Chapter 4

TAXES AND LABOR SUPPLY*

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1. 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% 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 (Federal Insurance Contributions Act) taxes 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 1.1 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 75% of federal taxes raised.[1] Their potential effects on labor supply and 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

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[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.

Handbook of Public Economics, vol. I, edited by A.J. Auerbach and M. Feldstein

Table 1.1
Revenues from income and payroll taxes (billions).

Year	Income tax revenues	Payroll tax[a] revenues	Income tax % of federal revenues	Payroll tax % of federal revenues	Median marginal tax rate[b]	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	3.626	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

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

progressive taxation is to create a convex, non-linear 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 non-convexities 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 affect 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 non-linearity of the budget sets which taxation creates. Other problems such as components of the stochastic specification, limited dependent variables, and unobserved wages for non-workers 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.[2] The ratio of deadweight loss to tax revenue raised rises approximately with the tax rate. In

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

Table 1.1 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 2 considers the theory of labor supply with taxes. The effect of the non-linearity of the budget sets complicates the analysis so few definite conclusions can be reached. In Section 3 we develop an econometric model of labor supply so that the problems created by convex and non-convex budget sets can be solved. Section 4 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 5 we present empirical estimates for husbands and wives labor supply functions. We also calculate the economic cost of the tax system for certain individuals. Because of small numbers in cross-section samples, and measurement problems, high-income individuals are difficult to treat within the context of a labor supply model. Thus, in Section 6 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 7 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. The purpose of this chapter is to concentrate on the effects of taxes. A vast empirical literature in labor economics exists which considers labor supply without explicit consideration of taxes. A recent survey of this literature is given by Killingsworth (1983).

2. 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

$$\frac{\mathrm{d}h}{\mathrm{d}w} = \left.\frac{\partial h}{\partial w}\right|_{u=\bar{u}} + h\frac{\partial h}{\partial y}, \tag{2.1}$$

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 2.1. The composite good is used as numeraire, so consumption is measured on the vertical axis with hours supplied on the horizontal axis. Non-labor 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, the desired hours of work h^* can either increase or decrease according to equation (2.1). 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 (2.1) would then need to be modified to account for taxation of y to

$$\frac{\mathrm{d}h}{\mathrm{d}t} = \left.\frac{\partial h}{\partial w}\right|_{u=\bar{u}} \frac{\mathrm{d}w}{\mathrm{d}t} + h\frac{\partial h}{\partial y} + \frac{\partial h}{\partial y}\frac{\mathrm{d}y}{\mathrm{d}t}. \tag{2.2}$$

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

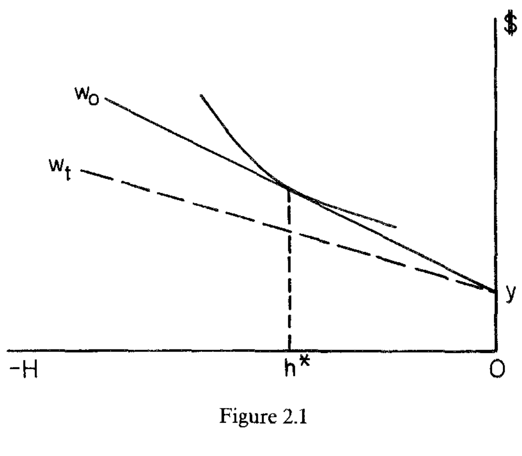

Figure 2.1

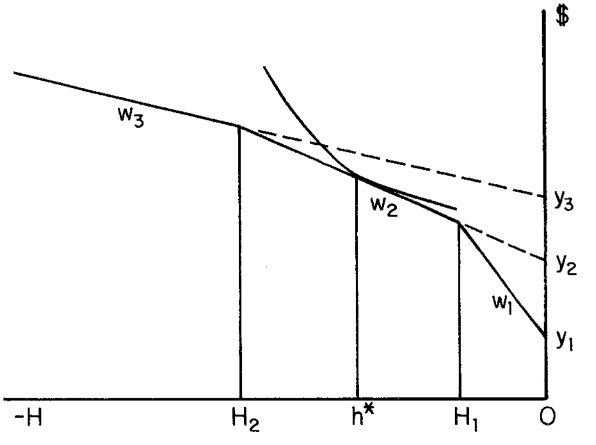

Figure 2.2

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 2.2 three marginal tax rates are considered, t_1, t_2 and t_3, which lead to three after-tax net wages, w_1, w_2 and 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 the individual faced the linear budget set $B_2 = (w_2, y_2)$, he would still choose hours of work h^* as in Figure 2.2. In assessing the effect of taxation on labor supply, two questions arise. How does h^* in Figure 2.2 differ from the no-tax situation of Figure 2.1? And how is h^* in Figure 2.2 affected by a change in the market wage w or the tax rates t_i?

To consider the first question we combine Figures 2.1 and 2.2 in Figure 2.3. 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 2.1 with offsetting income and substitution 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 substitution effect, which virtual income y_2 or y_3 exceeds y_1 and a further income effect from

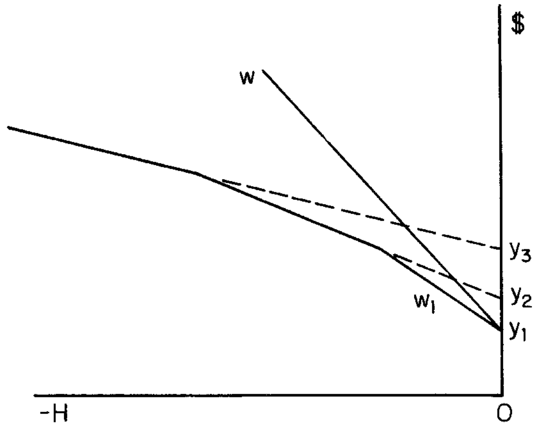

Figure 2.3

equation (2.1) is created which would reduce labor supply.[3] 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 2.4 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, i.e., $E_1 = y_1 + w_1 H_1$. Thus, the virtual incomes depend only on the tax system and non-labor 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 equation (2.2)

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 2.2 the w_3 segment rotates counterclockwise. The virtual income y_3 also rises. We have the same effect as

[3] 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 not 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.

