THE SURVEY OF INCOME AND PROGRAM PARTICIPATION

The Effect of Income Taxation on Labor Supply when Deductions are Endogenous

No. 62

Robert K. Triest
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ABSTRACT

This paper extends the standard static model of labor supply and taxation to the case where people are able to legally avoid taxes through the use of itemized deductions. Tax deductible expenditures are treated as a Hicksian composite good with a price (for those who decide to itemize) proportional to one minus the marginal tax rate. Estimation of the commonly used linear labor supply model (extended to incorporate the additional composite good) on a cross-section of prime aged married men suggests that tax deductible consumption is an uncompensated substitute for leisure (and complement with labor). The impact of taxes through the relative price of deductible expenditures appears to be much stronger than through the net wage.

I. Introduction

Previous research analyzing the effect of income taxation on labor supply has largely ignored the role of itemized deductions. No prior empirical work on labor supply has modeled the consumption of tax deductible consumption items as a choice variable. Hausman (1981) mentions the existence of itemized deductions, but does not treat them as endogenous in his model. A large literature has developed on the effects of taxation on the consumption of specific tax-deductible items, such as charitable contributions and owner-occupied housing. However, this literature treats labor supply as exogenous. This is surprising, since discussion of the role of itemized deductions has been prominent in much of the recent debate over tax reform. The current U.S. income tax reform combines marginal tax rate reductions with restrictions on the extent of deductions. Despite the importance of this subject, we know very little about the effect of itemized deductions and other tax preferences on the response of labor supply to income taxation.

Deductions play an important part in the U.S. income tax system. Approximately thirty five percent of all U.S. personal income tax returns filed for 1979 had deductions itemized (I.R.S., 1982). The proportion of revenue raised from returns with itemized deductions is higher than that since it is generally the low income tax units who use the standard deduction. Of the 1979 returns with itemized deductions, aggregate deductions were twenty three percent of aggregate adjusted gross income. If deductions are an increasing function of income, then the tax payments of a filing unit which itemizes will increase with its income at a rate lower than its statutory marginal tax rate. The analysis of federal income tax

returns presented by Triest (1987) indicates that this does occur. In this sense, the effective marginal tax rate is lower than the statutory marginal tax rate. [1]

The purpose of this paper is to analyze the implications of the existence of endogenously chosen deductions for the specification and estimation of labor supply functions. Section II presents the budget constraint which a worker faces in a static model when some expenditures are deductible from taxable income. Section III develops the implications of endogenous deductions for the specification of labor supply functions. It is shown that when the commonly used linear labor supply model is modified to allow for endogenous deductions, the coefficients on both the net wage and income terms may depend on the marginal tax rate. In section IV the problems which endogenous deductions create for empirical estimation are considered. In the endogenous deductions situation, the complete budget constraint estimation method proposed by Wales and Woodland (1979) and Burtless and Hausman (1978) is not feasible. A much simpler instrumental variables estimator is suggested. Section V contains empirical results from the estimation of a labor supply model in which deductions are endogenous. Section VI concludes the paper.

II. Specification of the Budget Constraint

As Heckman (1983) has pointed out, when expenditures on certain goods are tax deductible it is no longer appropriate to treat all consumption as a Hicksian composite commodity. Hicks' composite commodity theorem states that when the relative prices of a group of commodities are always constant, then that group of goods can be treated as a single commodity. In the case of labor supply without taxation, in a cross-section we observe variation only in the price of leisure (the

wage), and all other goods are treated as a composite. When there is income taxation with deductions for certain types of consumption, we observe variation in the price of leisure and the price of deductible consumption. In this case, consumption can be divided into two composite commodities, tax-deductible consumption and nondeductible consumption; leisure is the third composite commodity. The labor supply decision determines not only the marginal tax rate on income, but may also alter the relative price of deductible consumption.

For simplicity, we will look only at the case of a one-worker household in a static setting. In this case, the budget constraint is:

(1) $\qquad D + C + wL = Y + wT - R(I)$

where D is expenditure on deductible goods, C is expenditure on non-deductible goods, L is hours of leisure, w is the wage rate, Y is unearned income, T is the time endowment, I is taxable income, and R is the tax function. Taxes are a piecewise linear function of taxable income:

(2) $\qquad R(I) = R(I_j) + t_j(I - I_j)$

where j is the index of the bracket for someone with taxable income I, t_j is the marginal tax rate in bracket j, and I_j is the lower taxable income limit for bracket j. For itemizers, taxable income is given by:

(3) $\qquad I = w(T - L) + Y - D - E$

where E is the value of exemptions, which are assumed to be exogenous. For non-itemizers, taxable income is:

(4) $\qquad I = w(T - L) + Y - S - E$

where S is the standard deduction. Substituting the tax function into the budget constraint yields for an itemizer in bracket j

(5) $(1 - t_j)D + w(1 - t_j)L + C$

$$= (1 - t_j)(Y + wT) + t_j E + t_j I_j - R(I_j).$$

The corresponding expression for a non-itemizer in bracket j is

(6) $D + w(1 - t_j)L + C$

$$= (1 - t_j)(Y + wT) + t_j(E + S) + t_j I_j - R(I_j).$$

Some expenditures, such as moving expenses, are tax deductible even for non-itemizers. Expenditures of this type are ignored in this paper.

