measure within which to have frame questions about the 'optimal' progressivity of the tax system or the cost of marginal government expenditure.[15] Also, deadweight loss calculations are central to proposals for tax reform measures. And the deadweight loss question stands apart from labor supply

effects since large deadweight loss exists even when counteracting income and substitution effects lead to small labor supply changes. The size of the deadweight loss associated with the income tax is perhaps the most important finding of the recent labor supply literature which considers the effect of taxes. Deadweight loss calculations are likely to influence future discussions on tax changes among economists and perhaps policy makers as well.

C.   Wives: Income taxation is generally thought to have important effects on wives labor force behavior. Wives labor force participation in the U.S. is approximately 50%. When the labor force participation decision is made by a woman whose husband is employed, the tax rate which enters her decision is calculated from the husband's earnings.[16] Since this marginal tax rate is around 25% on average, taxes should be expected to be important in wives labor supply decisions.[17] Since relatively large uncompensated wages elasticities are often estimated for wives, the effect of various tax reform proposals may have important effects. However, it is important to remember that since 50% of wives do not work, their reaction to marginal changes in taxes will be zero to a great extent. Wives already at work will change their desired hours and some wives will decide to enter the labor force in response to a tax cut, but most nonparticipants will remain so. Therefore, elasticity estimates should be used with caution in considering tax changes.

We consider four sets of estimates for wives' labor supply behavior which consider the effect of taxation: Ashworth & Ulph (1981) for Great Britain, Hausman (1981) for the U.S., Nakamura and Nakamura (1981) for Canada and the U.S., and Rosen (1976) for the U.S. The results are given in Table 4.6. The

TABLE 4.6

Wives Labor Supply Results

	Authors	Data	Model	Wage Elasticity	Income Elasticity
1.	Ashworth-Ulph	UK	Generalized CES	.19	-.14
2.	Hausman	PSID	Linear	.91	-.50[†]
3.	Nakamura-Nakamura	US Census	Linear	-.16*	-.05*
3a.	Nakamura-Nakamura	Canada Census	Linear	-.30*	-.19*
4.	Rosen	Parnes (NLS)	Linear	2.3	-.42**

[†]Evaluated for mean women who works full time at virtual income which includes husband's earnings.

*For the age group 35-39 Younger age groups have larger elasticities while older age groups have smaller elasticities.

**Estimated from results given in the paper.

estimates vary widely with the Ashworth-Ulph and Hausman results in the range of studies which do not account for taxes. Rosen's estimated wage elasticity of 2.3 seems quite high. Econometric problems which include incorrect treatment of virtual income and an inconsistent estimation technique may explain the divergence. In subsequent analysis Feenberg-Rosen (1983) have used wage elasticity estimates of 1.0. The most surprising result is that of Nakamura-Nakamura (1981) who find significant negative uncompensated wage elasticities which range from -.39 for the 25-29 age group to -.06 for the 50-54 age group. Almost no other econometric study of wives labor supply, whether or not taxes are considered, estimates a negative wage elasticity. The Nakamura-Nakamura paper has an incorrect treatment of virtual income together with other econometric problems. Yet their finding that higher wages lead to lower labor supply for wives together with the implication that the effect of income taxation is to

increase wives labor supply is so at odds with previous studies that it should perhaps be disregarded unless further studies provide additional confirmation. The estimated income elasticities are all negative so that taxation has two counteracting effects: by decreasing husbands not earnings its increases wives labor supply but by its effect on virtual income it decreases labor supply. The overal effect of the income tax seems quite clearly (apart from the Nakamura results) to decrease wives labor supply because of the sizeable uncompensated wage elasticity which is typically found.

In Table 4.7 we present results of Hausman (1981) for a sample of wives by quintiles. Note that the effect of taxation is to increase labor supply for the lowest wage quintile but to decrease labor supply for the other quintile. The overall effect compared to the no tax case is a reduction in labor supply by 18%. Hausman also found substantial deadweight loss to tax revenues with the

TABLE 4.7

The Effect of Taxes on Wives Labor Supply in the U.S.

Market Wage	$2.11	$2.50	$3.03	$3.63	$5.79	Total
Change in Labor Supply	+31.2%	-14.2%	20.3%	-23.8%	-22.9%	-18.2%
DWL/Tax Revenue	4.6%	15.3%	15.9%	16.5%	35.7%	18.4%

ratio about 18%. Given the magnitude of the estimated elasticities the deadweight loss estimate might seem small. However, when the fact that nonparticipants in the absence of taxation will generally remain nonparticipants when taxes are levied and remain at the same utility level is taken into account, the finding is reasonable. The deadweight loss ratio would more than double,

i.e., exceed 40%, for labor force participants. Hausman (1981b) considers a 10% tax cut and estimates that wives labor supply would increase by 4.1%. For a 30% tax cut he estimates the increase in labor supply to be 9.4%. Deadweight loss is decreased significantly. Hausman's results demonstrate an important influence of taxes on wives labor force behavior together with a substantial economic cost of the current tax system.

Feenberg-Rosen (1983) simulate the effects of numerous proposed changes in the tax law on wives labor force behavior. We consider two cases: a tax credit of 10% on the first $10,000 of earnings and taxation of wives as single individuals. For the tax credit case they find only a very small effect on hours of work. The impact of the lower marginal tax rate on some individual is just about cancelled by the income effect it has on other workers. However, the effect of the tax change on current nonparticipants is not treated altogether correctly. Income splitting leads to predicted increase in labor supply of about 5.5% for wives. Thus, the effect of lower marginal tax rates leads to increased labor supply although some of the progressivity of the income tax is lost when it is judged at the family level.

The results for wives demonstrate that income taxation has an important effect on wives labor supply decisions. The economic cost of the tax system is also substantial. Because of the joint treatment of family income, wives typically face substantial marginal tax rates on their earnings. No consensus has bewen reached on the proper tax treatment of the family in the presence of progressive taxation. Further econometric work will focus on more of a joint decision framework for husband and wives, yet it is unlikely that the major findings of an important effect of taxes will change drastically. Various tax

reform proposals such as tax credits reduce the effect of progressivity on wives. However, important issues will remain unless a tax system rate with constant marginal tax rates is adopted.