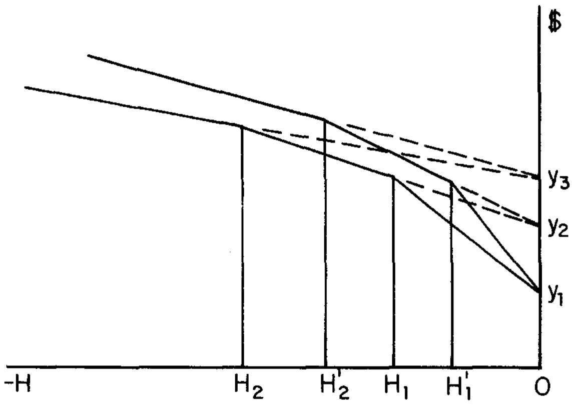

Figure 2.4

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 (2.2). 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 decrease his preferred hours to H_2 if the substitution effect is large enough, but will not decrease the preferred hours down to the second budget segment. 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 whose initial $h^* \leq H_1$, 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 $h^* \leq H_1$ but the 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

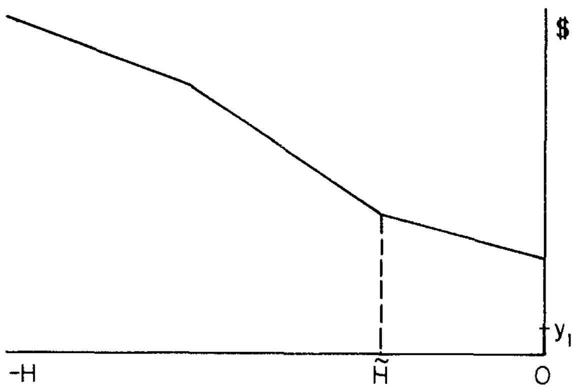

Figure 2.5

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.[4] Non-convex budget sets arise from the presence of government transfer programs. The three most important programs of this type are AFDC, social security, and a negative income tax (NIT) program. In Figures 2.5 and 2.6 we show the two most common types of non-convex budget sets.[5] 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 0.4 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 2.6 has one additional complication which arises as an earnings disregard in social security benefits or as a maximum

[4]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.

[5]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.

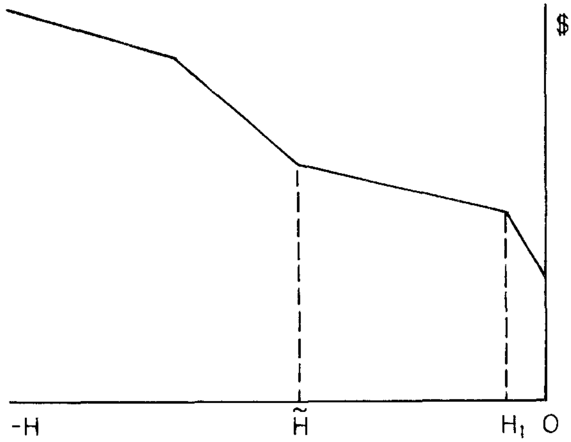

Figure 2.6

payment amount in some AFDC programs.[6] Hours up to H_1 are taxed only at FICA rates where H_1 is determined by E_1. Thus earnings up to a set amount are "disregarded" or not taxed by the program which is giving the transfer. 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 at the budget set.

Figures 2.7 and 2.8 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 of having multiple optima as in Figure 2.7 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 2.8 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.[7] Furthermore, the effect on h^* of a change in the market wage, taxes, or the earnings limits is "smooth" in an appropriate

[6]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.

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

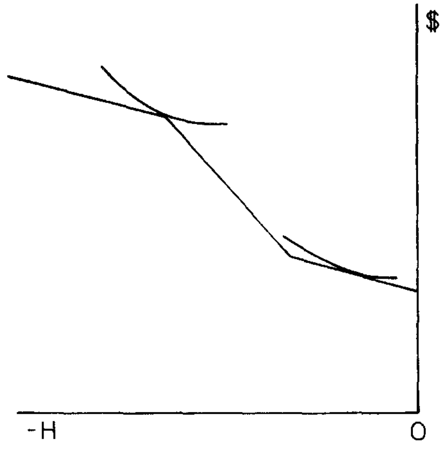

Figure 2.7

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 (2.2) is not usable since the possibility of a jump from one budget segment to another is always present.

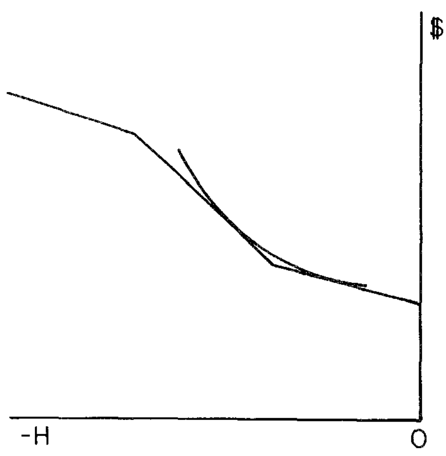

Figure 2.8

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 2.7, virtual incomes again fall while w_i remains constant so that the local effect 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 econometric models will need to incorporate these problems into the theory and estimation.[8] 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.[9] 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.[10] An effect of taxes is to make non-pecuniary 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

[8] Considerable research is currently undertaken in these areas.

[9] 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.

[10] 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.

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 in an inadequate measure of earnings. Furthermore, issues 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. But further empirical research based on less restrictive models may find a more important role for intertemporal considerations.