The primary objection to treating deductions as a composite commodity in a static labor supply model is that it ignores all intertemporal considerations. Interest payments, in particular, can only be properly modeled in a dynamic model. However, a dynamic model which fully accounts for the possibility of agents avoiding taxes through asset portfolio manipulation, use of income averaging, and use of deductions would be much more complex than the dynamic labor supply models developed up to now. Modeling deductions as a Hicksian composite good in a static setting seems to be a sensible first step in investigating the effect of legal tax avoidance on labor supply.

Incorporation of social security taxes into the analysis requires some modification of this framework. Social security taxes apply to labor income before deductions. Therefore, for itemizers who are below the upper limit on social security taxable earned income the tax rate on labor income is greater than the "subsidy rate" on deductions. Social security is difficult to incorporate into a static model since future social security benefits are a function of present social security tax payments. Previous work has either ignored social security taxes or has treated the employee contribution as being equivalent to an ordinary income tax

and ignored the employer contribution (as in Hausman (1981)). The empirical work reported in this paper is based on the latter assumption.

State and local taxes have not been incorporated into the models estimated in this paper due to lack of data. Similarly, no attempt has been made to adjust the data for regional differences in consumer prices (including state and local sales taxes).

III. Specification of Preferences

If a worker is at an optimum at a point on the interior of one of the segments of the budget constraint presented above, then the worker's behavior is locally equivalent to utility maximization with a budget constraint which is a linear extension of that segment of the piecewise-linear constraint. If utility is a function of leisure, deductible consumption, and nondeductible consumption, then for itemizers the Marshallian labor supply (leisure demand) function is locally a function of the net wage, $w(1 - t_j)$, the price of deductible consumption relative to nondeductible consumption, $(1 - t_j)$, and "virtual" income, $(1 - t_j)(Y + wT) + t_jE + t_jI_j - R(I_j)$.[2] Note that the tax rate enters the labor supply function through all three arguments. Income taxation can be viewed as combining a lowering of the prices of leisure and deductible consumption with an implicit lump sum tax equal to $t_j(Y + wT) - t_jE - t_jI_j + R(I_j)$ (see figure 1). The second part of this expression, $-t_jE - t_jI_j + R(I_j)$, is an adjustment for the fact that the marginal tax rate times taxable income is not necessarily equal to taxes paid. When the marginal rate increases with income, this adjustment will be negative. This is the source of the claim sometimes made that progressive taxation combines a lowering of

FIGURE 1
ALTERNATIVE REPRESENTATIONS OF VIRTUAL INCOME
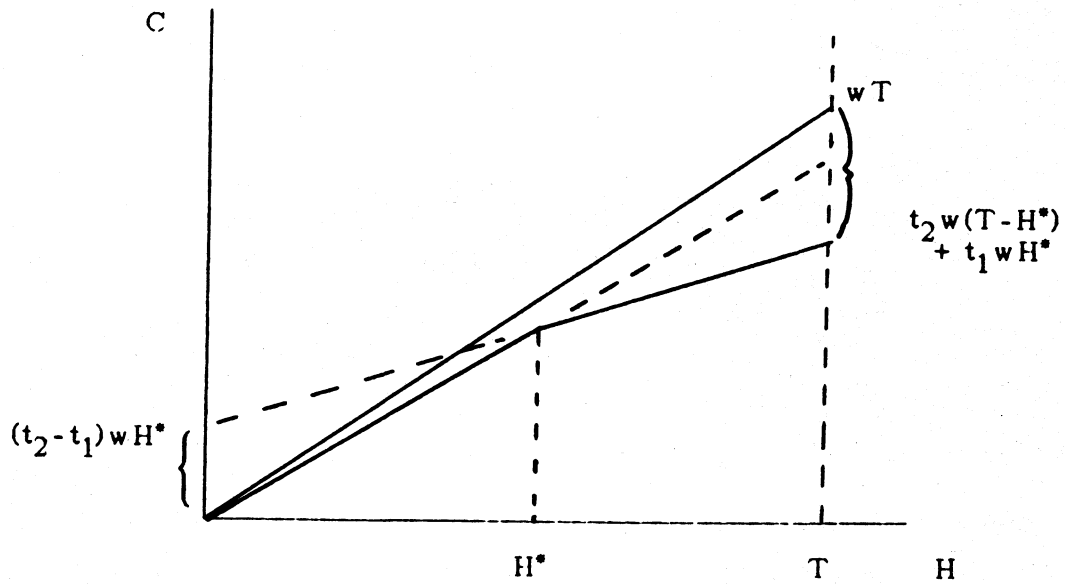
t_1 = marginal tax rate in income from 0 to wH^*