NOTES

[1] Hausman (1983) investigates this issue.

[2] Hausman (1981) does account for zero hours considerations. Ham (1981) considers constraints on further work at the given wage.

[3] Moffitt and Nicholson (1982) consider this problem for a special sample of individuals for which data are available.

[4] Ashworth and Ulph (1981) estimate household models of labor supply. See also Hausman and Ruud (1983).

[5] This variation is calculated after the self-employed and farmers have been eliminated from the sample.

[6] We do not use the earlier result of Hall (1973) and Wales (1973) and Brown-Levin-Ulph (1976) because of difficulties of interpretation and econometric technique.

[7] Some models find a backward banding curve only for medium and high wage males.

[8] Note that a distribution ordered by wages is probably better, since labor supply choice enters the income measure.

[9] Auerbach (this volume) contains a more detailed discussion of deadweight loss.

[10] These measures correspond to the area under the compensated demand curve which is determined by the substitution effect in the Slutsky equation. For further discussion see Hausman (1981c) or Diewert (1982).

[11] For a more formal treatment see Varian (1978) or Diewert (1982).

[12] The alternative measure of the equivalent variatrion uses post-tax utility U' as the basis for measuring welfare loss. For labor supply in the two good set-up the equivalent variation typically gives a higher measure of welfare loss than does the compensating variation.

[13] Here we follow Diamond and McFadden (1974) and use taxes raised at the compensated point. Kay (1980) has recently argued in favor of using the uncompensated point. As with C.V. and E.V. measures the problem is essentially one of which is the better index number basis.

[14] As a historical note it is interesting to point out that Harberger's (1964) seminal calculation of the deadweight loss from the income tax used an income elasticity quite close to the estimate of Hausman (1981). However, he took the uncompensated wage elasticity to be large and negative. Therefore, the Slutsky equation led to a near zero compensated wage elasticity so that Harberger's estimate of the deadweight loss was very small. On the contrary, Hausman (1981) finds the uncompensated wage elasticity to be near zero.

[15] Of course problems still exist due to the necessity f interpersonal comparisons, c.f. Atkinson-Stiglitz (1976) and Stiglitz (1982). The optimal income tax literature begins with Mirrlees (1971). For surveys of the literature see Mirrlees (1982) and Atkinson-Stiglitz (1980).

[16] The child care credit reduces the tax rate but its effect on the participation decision is decreased because of fixed costs. Also note that beginning in 1983 the apprpriate marginal tax rate will decrease because of a credit included in the 1981 tax reform legislation.

[17] Given these facts it is a surprising that labor economists who work on female labor supply have largely ignored taxes. The recent book edited by Smith (1980) has only one mention of taxes in all of the papers. This omission is even more surprising in light of the substantial estimated labor supply elasticities.

[18] The large negative elasticity estimates are incompatible with economic theory because they imply a downward sloping compensated labor supply curve.

[19] These estimates take into account the labor supply response of husbands and their change in net, after tax, income.

5. High Income Groups

Considerable interest has arisen over potentially large work disincentive effects on two economic groups: very low income and very high income groups. Both groups face high marginal tax rates on earned income; usually the marginal rate is .5 or higher. Our knowledge of the effect of the high marginal tax rates on low income groups has been increased considerably by government-constructed cross section data sets and most importantly by the four negative income tax experiments. The results of these NIT experiments will be considered in the next section. Yet very little reform of the tax system and its treatment of low income individuals has been accomplished. On the other hand, our knowledge of the effect of high marginal tax rates on high income groups has advanced little in the past decade.[1] Yet significant changes in the tax systems as they affect earned income for high income groups has taken place. The United States lowered the maximum marginal tax rate on earned income from .7 to .5 in 1969, and the Thatcher government in England has also significantly reduced the highest marginal rates in 1979. Furthermore, earnings at which the maximum tax level is reached have increased dramatically in the U.S. under the tax reform legislation of 1981. In 1983 the 50% rate will be reached at $109,000 on a joint return; in 1984 the maximum rate will be reached at $162,000. The change in rates from Table 2.2 is remarkable. While high income groups certainly complain loudly about taxes, none of the surveys which we will summarize have found a significant disincentive effect of the high tax rates. Thus we might conclude that a convincing efficiency argument does not exist for lowering the marginal rates of high income groups, but vertical equity considerations have probably been foremost in legislators' deliberations.[2]

Almost all of our empirical knowledge of the effect of taxation on the labor

supply of high income groups arises from interview surveys. An important sample selection problem exists which has remained almost unnoticed, Holland (1976). Since we would expect on average high income groups work more, those individuals who are led to work less by the disincentive effect of the tax system are less likely to be surveyed. Thus, a sample selection bias exists for the finding of a small disincentive effect. And a small disincentive effect has been the overwhelming finding of the interview surveys. Yet the empirical results have been so striking, that is probably safe to conclude that the sample bias is not giving a spurious result. For instance, it does not appear that within the surveys that the highest income groups are affected to a lesser extent than lower income groups. Thus, the primary finding of the survey literature is that while a disincentive does exist, its likely magnitude is not especially large.

The classic study in disincentive effects on high income groups is Break's (1957) survey of lawyers and accountants in Great Britain. Break conducted 306 interviews on a group of individuals both familiar with and having the ability to react to the disincentive effect of the high marginal tax rates which existed in Great Britain at that time. Break found that the majority of the respondents were not significantly affected by the tax system on their work effort. Of the 49% who reported an effect, only 18% cited disincentive effects while 31% cited an incentive effect from the tax system. Thus, the overall income effect dominated the substitution effect for these individuals.[3] Using a much more stringent criterion where the interpretation of the sample responses was clearest, Break concluded that 14% of the sample were significantly affected by taxation. The tax incentive effect still predominated with 8% of the original sample working harder because of the tax effect. Still, Break concluded that a

a small net disincentive effect might exist because the 6% who reported a significant disincentive effect had higher earnings than the 8% who reported an incentive effect.