Another potentially important intertemporal consideration is that the models that we have specified are static labor supply models. Intertemporal considerations may render the static approach inapplicable except under very strong separability assumptions. How would our approach change if life cycle considerations are accounted for? Blundell and Walker (1984) have demonstrated that only a minor change is required. Under the assumption which is typically made in life cycle models, a two-stage budgeting approach makes the labor supply decision conditional on planned life cycle asset accumulation.[11] At the first stage the lifetime budget is allocated to equalize the marginal utility of money in each period. At the second stage the labor supply decision is made conditional on this allocation. The second-stage decision is therefore analogous to our static approach except that non-labor income must be replaced by net dissaving in the period. MaCurdy (1981) discusses the interpretation of the estimated coefficients from the labor supply model in a life cycle context. However, note that the tax system still only taxes the income component of this dissaving. The static specification then becomes correct only if assets remain constant over the life cycle.

The specification of a static labor supply model may thus lead to biased estimates because the incorrect measure of virtual income is being used in the labor supply equation. Note, however, that most of the variation in virtual income, which enters the labor supply equation occurs because of the tax system. The variation in net dissavings compared to the variations caused by the tax system may be small. More research is required here. What is primarily needed is a cross-section data set which contains both labor supply information and also carefully constructed information on net dissavings over the period of observation.

MaCurdy (1983) takes a different approach to the problem of incorporating life cycle considerations. He estimates the marginal rate of substitution function between consumption and hours of work. Thus, data on both labor supply and consumption is needed. Unfortunately, it is not straightforward to see how constraints such as zero hours of work can be applied in the MaCurdy formulation. Further econometric problems exist with respect to errors-in-variables problems in representing the tax system. In its initial application to the Denver

[11] Deaton and Muellbauer (1980) discuss two-stage budgetary approaches.

Income Maintenance Experiment, MaCurdy estimates labor supply elasticities which are extreme outliers with respect to previous results which will be discussed subsequently. Further research will hopefully determine whether MaCurdy's results arise because of the life cycle considerations which previous studies have ignored or because of the econometric specifications which he uses.

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 these limitations in mind.

3. 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 become 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 non-convexities. 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 non-convexities together with quite high marginal tax rates.

We first outline the basic federal income tax system in 1980 by twelve brackets.[12] 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

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

Table 3.1
Basic federal tax rates for 1980 on earned income for married couples.

Taxable income	Marginal rate	Average rate at midpoint
0–2,000	0.14	0.140
2,000–4,000	0.16	0.147
4,000–8,000	0.18	0.160
8,000–12,000	0.21	0.174
12,000–16,000	0.24	0.189
16,000–20,000	0.28	0.204
20,000–24,000	0.32	0.222
24,000–32,000	0.37	0.250
32,000–42,000	0.43	0.287
42,000–56,000	0.49	0.331
56,000 +	0.50	—

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 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 $1,000 per person was allowed in 1980. The standard deduction, or zero bracket amount, was $3,400 for married couples in 1980.[13] 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 of 10% below $5,000 of gross income. From $6,000 to $10,000 the credit is reduced by 12.5%, so that the breakeven point is reached at $10,000 when the credit has been completely exhausted. A non-convexity 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 0.38 to about 0.32, which also creates a non-convexity.[14] We provide some historical data

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

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

Table 3.2
Federal income tax: Selected marginal rates.

Taxable income (1000's)	1950 (1.0, 3.3)[c]	1969 (1.23, 5.6)	1970[a] (1.61, 9.8)	1980 (3.42, 21.0)	1984[b]
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[d]	38
38–44	69	69	59	50	42
50–60	75	75	64	50	46
60–70	78	78	66	5C	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

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

on tax rates and actual marginal rates to provide a historical perspective on the income tax system.[15]

In Table 3.2 we provide a summary of marginal tax rates for the period 1950–1984, according to current legislation.[16] 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 years 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 marginal 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

[15] 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 increased the neutrality of the tax system towards married persons.

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

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 3.2 is the significantly higher marginal tax rates faced by the median earned 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 on 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 present marginal tax rates from a sample of returns in Table 3.3, 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 3.2. The significant rise in the progressivity of the income tax in the 1960–1980 period is evident in Table 3.3. Note that for those households which paid tax, the marginal rate was between 0.18 and 0.26 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 be decreased 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 1964–1967 when the Kennedy tax cut

Table 3.3
Marginal rates of taxation on personal income.

Percentile of returns	Marginal rates				Average marginal tax rates[b]		
	1961	1969[a]	1974	1979	Year	Rate	Payroll tax included
1%	0.00	0.00	0.00	0.00	1950	15.2	—
5%	0.00	0.00	0.00	0.00	1955	16.3	—
10%	0.00	0.00	0.00	0.00	1960	16.4	19.4
25%	0.18	0.15	0.15	0.14	1965	14.0	17.6
50%	0.18	0.23	0.20	0.20	1970	17.2	22.0
75%	0.22	0.25	0.22	0.24	1975	17.4	23.3
90%	0.22	0.28	0.28	0.32			
95%	0.26	0.32	0.32	0.38			
99%	0.38	0.47	0.47	0.50			

[a]Includes an approximation for surtax changed in 1969.
[b]From Seater (1982).

lowered tax rates, the average marginal tax rate 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 forty-two states had either progressive of proportional tax systems. Sixteen states permitted deduction of federal income taxes. Among the states with progressive tax systems Delaware had the highest overall marginal tax rate of 19.8%. However, at $15,000 after personal exemptions, the marginal rate in California was 10%, in Hawaii 10%, in Minnesota 14%, and in New York state 10%. In Oregon the marginal tax rate was 10% above $15,000, and in Wisconsin the marginal rate was 11.4% at $15,000. Nebraska, Rhode Island and Vermont were the only states which took a constant percentage from the federal taxes paid. Rhode Island took the highest proportion, 17%. Among states with proportional rates after personal exemptions, Illinois had a rate of 2.5%, Massachusetts a rate of 5.4%, and Indiana and Pennsylvania rates of 2%. State governments 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, Aid for Dependent Children, tax and transfer system. It has often been contended that AFDC presents a significant disincentive to labor supply, and its replacement by NIT, Negative Income Tax, 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 non-convexity is created because at the breakeven point the marginal tax rate decreases from 0.67 to approximately 0.16. Thus, the potential disincentive effect is quite large.[17] 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 0.67 tax. Thus, in Figure 3.1 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.