t_2 = marginal tax rate on income greater than wH^*

$Y=0$; $E=0$; D is fixed

the price of leisure with an implicit lump sum subsidy. Table 1 shows the value of

$R(I_j) + t_j I_j$ corresponding to each bracket of the U.S. personal income tax in 1979

(the year the data used in this study was collected). The appendix to this paper

contains an explanation of other adjustments to virtual income, such as those for

exemptions, the standard deduction, and the upper limit to earnings subject to the

social security tax.

Since previous work analyzing the effect of taxation on labor supply has let

taxes affect labor supply only through the net wage and virtual income, it is

interesting to consider what assumptions might justify ignoring the effect of

taxation on the relative price of deductions in labor supply estimation. The most

obvious possibility is to assume that utility is weakly separable between {L,C} and

{D}; the utility function can then be written $U(f_1(L,C), f_2(D))$. The weak

separability assumption implies that the consumer's allocation process can be divided

into two stages. In the first, a decision is made on how to allocate income between

the two groups, ({L,C} and {D}). The group allocations are functions of all prices

and virtual income. In the second stage, a decision is made on how to divide the

{L,C} group budget between leisure and total nondeductible consumption. The

leisure and nondeductible consumption demands are functions of $w(1 - t_j)$ and the

group budget, $(1 - t_j)(Y + wT) + t_j E + t_j I_j - R(I_j) - (1 - t_j)D$. Since the group

budget is a funtion of all prices and virtual income, it must be treated as

endogenous in estimation.

The two stage budgeting which is implicit in the weak separability assumption

is not very appealing. The best justification for it might be that some tax

deductions, such as those for mortgage interest payments, represent the result of

TABLE 1
1979 U.S. PERSONAL INCOME TAX

TAXABLE INCOME RANGE (DOLLARS)	MARGINAL TAX RATE	IMPLICIT LUMP SUM SUBSIDY DUE TO THE TAX SYSTEM
O - 3400	0	0
3400 - 5500	.14	476
5500 - 7600	.16	586
7600 - 11900	.18	738
11900 - 16000	.21	1095
16000 - 20200	.24	1575
20200 - 29900	.32	3367
29900 - 35200	.37	4862
35200 - 45800	.43	6974
45800 - 60000	.49	9722
60000 - 100000	.50	10322

Note: The third column shows the $[t_j I_j - R(I_j)]$ adjustment to unearned income which must be made in linearizing the budget constraint. In 1979 employees paid a social security tax of 6.13% on earnings of up to $22900. For workers with earnings over this amount, $1403 (the maximum FICA payment) needs to be subtracted from unearned income in calculating virtual income. See the appendix for details on other adjustments to virtual income.

long term consumption contracts. However, labor supply also often at least implicitly involves such long term considerations.

If the weak separability assumption holds, then one must estimate both the labor supply function and the deductions demand function in order to make inferences concerning the effect of a marginal change in the tax rate on labor supply. The deductions demand function must be estimated in order to calculate the effect of a tax change on the {C,L} group allocation. The reason for this is that deductions enter into the virtual income term in the labor supply function. A change in the marginal tax rate may cause, through either the net price or virtual income arguments, a change in the level of deductible consumption. The tax-induced change in deductible consumption may cause a change in labor supply through its effect on the virtual income argument in the labor supply function. Thus, even if the weak separability assumption is justified, little is gained from it.

It is interesting to consider the implications of another possible separability assumption. If {C} is weakly separable from {L,D}, then in the second stage of the allocation procedure labor supply is a function of the price of leisure relative to deductible items, w, and the group budget allocation, $(1 - t_j)(Y + w T) + t_j E + t_j I_j - R(I_j) - C$. In this case, taxes enter the labor supply function only through the income argument. The gross wage is used as the price of leisure in this case since it is the price of leisure relative to deductible consumption items (the gross wage), rather than the price of leisure relative to non-deductible items (the net wage), which is relevant in the second stage of the budgeting process. Although this separability assumption is not especially compelling, it illustrates the extreme effect such assumptions can have on specification.