Break's original study has been repeated by Fields and Stanbury (1970,1971). Fields and Stanbury find a significantly higher percentage of respondents report a disincentive effect than did Break. They concluded that the disincentive effects had become more important over time as individuals had adjusted their labor supply slowly to the continued high marginal tax rates. But, on the other hand, the 6% who showed significant disincentive effects in Break's survey had fallen to only 2% which those individuals with significant incentive effects had also declined markedly. Both studies do find that disincentive effects increase with income yet we might well conclude that this finding primarily arises from an income effect, not a substitution effect. The single important quantitiative finding in the Fields and Stanbury survey is that no significant difference exists between average number of hours worked among groups of individuals who reported disincentive effects, incentive effects, or no significant tax effects. Thus, whatever net effect may exist its likely empirical magnitude is small.

Similar interview survey of American business executives have been conducted by Sanders (1951) and by Holland (1969). From his interviews of 135 business executives and 25 professional men, Sanders found the effects of taxation to be quite small. Sanders concluded that important non-financial incentives more than outweigh the change in financial incentives that taxation creates. Probably the most important effect of taxation that Sanders found was the amount of time used in creating responses to taxation through investment and tax avoidance programs. The economic cost of this type of response is probably substantial and has

undoubtedly increased in magnitude since Sanders' survey.[4]

Holland (1969) conducted interviews of 125 business executives in which he attempted to isolate the substitution effect by considering a hypothetical tax on potential income. The amount of the tax would be about the same as the tax paid currently. However, it appears to me that the effort is not totally successful because of the nonlinearity of the budget set discussed in Section 1. There we pointed out that the Slutsky equation does not adequately describe the tax response because of the presence of virtual incomes different from nonlabor income. Thus, Holland's technique would seem to be exactly correct only in the case of a proportional tax system.[5] Holland's findings are much in line with previous results. The hypothetical change in the tax system would have no effect on 80% of the sample. Fifteen percent of the sample indicated they would work harder while one individual claimed he would work less hard. Holland seems to conclude that on average a tax incentive effect exists, at least in the substitution effect. But he concludes also that the magnitude is likely to be small. Thus, his results accord well with the Break results and Sanders results.

The last sample interview we consider is Barlow, Brazer, and Morgan (1966). They conducted 957 interviews with individuals who had income exceeding $10,000 in 1961. They also attempted to include a disproportionately large number of very high income people in the sample. Their results are again very similar to previous findings. Approximately 88% of the sample individuals responded that the income tax did not effect their work effort. Among the 1/8 of the sample which reported disincentive effects. Barlow, et al. concluded that the actual magnitude of the disincentive isd likely to be very small. In fact, they estimated the total effect on the economy to be of the order of .3% in 1963.

Given the rather different sample coverage the Barlow results seem quite similar to the results found in the other studies.

From these results we should not reach the too sanguine conclusion that high marginal tax rates may not have a significant economic cost. We have already mentioned the large amount of effort that goes into shifting ordinary income into capital gains which are taxed at a much lower rate. Evidence of considerable economic waste appears periodically from these schemes. But, the important point to note here is that these machinations seem to have very little effect on work effort. Presumably, for most people it is very difficult if not impossible to shift compensation from working directly into capital gains. Furthermore, the sensitivity of their work response is low to a given marginal tax rate. Perhaps these results are not too surprising. For non-high income individuals, the (uncompensated) work disincentive effects is found to be small in econometric studies. Previous findings that, if anything, the income effect predominates is in accordance with Break's findings. Recent econometric studies have found the income effect to be the most important determinant in behavior toward taxation. Thus, in terms of work response it does not appear that the rich are different than the rest of us. But, they do have more money.

NOTES

[1] The last significant survey is Holland (1969). Also, the most recent extensive survey of the literature is Holland (1976).

[2] Certainly large amounts of economic resources are used to lessen the burden of taxation by using the capital gains provisions and other tax preference provisions of the tax laws. But this observation has little bearing on the work effort of the high income groups themselves.

[3] From a social welfare analysis point of view, little comfort arises from these findings. It is important to remember that only the substitution effect creates deadweight loss. Thus, even if the income effect is large enough to outweigh the substitution effect, considerable deadweight loss may still exist.

[4] Executive compensation through stock options and other non-wage compensation become an effective and important method to partly avoiding the high marginal rates. But the combined effect of the .5 tax limit on earned income in the 1969 Tax Reform Act and the 1976 Tax Reform Act provision for stock option plans decrease the importance of non-wage compensation. The tax legislation of 1981 increased the attractiveness of stock options to their pre-1976 status.

[5] It is the case that Holland will find the sign of the substitution effect. However, his work cannot be used to estimate empirical magnitudes.

6.   Evidence from NIT's and Social Security Effects

Four negative income tax (NIT) experiments have been conducted by the government to produce information about the likely effects on labor supply of replacing the current welfare system by an NIT. Three urban experiments took place in New Jersey, Gary, Indiana, and Seattle-Denver. A rural experiment also took place in Iowa and North Carolina. We review only the urban experiments since we have excluded farmers from our previous analysis.[1] In principle, the NIT experiments might seem to be an ideal laboratory in which to determine the effect of taxes on the labor supply response of low income workers.[2] Observations were recorded on individuals before the experiment began, and during the three year period of the experiments two groups were observed. The experimental group was subject to an NIT plan while a control group received nominal payments to participate in the experiments. Yet the initial results were not clear cut. Analysts found the results disappointing. A. Rees, in his summary of the New Jersey results, concluded that "the differences in work behavior between experimentals and controls for male heads...were, as we expected, very small. Contrary to our expectations, all do not show a clear and significant pattern; indeed they show a discernable pattern only after a great deal of refined analysis."[3] Unforeseen problems did arise which, in retrospect, is not surprising since the New Jersey NIT experiment was the first social experiment ever conducted. Statistical problems which arise in conducting experiments with human subjects over time had not been accounted for.[4] For instance, the attrition problem in the New Jersey experiment almost certainly accounts for the anomalous results found for black and hispanic males.