The workings of NIT tax systems resemble AFDC as in Figure 3.1, 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

[17] 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.

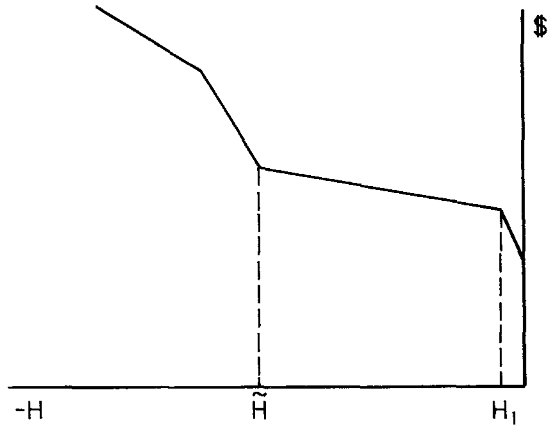

Figure 3.1

poverty limit which depends on family size and the local cost of living. The guarantee has been set at between 0.75 and 1.25 times the poverty limit in the NIT experiments. For instance, in Indiana 0.75 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 0.67 to a value between 0.4 and 0.6. The budget set has the non-convex form of Figure 3.2, where beyond breakeven hours, $\tilde{H}$, the individual returns to the federal tax system. At breakeven hours, the marginal tax rate falls from 0.4 and 0.7 to around 0.25 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 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 non-convexity 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 3.1. A level of benefits is determined by the earnings history covered by social security and by 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 0.5 until breakeven hours $\tilde{H}$ are reached. Thus, we again seem to have a

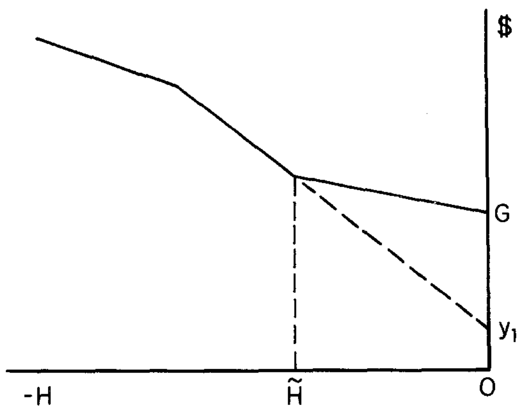

Figure 3.2

possibly large disincentive to working.[18] 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 in 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 disincentive 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.[19]

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, non-convexities

[18] 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.

[19] 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 on 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 this paper.

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.

4. 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.[20] 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 non-linearity 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.[21] Given a market wage which is constant over hours worked and a tax system which is given exogenously by the government, the non-linear budget set faced by the individual in deciding on his preferred hours of work is determined exogenously to his choice.[22] An econometric model needs to take the exogenous non-linear budget set and to explain the individual choice of desired hours. We first describe such a model for convex and non-convex 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

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

[21] In 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 Rosen (1976) introduced instrumental variable techniques to take account of this problem.

[22] If the market wage depends on hours worked, the same reasoning holds since the budget set is still exogenous. A more fundamental problem exists over the question of whether labor supply models, with or without taxes, are identified. Unobserved individual effects may exist in both the wage equation and hours equation. If these individual effects also influence variables such as education which appear in the wage equation but not in the hours equation and thus serve to identify the hours equation, we would lose identification.

so we begin with a slight generalization of the usual type of labor supply specification,

$$h = \tilde{g}(w, y, z, \beta) + \varepsilon = h^* + \varepsilon, \tag{4.1}$$

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 non-labor income. The stochastic term is assumed to have classical properties so that no quantity constraints on hours worked exist. However, $0 \leq h \leq \overline{H}$, where H is a physical maximum to hours worked. We also assume that, when the β's are estimated, 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 $i = 1, \dots, m$.[23] To find h^* we take the specification of desired hours on a given budget segment B_i,

$$h_i^* = g(w_i, y_i, z, \beta). \tag{4.2}$$

Calculate h_i^* and if $0 \leq h_i^* \leq H_i$ where the H_i's are kink point hours in Figure 2.2, 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 $H_1 \leq h_2^* \leq H_2$, we again would have the unique optimum. If we have bracketed the kink point so that $h_1^* > H_1$ 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 non-linear 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.[24] Perhaps a better technique would be to use Tobit, which enforces the constraint that $h_j \geq 0$.

The case of the non-convex budget set as in Figure 2.5 or Figure 2.6 is more complicated because equation (4.2) can lead to more than one feasible tangency which leads to many potential h_i^*'s. How can we decide which of these feasible

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

[24] A potential problem exists in the asymptotic expansions used to compute the standard errors of the coefficients.

h_i^*'s is the global optimum? Burtless and Hausman (1978) initially demonstrated the technique of working backwards from the labor supply specification of equation (4.2) to the underlying preferences which can be represented by a utility function.[25] The basic idea is to make use of Roy's identity which generated the labor supply function from the indirect utility function $v(w_i, y_i)$,

$$\frac{\partial v(w_i, y_i)}{\partial w_i} \Bigg/ \frac{\partial v(w_i, y_i)}{\partial y_i} = h_i^* = g(w_i, y_i, z, \beta), \tag{4.3}$$

along a given budget segment. As long as the Slutsky condition holds $v(w_i, y_i)$ can always be recovered by solving the differential equation (4.3). In fact, $v(\ )$ often has a quite simple closed form for commonly used labor supply specifications. For the linear supply specification

$$h_i^* = \alpha w_i + \beta y_i + z\gamma, \tag{4.4}$$

Hausman (1980) solved for the indirect utility function

$$v(w_i, y_i) = e^{\beta w_i}\left(y_i + \frac{\alpha}{\beta} w_i - \frac{\alpha}{\beta^2} + \frac{z\gamma}{\beta}\right). \tag{4.5}$$

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^*.[26] Then, as with the convex budget set case, we can use either non-linear 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 (4.2) 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 non-convex case requires global comparisons because of the possibility of multiple tangencies of indifference curves with the budget set.