In many studies, labor supply has been specified as a linear function of the wage and unearned income. Hausman (1981) derived the parametric form of the underlying preferences which would result in linear labor supply when there is a single consumption good. Deaton and Muellbauer (1981) generalized this result to the case of many consumption goods. They showed that linear labor supply requires that the expenditure function be of the form:

$$(7) \qquad e(u,w,p) \; = \; -n(u,p)e^{\frac{w}{b(p)}} \; + \; w\,a(p) \; + \; c(p)$$

where u is the utility level, $\mathbf{p}$ is the vector of consumer prices (excluding the wage), n(u,p) is a positive decreasing function of u and is homogeneous of degree one in $\mathbf{p}$, a(p) is positive and homogeneous of degree zero, b(p) is positve and homogenous of degree one, and c(p) is homogenous of degree one. The various restrictions are needed to insure that the expenditure function is homogeneous of degree one in $\mathbf{p}$ and w, nondecreasing in $\mathbf{p}$ and w, increasing in u, and concave in $\mathbf{p}$ and w. The expenditure function gives the minimum value of "full" income (including the value of the time endowment) needed to reach a given utility level: e(u,w,p) $=$ wT $+$ Y. The form of the labor supply function can be obtained by differentiating with respect to w (to obtain the Hicksian leisure demand) and substituting for n(u,p):[3]

$$(8) \quad H(w,\mathbf{p},Y) = \left[T \; - \; a(p) \; + \; \frac{c(p)}{b(p)} \right] \; + \; \left[\frac{a(p)-T}{b(p)} \right] w \; - \; \left[\frac{1}{b(p)} \right] Y$$

where H is hours of work (H + L $\equiv$ T). This is similar to Hausman's specification, although stringent restrictions on this model are needed in order for it to be compatible with Hausman's stochastic assumptions.[4] While Hausman allows the

coefficient on virtual income to vary randomly (with a truncated normal distribution) over the population to incorporate heterogeneity in preferences into his model, the endogenous deductions specification allows the coefficient on virtual income to vary systematically with the marginal tax rate (for itemizers). In the endogenous deductions specification, the coefficient on virtual income, $\frac{1}{b(p)}$, is a function of the prices of all consumer goods (excluding leisure). For itemizers, the relative prices of these goods depends on the marginal tax rate that they face.

This specification can be adapted to the case of endogenous deductions by making functional form assumptions about $a(p)$, $b(p)$, and $c(p)$. We take $a(p) = a$, a special case of homogeneity of degree zero. A simple functional form for $b(p)$ which is consistent with linear homogeneity is $b(p) = \sum_i b_i p_i$, where the summation is over all consumer prices. Assume prices 1 through $d-1$ are the prices of deductible goods and d through n are the prices of nondeductible goods. Letting p_i refer to the gross price for good i, and $p_i(1-t_j)$ the net price for an itemizer in bracket j, we can write $b(p)$ as:

$$b(p) = \sum_{i=1}^{d-1} b_i(1-t_j)p_i + \sum_{i=d}^{n} b_i p_i$$

$$= (1-t_j)\sum_{i=1}^{d-1} b_i p_i + \sum_{i=d}^{n} b_i p_i$$

$$= b_d(1-t_j) + b_n$$

For non-itemizers, $b(p) = b_d + b_n$. Assuming the same functional form for $c(p)$:

$$c(p) = \begin{cases} c_d(1 - t_j) + c_n & \text{for itemizers in bracket } j \\ c_d + c_n & \text{for nonitemizers} \end{cases}$$

Substituting these expressions into the labor supply function for itemizers yields:

$$(9) \qquad H = \left[T - a + \frac{c_d(1 - t_j) + c_n}{b_d(1 - t_j) + b_n} \right] + \left[\frac{a - T}{b_d(1 - t_j) + b_n} \right] w^*$$

$$+ \left[\frac{1}{b_d(1 - t_j) + b_n} \right] Y^*$$

where $w^* = w(1 - t_j)$ and $Y^* = (1 - t_j)Y + t_j E + t_j I_j - R(I_j)$. Labor supply is still linear in the net wage and virtual income, but it is nonlinear in the marginal tax rate. Note that b_d, b_n, c_d, and c_n are all dependent on the particular types of deductions allowed. Knowledge of these parameters is not sufficient to predict the effect on labor supply of a change in the range of consumption goods which may be deducted. The labor supply of nonitemizers is:

$$(10) \qquad H = \left[T - a + \frac{c_d + c_n}{b_d + b_n} \right] + \left[\frac{a - T}{b_d + b_n} \right] w^* + \left[\frac{1}{b_d + b_n} \right] Y^*$$