Subsequent analysis of the New

Jersey and other two urban NIT experiments has led to more definite conclusions

about the labor supply response. We will give a brief review of the evidence.

We first consider the evidence for male heads of households. Two important

differences from the non-NIT framework arise for the analysis. Contrary to the

usual case of analyzing the effect of taxes on labor supply where the

substitution effect is considered to be much more important than the income

effect, both the income and substitution effect are important for an NIT. The

expected additional cost of an NIT program over the existing welfare program is a

crucial consideration. Thus, we are very interested in the overall labor supply

response rather than just the distortion created by taxation. The second

difference is that for males both the income and substitution effect work to

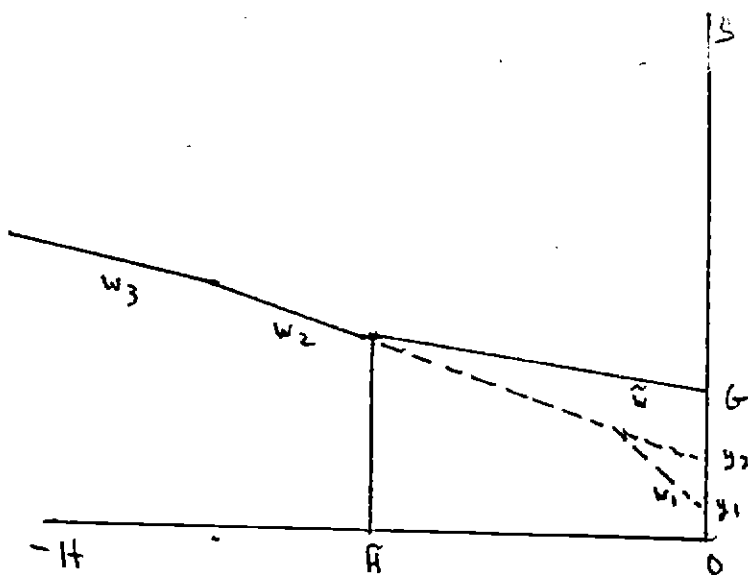reduce labor supply. In Figure 6.1 we show how the NIT alters the budget set.

Figure 6.1

Non-labor income y is replaced by the NIT guarantee G which will havew the effect of reducing labor supply for an individual who was initially on the first budget segment so long as leisure is a normal good. At the same time the net wage w_1 which was subject only to FICA contributions now is lowered to $\tilde{w}$ which is subject to approximately a .5 tax rate. Thus, labor supply will be reduced since the NIT budget segment lies uniformly above the first non-NIT budget segment.[5] For individuals initially on the second segment but below breakeven $\tilde{H}$ the same reasoning holds. Non-labor income has risen from $\bar{y}_2$ to G and $\tilde{w}$ is less than w_2. Lastly, many individuals above breakeven hours $\tilde{H}$ will not change their labor supply at all, but others will shift down below $\tilde{H}$ because of the income effect of the guarantee.

In fact, the findings agree with this economic theory. The labor supply reduction in hours worked for white males in New Jersey was about 4% uncorrected for attrition. In Gary for black males it was about 6% uncorrected for attrition and 10% when corrected for attrition, and in Seattle-Denver the response was 5% uncorrected for attrition. While these overall results are of interest, they are not sufficient for policy purposes. They are an average response over the many NIT plans used in each experiment.[6] To obtain reliable cost estimates, it is necessary to construct a model which permits determination of income and substitution effects. Then the cost of different plans can be forecast from the estimated parameters.[7]

Hausman-Wise (1976) was the first paper which took explicit account of the form of the NIT budget set in constructing an empirical model. They used an instrumental variable procedure to predict the net wage and virtual income along

with a budget segment and estimated a log linear labor supply specification for white males in the New Jersey experiment. They found an uncompensated wage elasticity of .14 and an income elasticity of - .023. Thus both effects in Figure 6.1 have significant effects in reducing labor supply. The poverty level for a four person in New Jersey was $3,300. Thus for an individual who received the poverty limit as the guarantee and faced a 50% marginal tax rate the uncompensated wage effect would lead to an expected labor supply reduction of about 8% while the income response would lead to an expected reduction of between 10-16% if the person had initially been on the first budget segment. Taking midpoints we would have an overall expected response of 21% in labor supply. For an individual initially on the second segment he might have no response to an NIT at all. For those initially below breakeven hours $\widetilde{H}$ on the second segment the wage effect is 6% with the income effect leads to a reduction of 1% so that the overall response is about 7%. Taking weighted averages of the two responses leads to an expected labor supply reduction for those individuals below breakeven hours of 16.5%. It is very important to note that the model predicts only 17.6% of the population will fall below breakeven so that the overall population response is about 4%.[8] Some confusion has arisen over the response conditioned on being below breakeven hours and the overall population response. The latter response is appropriate for cost estimates of an NIT.

Burtless-Hausman (1978) analyze the labor supply response among black males in the Gary NIT experiment. They use a procedure to treat taxes very similar to the technique used in Section 4 except for the choice of a log linear labor supply surve. In particular, they treat the budget set as exogenous rather than using an ad hoc instrumental variable procedure and they also allow for a

distribution of tastes in the population. Here in Table 6.1 we present their results for both control individuals and for experimental individuals on a weekly basis for the mean individual in the sample. We first note that breakeven hours are quite high for some of the plans so that the individual will almost certainly be below breakeven. Also note that a significant dispersion exists in the expected response – it is about 13% for low wage groups. Perhaps even more importantly the distribution of tastes parameter indicated that most of the response takes place via the income effect for a small number of individuals. The great majority of individuals do not significantly alter their work response so that the effect of the NIT leads to a very skewed response in the population. On the other hand, the uncompensated wage change has very little effect. We can see the income and substitution effect by comparing the rows which correspond to a $2.25 wage since the individuals will always be on the first budget. No difference in responsde at all is found for the .4 or .6 tax rate while the high guarantee leads to a 9% greater response than does the low guarantee. At higher wage rates the amount of the tax does play a role, but only because it changes the amount of breakeven hours and thus the probability of being above breakeven. The find that the income effect is the major determinant of labor supply reduction among males was also found by Moffitt (1978) who used a quite different different probit type of model. The results differ markedly from the Hausman-Wise findings for New Jersey where the income effect explained about 68% of the change in hours. It would be interesting to determine if this result occurs because of different model specification or because of a fundamentally different response pattern among the two populations.[9]