[25] 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. Alternatively, one can begin with a utility function specification and derive the labor supply function as Wales and Woodland (1979), Ashworth and Ulph (1981a), and Ruffell (1981) did.

[26] 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 and Muellbauer (1981) for techniques to be used here. As Figure 2.8 shows, a tangency will not occur at a non-convex kink point, but it may occur later on a convex portion of the budget set.

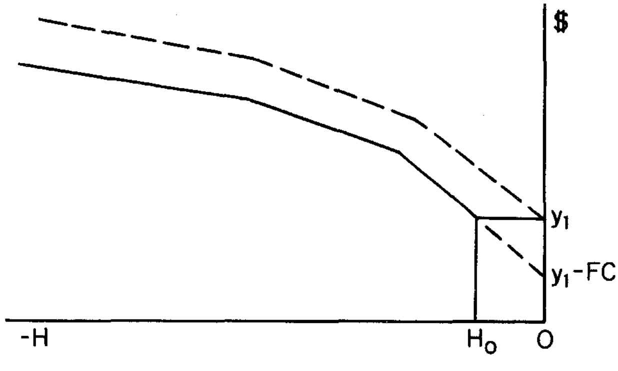

Figure 4.1

We next introduce the possibility of variation in tastes.[27] In the labor supply specification of equation (4.1), 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 and 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.[28] They also found that variation in β represented approximately eight 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 (1983) tests and rejects the constant preference (no parameter variation) model. However, his results in 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 non-rectangular regions for the more general specification has led to the 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.

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,

[27] For many linear regression specifications where the effect of taxes are not accounted for, variation in preferences leads only to an efficiency issue for the econometric estimator. However, taxes create an essential non-linearity 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 and 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.

[28] It is interesting to note that Greenberg and 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.

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 non-convexity in the budget set at the origin. Thus, even if the original budget set is convex as in Figure 2.2, 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 4.1 non-labor income is y_1 with the original convex budget set drawn by the dotted line. However, 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 non-convexity invalidates the simple reservation wage theory of labor force participation since hours also need to be accounted for. Hausman (1980, 1981a) 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.[29]

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 forty 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 and Wise (1978), Zabalza et al. (1980). For example, suppose we begin with the linear labor supply specification $h_i^* = \alpha w_i + \beta y_i - z\gamma$, along with the associated indirect utility function of equation (4.5). 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.[30] 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, w_i is the net wage at forty hours, and y_i is the corresponding virtual income. 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

$$u(h,x) = \frac{1}{\beta}\left(h - \frac{\alpha}{\beta}\right)\exp\left[\left(1 - \beta\left(x + \frac{z\gamma}{\beta} - \frac{\alpha}{\beta^2}\right)\right)\Big/\left(\frac{\alpha}{\beta} - h\right)\right], \tag{4.6}$$

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

[30]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.

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 appropriate 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 fourteen hours. Thus, the model of flexible labor supply with fixed costs may provide a reasonably good approximation, especially in the long run.[31]

A question of some interest might be: what are the directions 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 (4.4). 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 market wage w_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. The positive correlation between the net wage and income arises under progressive taxes because higher wages put the taxpayer into higher brackets which will have higher virtual incomes. In fact, empirical studies of males which do not account for taxes typically estimate α to

[31] 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.

be negative and substantial.[32] On the other hand, estimates which account for taxes [e.g., Burtless and Hausman (1978), Wales and Woodland (1979), Hausman (1981), Ashworth and Ulph (1981), Blomquist (1983), and 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 often 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 (4.4). Then two counteracting biases are 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 wife's virtual income, the effect of the bias should not be as important as in the husband's case. The empirical evidence to date supports this tentative conclusion.

In this section we have demonstrated how the non-linearity 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 non-convex, 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.

5. 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

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

used as summary measures in demand studies, are not fully adequate to assess the effect of taxation for the following reasons: (1) Non-linearity of the budget sets can lead to large changes in labor supply with small changes in taxes. The non-convexity of many of the budget sets leads to this result. (2) About 50% 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 affect 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 (2.2) demonstrates the correct relationship. (4) If variations in preferences are specified [e.g., Burtless and Hausman (1978), Hausman (1981a, 1982a), and Blomquist (1983)], behavior of the "mean" individual may differ from the mean population response.[33] This difference arises from the non-linearity 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.

5.1. Prime-age males

These individuals are usually taken to be from 25 to either 55 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.[34] 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.[35] Another needed advance is an integrated model of family labor supply with taxes to take account of wives labor market activity and its possible effect on husband's labor market behavior. Hausman and Ruud (1984) present results from a family model of labor supply. Significant interaction among the husband's and wife's labor supply behavior is found to be present.[36]

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 uniformly at work for 40 hours per week and 2,000

[33] Hausman (1983) investigates this issue.

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

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

[36] Ashworth and Ulph (1981b) also estimate household models of labor supply.

hours per year. On the contrary, 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 data.[37] Men presumably choose jobs which have the number of hours which most closely correspond to their desired hours taking account of overtime 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 and Woodland (1979), Ashworth and Ulph (1981), Hausman (1981a), Blomquist (1983), and Hausman and Ruud (1984).[38] The results are given in Table 5.1. First, note that the 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 -0.04 to -0.17 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 (2.1) and (2.2) demonstrate, the theoretical effect is indeterminate. Most models for prime-age males which ignore taxes estimate a backward-bending labor supply curve.[39] 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

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

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

[39]Some models find a backward-bending curve only for medium- and high-wage males.