where $w^* = w(1 - t_j)$ and $Y^* = (1 - t_j)Y + t_j(E + S) + t_j I_j - R(I_j)$. Now Y^* differs from the formula for virtual income presented earlier since the part of it reflecting the value of the time endowment, $w(1 - t_j)T$, has been shifted to the wage term. When there are no itemizers in the sample used for estimation, only the sum of b_d and b_n, rather than the individual parameters, can be identified (the same holds true for c_d and c_n). Somewhat less obviously, restrictions on the functional form presented above are needed for identification even when some itemizers are in

the sample. This is due to the partial derivatives of H with respect to b_d, b_n, c_d and c_n being linearly dependent.[5] One possible restriction is to assume that b_d equals zero. With this restriction, labor supply is linear in the variables for both itemizers and those who use the standard deduction. Estimation can proceed with c_n assumed to be a function of demographic variables and incorporating an additive stochastic term representing unobserved heterogeneity in preferences. This is the specification which is used in section V below.

IV. Estimation Problems

The main problem in estimation is due to the fact that the marginal tax rate in not independent of either hours worked or deductions. The leading method for handling estimation problems of this type is the complete budget constraint technique described by Moffitt (1986). Two statistical problems result from the marginal tax rate being a function of hours of work. First, if the tax rate is imputed based (at least in part) on hours of work times the wage (earnings), then measurement error in hours of work will result in measurement error in the calculated marginal tax rate. A similar problem results if actual and desired hours of work differ due to optimization error. If no correction is made for this, parameter estimates will be inconsistent. Second, if there is any unobserved heterogeneity in preferences for hours of work, then the marginal tax rate will generally not be independent of the heterogeneity term. Those who prefer more hours of work than average (conditional on observed characteristics) will tend to face higher than average marginal tax rates. Wales and Woodland (1979) considered only the first of these problems (measurement error). The estimators used by

Burtless and Hausman (1978) and Hausman (1981) correct for both the measurement error and simultaneity problems.

However, allowing for both heterogeneity and measurement error is computationally very difficult when deductions are endogenous. Due mainly to computational constraints, there has been no work to date which has allowed for both heterogeneity and optimization/measurement error in the estimation of consumer demand (and labor supply) systems with nonlinear budget constraints when the demands for two or more goods are simultaneously determined. Hausman and Ruud (1984) estimate a two good demand system (husband's leisure and wife's leisure), but they do not allow for unobserved heterogeneity of preferences. However, assuming that all unexplained variation in hours of work is due to optimization or measurement error does not seem very attractive. The alternative approach of assuming that all unexplained variation in hours of work is due to unobserved differences in preferences for leisure, while restrictive, seems preferable.

As noted by MaCurdy (1983), when observed and desired hours of work are equal straightforward instrumental variables estimation is consistent. The gross wage and unearned income can serve as instruments for the net wage and virtual income. However, when there is measurement error in hours of work the distribution of the induced measurement error in the imputed marginal tax rate (and related variables) depends on the location of observed hours of work on the budget constraint. For example, if the measurement error in hours of work has a symmetric distribution with zero expectation, the expected measurement error for the net wage will tend to be negative for observed hours just less than the hours

at the kink point of a convex constraint, and positive for observed hours slightly greater than the kink hours. For this reason, the instrumental variables estimator cannot be used in this situation. Triest (1987) presents monte-carlo results which suggest that the instrumental variables estimates are not very sensitive to deviations between observed and desired hours of work. This suggests that instrumental variables might be a useful estimation technique even when some measurement error in hours of work exists.

One drawback of the instrumental variables approach is that it cannot handle observations where hours of work is observed exactly at a kink point, since at such points the marginal tax rate is not well defined. If the only source of stochastic variation in hours of work is unobserved heterogeneity, then there is positive probability of observing observations at each kink point (of a convex constraint). In practice, however, we never have enough information to determine if a sample member is exactly at a kink point.

In this paper, I assume that the only source of unexplained variation in labor supply is due to an additive stochastic term representing heterogeneity in preferences and use the instrumental variables method for estimation. Since the marginal tax rate is endogenous in this model, the right hand side variables which depend on the marginal tax rate (the net wage, the price of deductible relative to nondeductible consumption, and virtual income) must also be treated as endogenous. The decision to itemize is automatically treated as endogenous by allowing for the endogeneity of the relative price of deductible consumption. This price is equal to one for those who choose not to itemize. Section V provides details on the specification used and the choice of instruments.

Although measurement error in hours of work is not allowed for in the estimation, the dataset used minimizes the problem of induced measurement error in the virtual income and net wage variables which usually plagues the instrumental variables estimator. This is elaborated on in the next section, where the dataset is described.