The final labor supply results for males that we review are the findings of

TABLE 6.1

Location of 15 Budget Lines In Gary Experiment

Financial Plan and Gross Wage/Hr ($)	w_1 ($)	w_2 ($)	y_1 ($)	y_2 ($)	Hours at Kink Point	Expected Hours	Change from Control (%)	95% Confidence Range of Expected Hours	Probability of Below Break-even Point
Control:									
2.25	2.07	1.67	2.72	27.82	43.16	43.55	...	...	...
4.25	3.92	3.15	2.72	27.82	22.85	40.37	...	36.8, 45.38	...
6.25	5.76	4.63	2.72	27.82	27.82	40.34	...	36.8, 45.38	...
								36.8, 45.38	
40% tax/low guarantee:									
2.25	1.35	1.67	78.63	27.82	159.59	38.68	-11.8	34.15, 44.95	1.0
4.25	2.53	3.15	78.63	27.82	81.77	38.68	-4.3	34.15, 44.95	1.0
6.25	3.75	4.63	78.63	27.82	57.45	38.68	4.2	34.15, 44.95	1.0
60% tax/low guarantee:									
2.25	0.90	1.67	78.09	27.82	65.42	38.69	-11.8	34.17, 44.96	1.0
4.25	1.70	3.15	78.09	27.82	34.63	39.62	-1.9	34.16, 43.48	.21
6.25	2.50	4.63	78.09	27.82	23.55	40.23	-.3	34.16, 45.38	.02
40% high/tax guarantee:									
2.25	1.35	1.67	102.63	27.82	234.97	38.27	-12.9	33.50, 44.85	1.0
4.25	2.53	3.15	102.63	27.82	120.39	38.27	-5.3	33.50, 44.85	1.0
6.25	3.75	4.63	102.63	27.82	84.59	38.27	-5.3	33.50, 44.85	1.0
60% tax/high guarantee:									
2.25	.90	1.67	101.09	27.82	96.66	38.29	-12.9	33.50, 44.84	1.0
4.25	1.70	3.15	102.09	27.82	51.17	38.29	-5.3	33.50, 44.84	1.0
6.25	2.50	4.63	102.09	27.82	34.86	39.38	-2.4	33.50, 45.38	.23

Keeley, et al. (1978) for the Seattle-Denver experiment. While the Seattle-Denver experiment is superior in certain respects from the other urban experiments, the ad hoc method used by the authors to treat the budget set is not entirely satisfactory. They use a first difference specification where the change in income is done at pre-experimental hours of work for the individual as is the change in the net wage rate. Since pre-experimental hours are an endogenous variable, an important simultaneous equation bias may be introduced.[10] However, the magnitude of the bias is difficult to estimate. At the mean of the sample Keeley et al. found the income effect to explain 46% of the reduction in hours while the change in the wage explained the other 54%. These results differ markedly from the results in the New Jersey and Gary sample where the change in non-labor income is the more determinant of the reduction in labor supply. Again, it would be interesting to ascertain whether the different results arise because of the model used.

The other group whose labor supply might be markedly affected by introduction of a NIT is working wives. Neither the New Jersey nor the Gary experiments had sufficient number of working wives to allow model estimation. Keeley, et al. find an average response elasticity about four times as large for wives as for husbands. The mean labor force reduction is 22%. Here the change in income accounted for 75% of the total effect. Since most of these women presumably had working husbands, such a large scale withdrawal from the labor force could be an important effect of an NIT.

The last group to be considered is female headed households. Most of the affected population qualifies for AFDC so that introduction of an NIT leads to a substantially higher guarantee and somewhat lower tax rate under most NIT plans.

Keeley, et al. found the female heads response to be about twice as large as the male response. The mean labor force reduction is 11%. Here they found the income effect to explain about 66% of the total response. Hausman (1980) in a study of labor force participation among black females who headed households in Gary again found the level of the guarantee to be much more important than the NIT tax rate. For instance he finds that the change from a .4 to .6 NIT tax rate reduces the probability of participation by about 2.5% while a change in the NIT guarantee from .75 of the poverty limit to the poverty limit reduces the probability of participation 6.5%. In terms of comparing the expected effort to that of AFDC it seems likely that a reduction in labor supply would result. Even if the marginal tax rate fell from the AFDC level of .67 to an NIT level of .4 the accompanying higher benefits would create a net disincentive effect. The net result would be a significant increase in the cost of family support for female headed households. At the same time the extra income which would go to the lowest income group in the economy might well lead to a net gain in social welfare.

The other literature which we review is the effect of the social security earnings test on retirement behavior and labor supply. We discussed the social security beneficiary budget set in Section 3 where we emphasized the intertemporal aspects of the model. An important empirical fact does appear with respect to social security. Labor force participation has decreased among the elderly over the postwar period in the United States. From

1960 to 1975 labor force participation for males over 65 fell from 33% to 22%. Over the same period for men aged 62-64 it fell from 81% to 60%. 1961 is the year in which Social Security eligibility for men 62-64 was introduced. An important policy question is whether the decline in male labor force participation is almost wholly a result of the early retirement provision of Social Security and the rising real benefit level. Rising real income for potential retirees during the period offers an alternative explanation for part of the observed behavior. Given recent policy proposals to extend the age of early retirement from 62 to 65 years of age, the causes of early retirement assume an important role in financial projections for the Social Security system. Three recent papers consider the causes of retirement over the 1965-1975 period. Baskin-Hurd (1982) ascribe almost all the decrease in labor force participation to Social Security. Diamond-Hausman (1982a,1982b) find that Social Security is the most important factor, yet if early retirement between ages 62-65 were stopped, the retirement probability would decrease by about 1/2 so that a significant number of men would still retire during that age period.[11] Further research is required here because of the complex interaction of non-retirement labor supply and its effect on future social security benefits, c.f. Blinder et al. (1980).