Table 5.1
Prime-age male labor supply results.

Authors	Data	Model	Wage elasticity	Income elasticity
Wales–Woodland	PSID[a]	CES	0.09[b]	−0.11[b]
Ashworth–Ulph	U.K.	Generalized CES	−0.13	−0.05
Hausman[c]	PSID	Linear	0.00	−0.17
Blomquist[c]	Sweden	Linear	0.08	−0.04
Hausman–Ruud[d]	PSID	Generalized linear	−0.03	−0.10

[a] Panel Study of Income Dynamics.
[b] Results are approximate since means of data were not given.
[c] Specification permits variation in preferences. Mean results are given.
[d] Estimated from a model of family labor supply.

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, 1981c) 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 5.2 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 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 5.2 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

Table 5.2
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	+0.4%	+0.5%	+0.9%	+1.7%	+1.47%
30% tax cut	+1.3%	+1.6%	+2.7%	+3.1%	+4.6%

Table 5.3
The effect of tax rate changes on prime-age male labor supply in the U.K.

	Quintiles					
	1	2	3	4	5	Total
15% tax cut	−0.3%	+0.7%	+0.8%	+1.6%	+2.1%	+1.8%
7% tax cut	−0.1%	+0.3%	+0.3%	+0.9%	+0.9%	+0.8%
7% tax rise	+0.1%	−0.5%	−1.0%	−0.9%	−0.8%	−1.2%
15% tax rise	+0.3%	−1.1%	−2.3%	−2.6%	−2.1%	−2.9%

exact. However, neither of the two tax cuts is nearly self-financing as Hausman's (1981c) 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 $4,000 (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 (1981a) 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 four 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 5.3 the percentage change in labor supply is given for the entire sample as well as for each quintile of the income (not wage) distribution.[40]

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 and 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 5.3 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 (1981c) found.

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

Table 5.4
The effect of taxes on prime-age males in Sweden.

	Market wage			
	10.0 Skr	20.03 Skr	40.0 Skr	Total
Change in labor supply	−4.7%	−13.6%	−27.1%	−13.1%
Proportional tax	−1.9%	+6.2%	+11.4%	+6.9%

The last set of results which we consider are Blomquist's (1983) 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. In Table 5.4 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 5.2. Much of this difference arises from the considerably higher level of taxation in Sweden. In the second row of Table 5.4 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. Blomquist's estimates indicate a substantial effect of taxes on labor supply in Sweden.

5.2. *Economic welfare*

The welfare cost of the distortion created by the imposition 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.[41] 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 (1981b) has demonstrated that in the case of labor supply this method can be very inaccurate. Instead the theoretically correct notion of either the compensating variation or equivalent variation should be used.[42] These measures, set forth by

[41]Auerbach (this volume) contains a more detailed discussion of deadweight loss.
[42]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 (1981b) or Diewert (1982).

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 wages and prices.[43] 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

$$CV(w,w',U)=e(w',U)-e(w,U). \tag{5.1}$$

Equation (5.1) 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 substitution effect in the Slutsky equation (2.1). 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 (5.1) rather than actual non-labor income.[44]

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 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

$$\begin{aligned} DWL(w,w',U) &= CV(w,w',U)-T(w,w',U) \\ &= e(w',U)-e(w,U)-T(w,w',U). \end{aligned} \tag{5.2}$$

Equation (5.2) 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 $T(w,w',U)$.[45] 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

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

[44] The alternative measure of the equivalent variation 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.

[45] 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 CV and EV measures the problem is essentially one of which is the better index number basis.

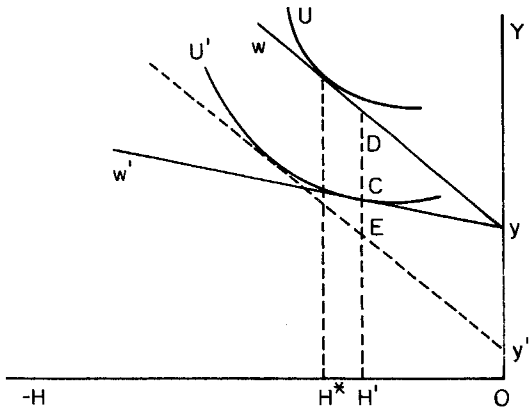

Figure 5.1

variation gives the welfare loss to the individual. In Figure 5.1 the compensating variation and deadweight loss are shown in terms of our simple wage tax example of Figure 2.2. 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 5.5 we present Hausman's results from deadweight loss of taxation of labor supply in the U.S. The first row gives the deadweight loss in each of the wage quintiles. 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.[46] The next two rows of Table 5.5 calculate the deadweight loss under two tax cut proposals to give 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

[46]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 (1981a) finds the uncompensated wage elasticity to be near zero.

Table 5.5
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%

deadweight loss to tax revenue ratio declines to 7.1%. A progressive linear income tax of 20.7% with an exemption level of $4,000 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 (1983) 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 policymakers worry about. Yet, the deadweight loss effects may be more important from an economist's 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 frame questions about the "optimal" progressivity of the tax system or the cost of marginal government expenditure.[47] 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 policymakers as well.

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

Table 5.6
Wives labor supply results.