V. Estimation Results

The data for estimation comes from the 1979 Income Survey Development Program (ISDP). The main advantage of the ISDP data is that it contains fairly detailed information on taxes paid. Sample members were directly asked whether or not they itemized deductions and how much they paid in taxes. The tax data was collected in April, May and June of 1980. Since this information was collected at about the same time (or shortly after) 1979 tax returns were filed, response error is probably relatively low. Information on labor force behavior was collected quarterly during 1979. Since the recall period is much shorter than for most surveys, the accuracy of the labor supply and earnings data should be very good.

The fact that this dataset allows the statutory marginal tax rate for both earnings and deductible consumption to be determined without reference to hours of work greatly lessens the induced errors in variables problem. Since the marginal tax rate is a function of tax payments, and we observe tax payments, we can impute the marginal tax rate without reference to hours of work.[6] In the more usual case where direct information about tax payments is not available, taxable income must first be imputed based on reported earned and unearned income. Earned income is itself often imputed by multiplying reported hours of work times the wage. In this

case, measurement error in hours of work can result in an incorrect marginal tax rate imputation. Note that even when we have direct information about tax payments, there is still a problem if actual and desired hours of work differ.

A subsample of married couples was selected for use in estimation. The selection criteria was that both spouses were between 25 and 60 years old, neither spouse reported extreme disability preventing employment, neither spouse had any farm or self employment income, and that data was completely reported for the variables used here. The fairly small sample size, 432, is due mainly to a high nonresponse rate on many of the questions related to nonearned income. Two percent of the husbands (9 observations) had zero hours of work; these observations were not used for the husbands' labor supply estimation.[7] The wage variable was calculated in two ways. For sample members who reported a wage rate at least once, an average of their reported wage rates was used. For sample members who never reported a wage rate (if, for example, they were paid on a salaried basis), average hourly earnings was used as the wage. Table 2 presents variable definitions, means, and standard deviations for the subsample used for estimation. Further details concerning construction of the data set are in the appendix to this paper.

To concentrate on the role of endogenous deductions, and to avoid controversies involving the treatment of agents with zero hours of work, labor supply functions were estimated only for husbands. Traditionally, this group of people was thought to have a negative uncompensated wage elasticity and a small positive compensated wage elasticity. Borjas and Heckman (1979) review several studies of male labor supply. After studies with particularly serious econometric

TABLE 2
SAMPLE DESCRIPTIVE STATISTICS

VARIABLE	MEAN	STD. DEV.	DEFINITION
HHOURS	2116.7	519.0	husband's hours of work (1979)
HWAGE	5.55	2.53	husband's net hourly wage (dollars)
VIRINC	6.88	6.05	husband's virtual income ($1000's)
HAGE	39.5	9.95	husband's age
HEDUC	12.29	3.13	husband's years of education
HDIS	.10		self reported disability indicator (= 1 if disabled; = 0 otherwise)
WERN	4572	4870	wife's earnings
WAGE	36.9	9.5	wife's age
WEDUC	12.3	2.6	wife's years of education
ITEMIZER	.55		itemized deducions indicator (= 1 if an itemizer; = 0 otherwise)
PDEDUC	.86	.14	relative price of deductible con.
UNERN	.35	1.23	asset income ($1000's)
HGWAGE	8.01	4.38	husband's gross wage
NCHLDLT6	.48	.72	number of children less than 6
NCHILD	.89	1.04	number of children between 6 and 15
BLACK	.05		black race indicator
NE	.25		northeast region indicator
NC	.28		north central region indicator
SE	.13		southeast region indicator
SC	.20		south central region indicator

Sample Size: 423

problems are removed from consideration, the estimated uncompensated wage elasticities range from —.19 to —.07, the estimated "total income" elasticities range from —.29 to —.17, and the estimated compensated wage elasticities range from .04 to .24. Hausman (1985) reviews labor supply studies which have incorporated taxes. The five studies of prime-age male labor supply he cites have uncompensated wage elasticities ranging from —0.13 to 0.09 and income elasticities ranging from —0.17 to —0.04.

The linear labor supply function derived in section three was estimated:

$$(11) \qquad H_i = \left[T - a + \gamma\right] + \left[\frac{a - T}{b_n}\right]w_i^* + \left[\frac{1}{b_n}\right]Y_i^* + \left[\frac{c_d}{b_n}\right]p_i + \xi_i$$

where H_i is annual hours of work of person i, p_i is the price of deductible relative to non-deductible consumption faced by person i (which is equal to one for non-itemizers and equal to one minus the marginal tax rate for itemizers), w_i^* is person i's net wage, Y_i^* is person i's virtual income, and ξ_i is a mean zero random variable which is independent across people. Equation (11) can be derived from equations (8) and (9) by setting b_d equal to zero and allowing c_n to vary randomly over people; γ is equal to the expectation of c_n divided by b_n.