The other dimension of the effect of Social Security is the earnings test for Social Security recipients. In 1982 earnings beyond $6,000 are subject to a 50% tax rate until all Social Security benefits are recovered, i.e., the breakeven point $\tilde{H}$ is reached in Figure 6.2. Burtless and Moffitt (1982) in a recent study find that the earnings test has a major effect on retired males labor supply decisions.[12] Among retired men who are working the frequency

distribution of hours worked has a pronounced spike at the kink point H_1 in Figure 6.2 which provides strong evidence of the incentive effect of the earnings test. This effect is to be expected given the pronounced kink at H_1 hours where the net wage is reduced for w to .5w. About 50% of working males were located at the kink point and 90% worked hours either at or below the kink point H_1. However, to analyze the overall effect of the earnings test non-participation
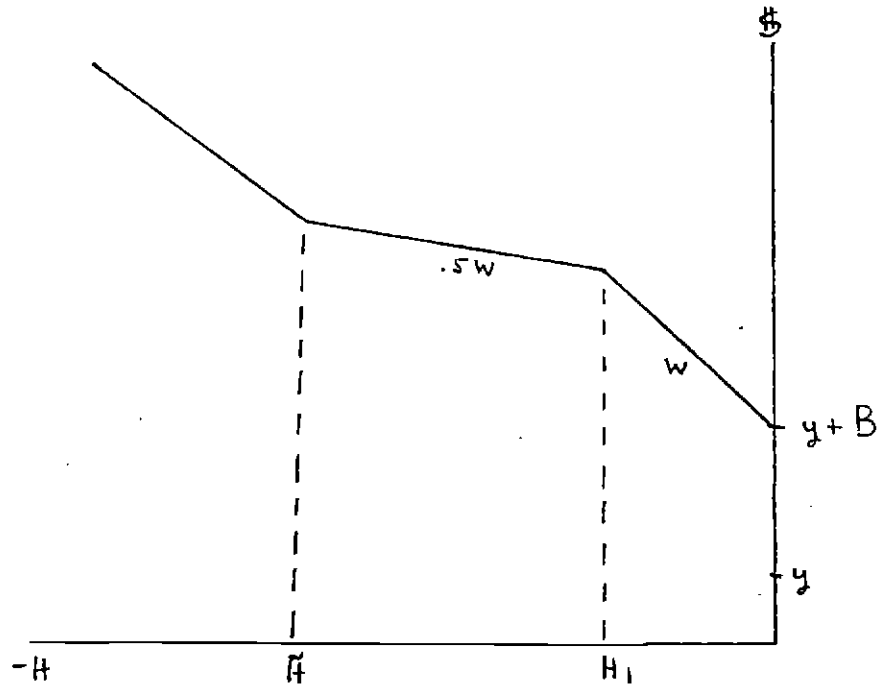

Figure 6.2

must be accounted for since upwards of 80% of the men in the Burtless-Moffitt sample worked zero hours. Thus, overall the earnings test leads to a reduction in expected hours of about 50 hours per year. However, for those men who are

working the removal of the earnings test would increase expected labor supply by about 400 hours per year. Thus, the situation is very similar to the case of wives discussed in Section 4 where tax changes have only a small expected effect on non labor force participants. But considering the problem in this context, Burtless-Moffitt may have overestimated the wage elasticity by their neglect of fixed costs to working.[13] Still, they have provided strong evidence of the effect of the earnings test on the labor supply behavior of Social Security recipients.

In this section we have considered the empirical evidence from the NIT experiments. Although numerous statistical and econometric problems arise, I feel we have learned much about labor supply behavior of low income workers. We now return to our question of the last section. There, we decided that labor supply behavior of high income persons was not too different than middle income individuals. What about low income people? From the experimental results, I conclude that the income effect is probably larger than we previously had thought. Especially for male heads of households I feel that introduction of an NIT would have a significant impact on labor force supply reduction by a small proportion of the population. I doubt that the NIT tax rate is nearly as important as the level of the NIT guarantee. Thus, low income males do have low wage elasticities as does the rest of the population; but their income elasticities may have an important effect on labor supply behavior given the size of the NIT guarantee. Similar results were found for female headed households although they presently have AFDC so that the change might not be as large. Lastly, the NIT results for wives seem quite different than the usual results. Their wages elasticities are much lower and income elasticities are much higher

than had been found for middle income wives. But, the evidence on wives is based on only one sample and one estimation technique. More research needs to be done on wives behavior under an NIT before we can be confident about the results.

Research of the effects of Social Security is still in an early stage of development. Little doubt would seem to exist that Social Security benefits are an important determinant of retirement decisions. Furthermore, the earnings test does have an important effect on labor supply behavior of retirees. Further research that accounts for the intertemporal aspects of the problem and the form of the lifetime budget set is still needed.

NOTES

[1] A further problem exists since the results from the rural experiment seem extremely difficult to interpret.

[2] All the experiments were designed basically to measure labor supply elasticities. However, other interesting areas of research such as family consumption patterns and family stability have been studied.

[3] For a series of papers on the New Jersey experiment see the Spring 1974 volume of The Journal of Human Resources.

[4] These problems are discussed in Hausman (1982b).

[5] So long as the NIT segment lies uniformly above the previous budget segment the net change in income must be positive. Thus, the income effect will reinforce the substitution effect and cause a reduction in labor supply. Thus, the level of the guarantee removes the usual interdeterminancy of the effect of a change in the net wage.

[6] Unfortunately, insufficient subjects were included in each cell of the experiment ot use classical ANOVA techniques to compute an accurate estimate of the response to each NIT plan. Statistical problems which arose during the design and duration of the experiment may preclude use of these techniques anyway. See Hausman-Wise (1977,1979a,1979b).

[7] Two potential problems arise in using the experimental results to produce cost estimates. First, the demand side of the market could change significantly for a nationwide NIT. In particular, individuals could choose work patterns to convexify their budget sets by working and not working in alternative accounting periods. Also, the limited duration of the experiment may miss important long range effects on both the supply and demand sides of the labor market.