Authors	Data	Model	Wage elasticity	Income elasticity
Ashworth–Ulph	U.K.	Generalized CES	0.19	−0.14
Hausman	PSID	Linear	0.91	−0.50[a]
Nakamura–Nakamura	U.S. Census	Linear	−0.16[b]	−0.05[b]
Nakamura–Nakamura	Canada Census	Linear	−0.30[b]	−0.19[b]
Rosen	Parnes (NLS)	Linear	2.30	−0.42[c]
Hausman–Ruud	PSID	Generalized linear	0.76	−0.36

[a]Evaluated for mean woman who works full time at virtual income which includes husband's earnings.
[b]For the age group 35–39; younger age groups have larger elasticities, while older age groups have smaller elasticities.
[c]Estimated from results given in the paper.

5.3. *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.[48] Since this marginal tax rate is around 25% on average, taxes should be expected to be important in wives labor supply decisions.[49] 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 non-participants will remain so. Therefore, elasticity estimates should be used with caution in considering tax changes.

We consider five sets of estimates for wives labor supply behavior which consider the effect of taxation: Ashworth and Ulph (1981a) for Great Britain, Hausman (1981a) for the U.S., Nakamura and Nakamura (1981) for Canada and the U.S., Rosen (1976) for the U.S., and Hausman and Ruud (1984) who use a model of family labor supply for the U.S. The results are given in Table 5.6. The estimates vary widely with the Ashworth–Ulph and Hausman results in the range

[48]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 appropriate marginal tax rate will decrease because of a credit included in the 1981 tax reform legislation.

[49]Given these facts it is 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.

Table 5.7
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%

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 and Rosen (1983) have used wage elasticity estimates of 1.0. The most surprising result is that of Nakamura and Nakamura (1981) who find significant *negative* uncompensated wage elasticities which range from −0.39 for the 25–29 age group to −0.06 for the 50–54 age group.[50] 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 net earnings it increases wives labor supply, but by its effect on virtual income it decreases labor supply. The overall effect of the income tax seems quite clearly (apart from the Nakamura–Nakamura results) to decrease wives labor supply because of the sizeable uncompensated wage elasticity which is typically found.

In Table 5.7 we present results of Hausman (1981a) for a sample of wives by quintiles.[51] Note that the effect of taxation is to increase labor supply for the lowest-wage quintile but to decrease labor supply for the other quintiles. 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 ratio about 18%. Given the magnitude of the estimated elasticities the deadweight loss estimate might seem small. However, when the fact that non-participants in the absence of taxation will generally remain non-participants when taxes are levied

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

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

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 (1981c) 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 and 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 non-participants is not treated altogether correctly. Income splitting leads to a 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 been 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 with constant marginal tax rates is adopted.

6. 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 0.5 or higher. Our knowledge of the effect of the high marginal tax rates on low-income groups have 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.[52] Yet significant changes in the tax systems as they affect earned income for high-income groups have taken place. The United States lowered the maximum marginal tax rate on earned income from 0.7 to 0.5 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 3.2 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.[53]

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 it 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

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

[53] 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.

incentive effect from the tax system. Thus, the overall income effect dominated the substitution effect for these individuals.[54] 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 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%, while 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 quantitative 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 surveys 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.[55]

[54] 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.

[55] Executive compensation through stock options and other non-wage compensation become an effective and important method to partly avoid the high marginal rates. But the combined effect of the 0.5 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.

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 non-linearity of the budget set discussed in Section 2. There we pointed out that the Slutsky equation does not adequately describe the tax response because of the presence of virtual incomes different from non-labor income. Thus, Holland's technique would seem to be exactly correct only in the case of a proportional tax system. 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 incomes 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 affect 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 is likely to be very small. In fact, they estimated the total effect on the economy to be of the order of 0.3% 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 low-income individuals, the (uncompensated) work disincentive effect is found to be small in econometric studies. Previous findings that, if anything, the income effect predominates, are 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.

7. 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.[56] 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.[57] 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."[58] 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.[59] 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 the 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 effects are important for an NIT. The expected ad-

[56]A further problem exists since the results from the rural experiment seem extremely difficult to interpret. Problems with the rural experiment are discussed in Palmer and Pechman (1978).

[57]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. A possible problem with the interpretation of the NIT results is the distinction between transitory and permanent responses. The Seattle–Denver experiment was designed to allow investigation of this potential problem. Hausman (1982b) discusses the issue and finds evidence that it may well affect the estimated responses.

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

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

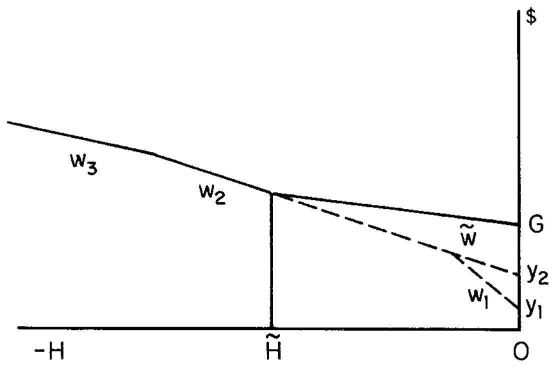

Figure 7.1

ditional 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 effects work to reduce labor supply. In Figure 7.1 we show how the NIT alters the budget set. Non-labor income y is replaced by the NIT guarantee G, which will have 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 0.5 tax rate. Thus, labor supply will be reduced since the NIT budget segment lies uniformly above the first non-NIT budget segment.[60] For individuals initially on the second segment, but below breakeven $\tilde{H}$, the same reasoning holds. Non-labor income has risen from $\tilde{y}_2$, 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

[60] 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.

over the many NIT plans used in each experiment.[61] 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.[62]

Hausman and 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 0.14 and an income elasticity of -0.023. Thus both effects in Figure 7.1 have significant effects in reducing labor supply. The poverty level for a four-person family 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. An individual initially on the second segment might have no response to an NIT at all. For those initially below breakeven hours $\tilde{H}$ on the second segment, the wage effect is 6% with the income effect leading 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%.[63] 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 and 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 5 except for the choice of a log-linear labor supply function. In particular, they treat the budget set as exogenous rather

[61] Unfortunately, insufficient subjects were included in each cell of the experiment to use classical analysis of variance 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 and Wise (1977, 1979, 1981).