While this specification is admittedly ad hoc, it is very similar to the linear functional form often used in labor supply studies. The key difference between this specification and those used in previous work is that the marginal tax rate enters the labor supply function as a separate argument in the specification used here.

Table 3a presents results of instrumental variables estimation of the linear labor supply specification (b_d equal to zero); calculations of the corresponding labor supply elasticities are presented in table 3b.[8] No demographic characteristics were included in these specifications. Column (1) contains results from estimation with the price of deductions coefficient constrained to be zero, while column (2) reports results from estimation when this constraint is dropped. Table 3b presents elasticity estimates based on the parameter estimates in table 3a. In both specifications, the compensated wage elasticity is of the theoretically correct positive sign, although it is very close to zero in the endogenous deductions specification (column (2)). When the relative price of deductions is added to the specification, the uncompensated wage elasticity changes from being positive to negative. However, both estimates are well within the range found in previous research. The most interesting result in these tables is the size of the uncompensated price of deductible consumption elasticity. This elasticity is negative and quite large in magnitude, being nearly eight times the size of the uncompensated wage elasticity. It is surprising that deductible consumption is much more strongly substitutable for leisure than is non-deductible consumption.

This result has quite interesting implications for the analysis of tax reform efforts. Holding virtual income constant, a decrease in the marginal tax rate will decrease the labor supply of itemizers through two different channels: (i) by increasing the net wage, and (ii) by increasing the relative price of deductible consumption. Since deductible consumption has been found to be an uncompensated substitute for leisure, an increase in its price causes an increase in the consumption of leisure (decrease in the supply of labor). Consider the case of an itemizer who

TABLE 3a
LABOR SUPPLY ESTIMATION RESULTS
(standard error in parentheses*)

Dependent Variable: HHOURS

VARIABLE	(1)	(2)
CONSTANT	2039.6	3722.7
	(93.6)	(713.9)
HWAGE	18.8	−30.7
	(11.4)	(24.6)
VIRINC	−4.4	−15.3
	(11.8)	(11.8)
PDEDUC		−1562.9
		(673.9)
σ	521.6	516.9

Instruments Used: UNERN, UNERN squared, HGWAGE, HGWAGE squared, HGWAGE*UNERN, HAGE, HAGE squared, HEDUC, HEDUC squared, HAGE*HEDUC, WAGE, WAGE squared, WEDUC, WEDUC squared, WAGE*WEDUC, NCHILD, NCHLDLT6, HDIS, BLACK, NE, NC, SE, SC

* all standard error reported in this paper were calculated using the heteroskedasticity consistent estimator proposed by White (1982).

TABLE 3b
LABOR SUPPLY ELASTICITY ESTIMATES
(standard error in parentheses)

Dependent Variable: HHOURS

ELASTICITY**	(1)	(2)
WAGE (uncompensated)	0.049 (0.029)	−0.081 (0.064)
INCOME	−0.024 (0.066)	−0.085 (0.066)
WAGE (compensated)	0.073 (0.080)	0.004 (0.092)
DEDUCTIONS (uncompensated)		−0.632 (0.273)

** All elasticities are evaluated at the sample means. The income elasticities reported here are equal to the mean net wage times the virtual income coefficient (adjusted for scaling); this is often called the "total income elasticity" and differs from the usual definition of elasticity.

has an initial net wage of five dollars per hour. The estimates in column (2) of table 3a suggest that, holding virtual income constant, a one percentage point decrease in the person's marginal tax rate would cause approximately a one and one half hour decrease in labor supply through the wage effect, and approximately a fifteen and one half hour decrease in labor supply through the price of deductible consumption effect.[9] The impact of the tax change through the price of deductions is over ten times as large as the effect through the net wage in this case.

That the price of deductible relative to nondeductible consumption has such a large impact on labor supply is very surprising. Due to the lack of other evidence on this issue, the estimates reported here must be treated with caution. A wide variety of factors which are not considered here may be influencing the results. Failure to account for fringe benefits, family decision making, on the job training, and other dynamic factors may be causing misspecification. However, most of the existing labor supply literature is open to criticism for neglecting at least one of these factors.

The results do have some intuitive appeal. Mortgage payments on owner occupied housing are an important component of deductions. It seems reasonable that leisure and housing might be substitutes. In Becker's (1965) time allocation framework, one might think of housing expenditures as going toward the rental of capital goods which increase leisure (or household production) productivity. These capital goods have the effect of increasing effective leisure time. In this context, one might expect that a decrease in the price of housing would result in a decrease in the demand for leisure time. It is important to remember that leisure is defined as all non-market work activities. When one realizes this, it does not seem

unreasonable that leisure and deductible consumption goods are uncompensated substitutes.