[8] The low proportion below breakeven is due to the study of white males who were relatively well off in New Jersey and Pennsylvania.

[9] The finding that it is the income effect which creates almost the entire labor supply response is corroborated further by the results of Hausman-Wise (1979a) who consider a model which corrects for attrition.

[10] A further problem exists since people initially above breakeven hours will not have their net wage or income affected by the experiment. The authors attempt to treat this problem by including a dummy variable which again would create simultaneous equation bias.

[11] These studies are in stark contrast to Gordon and Blinder (1980) who in their study of retirement descisions" assume(s) that social security is irrelevant to retirement decisions." (p.279). No empirical study, to the best of my knowledge, has come close to verifying this assumption.

[12] Burtless and Moffitt go along way towards a complete model of the lifetime budget set. However, since their model is basically cross sectional, they do not account for increases in future social security benefits from extra years of work in an entirely satisfactory manner.

[13] Hausman (1981a) found a lower wage elasticity for wives when fixed costs to working here accounted for. Cogan (1981) made a similar finding in a model without taxes.

REFERENCES

1.   Ashenfelter, O. and J. Heckman (1974), "The Estimation of Income and
     Substitution Effects in a Model of Family Labor Supply", Econometrica,
     42..

2.   Ashworth, J.A. and D.T. Ulph (1981), "Estimating Labour Supply with
     Piecewise Linear Budget Constraints", in C Brown (ed.), Taxation and
     Labor Supply, (London, 1981).

3.   _____, (1981), "Household Models", in C. Brown (ed.), Taxation and
     Labour Supply, (London, 1981).

4.   Atkinson, A. and J. Stiglitz (1976), "The Design of Tax Structure: Direct
     Versus Indirect Taxation", Journal of Public Economics, 6.

5.   _____ , (1980), Lectures on Public Finance, (New York).

6.   Atkinson, A. and N. Stern (1980), "On Labour Supply and Commodity Demand",
     Journal of Public Economics, 14.

7.   Atkinson, A. et. al. (1980), "On the Switch from Direct to Indirect
     Taxation", Journal of Public Economics, 14.

8.   Auerbach, A. (1982), "Measurement of Excess Burden and Optimal Taxation",
     mimeo.

9.   Barlow, R., H. Brazer, and J. Morgan (1966), Economic Behavior of the
     Affluent, (Washington).

10. Blinder, A. et. al. (1980), "Reconsidering the Work Disincentive Effects of
     Social Security", National Tax Journal, 33.

11. Blomquist, S. (1982), "The Effect of Income Taxation on Male Labor Supply",
     in Sweden, mimeo.

12. Blundell, R. and C. Walker (1982), "Modelling the Joint Determination of
     Household Labor Supply and Commodity Demands", Economic Journal, 92.

13. Borjas, G. and J. Heckman (1978), "Labor Supply Estimates for Public Policy
     Evaluation", Proceedings of the IRRA.

14. Boskin, M. and M. Hurd (1982), "The Effect of Social Security on Retirement
     in the Early 1970's, mimeo.

15. Break, G. (1957), "Taxes and Incentives to Work: An Empirical Study",
     American Economic Review, 48.

16. Brown, C. et. al. (1976), "Estimate of Laour Hours Supplied by Married Male
     Workers in Great Britain", Scottish Journal of Political Economy, 23.

17. ————— (1982), "Preliminary Family Labour Supply Estimates", mimeo.

18. Burtless, G. and J. Hausman (1978), "The Effect of Taxes on Labor Supply: Evaluating the Gary NIT Experiment", Journal of Political Economy, 86.

19. Burtless, G. and R. Moffitt (1982), "The Effect of Social Security on Labor Supply of the Aged", mimeo.

20. Cain, G. and H. Watts (1973), Income Maintenance and Labor Supply, (Chicago).

21. Cogan, J. (1980), "Married Womens Labour Supply", in J. Smith (ed.), Female Labor Supply, (Princeton, 1980).

    ————— (1981), "Fixed Costs and Labor Supply", Econometrica, 49.

22. Deaton, A. (1981), "Theoretical and Empirical Approaches to Consumer Demand Under Rationing", in A. Deaton (ed.), Essays in the Theory and Measurement of Consumer Behavior, (Cambridge).

23. Deaton, A. and J. Muellbauer (1980), Economics and Consumer Behavior, (Cambridge).

24. ————— (1981), "Functional Forms for Labor Supply and Commodity Demand with and Without Quantity Rationing", Econometrica, 49.

25. Diamond, P. and D. McFadden (1974), "Some Uses of the Expenditure Function in Public Finance", Journal of Public Economics, 3.

26. Diamond, P. and J. Hausman (1982a), "Individual Retirement and Savings Behavior", mimeo.

27. ————— (1982b), "Retirement and Unemployment Behavior of Older Men", mimeo.

28. Diewert, E. (1971), "Choice on Labor Markets and the Theory of the Allocation of Time", mimeo.

29. ————— (1982), "Duality Approaches to Consumer Theory", in K. Arrow and M. Intriligator, (eds.), Handbook of Mathematical Economics (Amsterdam, 1982).

30. Feenberg, D. and H. Rosen (1983), "Alternative Tax Treatment of the Family: Simulation Methodology and Results, in M. Feldstein (ed.), Tax Simulation Models, (Chicago, 1983).

31. Fields, D. and W. Stanbury (1970) "Disincentives and the Income Tax: Further Empirical Evidence", Public Finance, 25.

32. Fields, D. and W. Stanbury (1971) "Income Taxes and Incentives to Work: Some Additional Empirical Evidence", American Economic Review, 60.

33. Gordon, R. and Blinder, A. (1980), "Market Wages, Reservation Wages, and Retirement Decisions", Journal of Public Economics, 14.

34. Greenburg, D. and M. Kosters (1973), "Income Guarantees and the Working Poor", in Cain and Watts.

35. Hall, R. (1973), "Wages, Income and Hours of Work in the U.S. Labor Force", in Cain and Watts.

36. ————— (1982), "The Importance of Lifetime Jobs in the U.S. Economy", American Economic Review, 72.