[62] 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.

[63] The low proportion below breakeven is due to the study of white males who were relatively well off in New Jersey and Pennsylvania. Ashenfelter (1983) estimates a probit model which focuses on the probability of an individual being below the breakeven point.

Table 7.1
Location of fifteen budget lines in the 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	—	36.8, 45.38	—
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	—
40% tax/low guarantee:									
2.25	1.35	1.67	78.63	27.82	159.59	38.68	−11.8	34.15, 44.95	1.00
4.25	2.53	3.15	78.63	27.82	81.77	38.68	− 4.3	34.15, 44.95	1.00
6.25	3.75	4.63	78.63	27.82	57.45	38.68	4.2	34.15, 44.95	1.00
60% tax/low guarantee:									
2.25	0.90	1.67	78.09	27.82	65.42	38.69	−11.8	34.17, 44.96	1.00
4.25	1.70	3.15	78.09	27.82	34.63	39.62	− 1.9	34.16, 43.48	0.21
6.25	2.50	4.63	78.09	27.82	23.55	40.23	− 0.3	34.16, 45.38	0.02
40% tax/high guarantee:									
2.25	1.35	1.67	102.63	27.82	234.97	38.27	−12.9	33.50, 44.85	1.00
4.25	2.53	3.15	102.63	27.82	120.39	38.27	− 5.3	33.50, 44.85	1.00
6.25	3.75	4.63	102.63	27.82	84.59	38.27	− 5.3	33.50, 44.85	1.00
60% tax/high guarantee:									
2.25	0.90	1.67	101.09	27.82	96.66	38.29	−12.9	33.50, 44.84	1.00
4.25	1.70	3.15	102.09	27.82	51.17	38.29	− 5.3	33.50, 44.84	1.00
6.25	2.50	4.63	102.09	27.82	34.86	39.38	− 2.4	33.50, 45.38	0.23

than using an ad hoc instrumental variable procedure, and they also allow for a distribution of tastes in the population. Here in Table 7.1 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 effects by comparing the rows which correspond to a $2.25 wage since the individuals will always be on the first budget segment. No difference in response at all is found for the 0.4 or 0.6 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 finding 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 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.[64]

Other labor supply results for males that we briefly review are the findings of Keeley et al. (1978) for the Seattle–Denver experiment. While the Seattle–Denver experiment is superior in certain respects to 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.[65] 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 important 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 last study of male labor supply response in the NIT experiments that we review is MaCurdy (1983), who estimates a marginal rate of substitution function between consumption and labor supply from the Denver NIT. As we discussed previously, MaCurdy estimates his model within a life cycle context. MaCurdy's results are extreme in relation to other research on labor supply response. His estimated compensated substitution elasticity lies in the range of 0.74 to 1.43, which is on the order of 10–20 times higher than other estimates. Similarly, his estimated income elasticities range from -0.74 to -0.43, which are much greater in magnitude than other studies. It is possible that these results arise from the incorporation of the previously neglected life cycle considerations; but it seems more likely that they arise because of econometric problems associated with his marginal rate of substitution specification.

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

[65] 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.

The other group whose labor supply might be markedly affected by introduction of an NIT, is working wives. Neither the New Jersey nor the Gary experiments had sufficient numbers of working wives to allow model estimation. Keeley et al. found 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 0.4 to 0.6 NIT tax rate reduces the probability of participation by about 2.5%, while a change in the NIT guarantee from 0.75 of the poverty limit to the poverty limit reduces the probability of participation by 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 0.67 to an NIT level of 0.4, 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 considers the effect of the social security earnings test on retirement behavior and labor supply. We discussed the social security beneficiary budget set in Section 4, 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 post-war 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

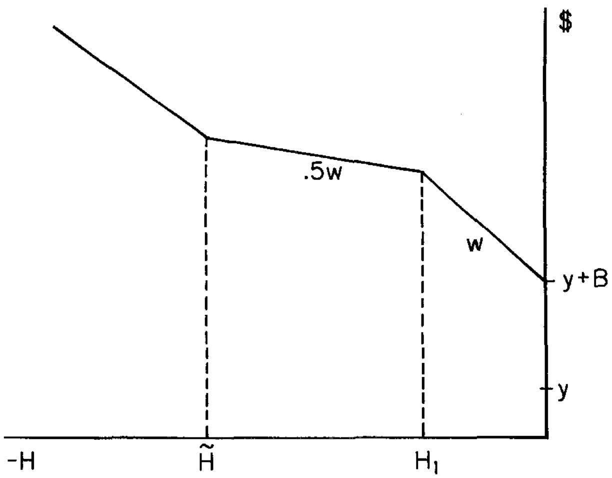

Figure 7.2

system. Three recent papers consider the causes of retirement over the 1965–1975 period. Boskin and Hurd (1982) ascribe almost all the decrease in labor force participation to social security. Diamond and Hausman (1984a, 1984b) 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 50%, so that a significant number of men would still retire during that age period.[66] Further research is required here because of the complex interaction of non-retirement labor supply and its effect on future social security benefits; cf. 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 7.2. Burtless and Moffitt (1982) in a recent study find that the earnings test has a major effect on retired males labor supply decisions.[67] Among retired men who are working the frequency distribution of hours worked has a pronounced spike at the kink point H_1 in Figure 7.2 which provides strong evidence of the incentive effect of the earnings test. This effect is to be expected

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

[67] Burtless and Moffitt go a long 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.

given the pronounced kink at H_1 hours, where the net wage is reduced from w to $0.5w$. 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 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 5, where tax changes have only a small expected effect on non-labor force participants. But considering the problem in this context, Burtless and Moffitt may have overestimated the wage elasticity by their neglect of fixed costs to working.[68] 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 from that of 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 lead to a significant 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 their 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.

[68] 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.

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