37. Ham, J. (1982), "Estimation of a Labour Supply Model with Censoring due to Unemployment and Underemployment", Review of Economic Studies, 49.

38. Hanoch, G. (1980), "A Multivariate Model of Labor Supply", in J. Smith (ed.) Female Labor Supply (Princeton).

39. Harberger, A. (1964), "Taxation, Resource Allocation and Welfare, in The Role of Direct and Indirect TAxes in the Federal Revenue System", (NBER, 1964).

40. Hanoch, G. and M. Honig (1978), "The Labor Supply Curve under Income Maintenance Programs", Journal of Public Economics, 9.

41. Hausman, J. (1979), "The Econometrics of Labor Supply on Convex Budget Sets", Economic Letters, 3.

42. ————— (1980), "The Effect of Wages, Taxes, and Fixed Costs on Womens Labor Force Participation", Journal of Public Economics, 14.

43. ————— (1981a), "Labor Supply" in H. Aaron and J. Pechman (eds.), How Taxes Effect Economic Activity (Brookings, 1981).

44. ————— (1981b), "Exact Consumers' Surplus and Deadweight Loss", American Economic Review, 71.

45. ————— (1981c), "Income and Payroll Tax Policy and Labor Supply, in L.H. Meyer (ed.), The Supply-Side Effects of Economics Policy, (St. Louis, 1981).

46. ————— (1982), "The Econometrics of Non-Linear Budget Sets", mimeo.

47. ————— (1982b), "The Effect of Time in Economic Experiments", in W. Hildebrand (ed.), Advances in Econometrics, (Cambridge).

48. ————— (1983), "Stochastic Problems in the Simulation of Labor Supply" in M. Feldstein (ed.), Tax Simulation Models, (Chicago, 1983).

49. Hausman, J. and D. Wise (1976), "The Evaluation of Results from Truncated Samples", _Annals of Economic and Social Measurement_, 5.

50. ————— (1977), "Social Experimentation, Truncated Distributions, and Efficient Estimation", _Econometrica_, 45.

51. ————— (1978), "A Conditional Probit Model for Qualitative Choice", _Econometrica_, 46.

52. ————— (1979), "Attrition Bias in Experimental and Panel Data", _Econometrica_, 47.

53. ————— (1981), "Stratification on Endogenous Variables and Estimation", in C. Manski and D. McFadden, _The Econometrics of Discrete Data_ (MIT Press).

54. Hausman, J. and P. Ruud (1983), "Family Labor Supply with Taxes", mimeo.

55. Holland, D. (1969), "The Effect of Taxation on Effort: The Results for Business Executives", in S. J. Bowers, _Proceedings of National Tax Association_.

56. Holland, D. (1976), "The Effect of Taxation on Incentives of Higher Income Groups", in IFS, _Fiscal Policy and Labour Supply_, No. 4.

57. Kay, J. (1980), "The Deadweight Loss from Tax System", _Journal of Public Economics_, 10.

58. Keeley, M. et. al. (1978), "The Estimation of Labor Supply Models Using Experimental Data", _American Economic Review_, 68.

59. Killingsworth, M. (1982), _Labor Supply_, forthcoming.

60. Kosters, M. (1969), "Effects of an Income Tax on Labor Supply", in A. Harberger and M. Bailey, eds., _The Taxation of Income Capital_ (Washington).

61. Lewis, G. (1956), "Hours of Work and Hours of Leisure", _IRRA Proceedings_, 9.

62. Mirrlees, J. (1971), "An Exploration in the Theory of Optimal Income Taxation", _Review of Economic Studies_, 38.

63. ————— (1982), "The Theory of Optimal Taxation", in K. Arrow and M. Intriligator (eds.), _Handbook of Mathematical Economics_ (Amsterdam, 1982).

64. Moffitt, R. (1979), "A Note on the Effect of Taxes and Transfers on Labor Supply", _Southern Economic Journal_.

65. Moffitt, R. and W. Nicholson (1982), "The Effect of Unemployment Insurance on Unemployment", Review of Economics and Statistics, 64.

66. Nakamura, A. and M. Nakamura (1981), "A Comparison of the Labor Force Behavior of Married Women in the U.S. and Canada, with Special Attention to the Impact of Income Taxes", Econometrica, 49.

67. Neary, J. and K. Roberts (1980), "The Theory of Household Behavior Under Rationing", European Economic Review, 13.

68. Pechman, J. (1976), Federal Tax Policy (3rd Ed.) (Washington).

69. Rosen, H. (1976), "Taxes in a Labor Supply Model with Joint Wage-Hours Determination", Econometrica 44.

70. Ruffell, R.J. (1981), "Direct Estimation of Labor Supply Functions with Piecewise Linear Budget Constraints", in C. Brown (ed.) Taxation and Labor Supply (London, 1981).

71. Sanders, T. (1951), Effects of Taxation on Executives (Boston).

72. Seater, J. (1982), "Marginal Federal Personal and Corporate Income Tax Rates in the U.S. 1909-1975", Journal of Monetary Economics, 10.

73. Smith, J. (ed.), (1980), Female Labor Supply, (Princeton).

74. Stiglitz, J. (1982), "Utilitarianism and Horizontal Equity", Journal of Public Economics, 18.

75. Steverle, E. and M. Hartzmark (1981), "Individual Income Taxation, 1947-79", National Tax Journal, 34.

76. Tax Foundation (1981), Facts and Figures on Government Finance, (Washington, 1981).

77. Varian, H. (1978), Microeconomic Theory, (New York, 1978).

78. Wales, T. (1973), "Estimation of a Labor Supply Curve for Self-Employed Business Proprietors", International Economic Review, 14.

79. Wales, T. and A. Woodland (1979), "Labor Supply and Progressive Taxes", Review of Economic Studies, 46.

80. Zabalza, A. et. al. (1980), "Social Security and the Choice between Full-Time Work, Part-Time Work and Retirement", Journal of Public Economics, 14.