Tables 4a and 4b are similar to tables 3a and 3b, but report the results of estimation when c_n is assumed to be a function of demographic characteristics (the demographic characteristics then enter the labor supply function linearly). The results here are somewhat disappointing. The compensated wage elasticity is negative both with and without the relative price of deductions in the specification; however, in both cases the associated standard errors are quite large. As before, the uncompensated price of deductions elasticity dwarfs the uncompensated wage elasticity. However, the incorrect sign of the estimated compensated wage elasticity casts some doubt on the reliability of the results.

VI. Conclusions

This paper has extended the standard static model of taxation and labor supply to the case where some consumption items are tax deductible. When this extension is made, the complete budget constraint estimation technique becomes impractical. Instrumental variables estimation of the endogenous deductions model suggests that deductible consumption items are uncompensated substitutes for the leisure time of prime age married males. The effect of taxation on labor supply through the impact of taxes on the price of deductible relative to nondeductible consumption expenditures is stronger than through the impact of taxes on the net wage.

Although the empirical estimates appear to be sensitive to specification, and

TABLE 4a
LABOR SUPPLY ESTIMATION RESULTS
(standard error in parentheses)

Dependent Variable: HHOURS

VARIABLE	(1)	(2)
CONSTANT	1843.6 (190.5)	3125.6 (701.6)
HWAGE	11.5 (11.6)	−27.7 (24.5)
VIRINC	23.5 (12.1)	13.4 (10.8)
PDEDUC		−1211.1 (669.8)
HAGE	0.8 (3.4)	0.30 (3.5)
NCHILD	38.2 (23.4)	39.6 (23.4)
NCHLDLT6	136.8 (51.6)	128.7 (50.4)
HDIS	−96.7 (76.4)	−124.2 (74.6)
σ	515.8	516.9

Instruments Used: UNERN, UNERN squared, HGWAGE, HGWAGE squared, HGWAGE*UNERN, HAGE, HAGE squared, HEDUC, HEDUC squared, HAGE*HEDUC, WAGE, WAGE squared, WEDUC, WEDUC squared, WAGE*WEDUC, NCHILD, NCHLDLT6, HDIS, BLACK, NE, NC, SE, SC

TABLE 4b
LABOR SUPPLY ELASTICITY ESTIMATES
(standard error in parentheses)

Dependent Variable: HHOURS

ELASTICITY	(1)	(2)
WAGE (uncompensated)	0.030 (0.030)	−0.073 (0.064)
INCOME	0.131 (0.067)	0.074 (0.060)
WAGE (compensated)	−0.100 (0.082)	−0.147 (0.089)
DEDUCTIONS (uncompensated)		−0.490 (0.271)

should not be taken as definitive, they do suggest that the relative price of deductions effect may be quite important. Further research is needed to see if the results reported here hold up when estimation is done with alternative datasets. In addition, there is a need to combine the analysis here with estimates of the effects of income taxation on the consumption of tax deductible items. This additional estimation will be needed in order to analyze the welfare implications of tax reforms.

NOTES

1. Although the divergence between the statutory and effective marginal tax rates does suggest that deductions are endogenous, it does not necessarily imply that it is important to take this endogeneity into account in estimating labor supply functions. Whether or not treating deductions as endogenous makes any difference in the estimated labor supply elasticities is an empirical question which is investigated in this paper.

2. The term "virtual income" was coined by Burtless and Hausman (1978). In their usage, however, it corresponds to the vertical intercept of the linearized budget constraint measured at zero hours of work. Here, it is equivalent to the vertical intercept at T hours of work. The two measures differ by the value of the time endowment.

3. Differentiating the expenditure function with respect to w yields the Hicksian leisure demand function:

$$L(u,w,p) = \frac{-n(u,p)e^{(w/b)}}{b} + a$$

Solving for $n(u,p)$ from the expenditure function:

$$n(u,p) = \frac{-1}{e^{(w/b)}}[e(u,w,p) - wa - c]$$

$$= \frac{-1}{e^{(w/b)}}[wT + Y - wa - c]$$

Substituting for $n(u,p)$ in the Hicksian leisure demand results in the Marshallian leisure demand:

$$L(w,p,Y) = a - \frac{c}{b} - \frac{a}{b}w + \frac{1}{b}(wT + Y)$$

Applying the identity $H + L \equiv T$ yields the Marshallian labor supply function:

$$H(w,p,Y) = T - a + \frac{c}{b} + \frac{a}{b}w - \frac{1}{b}(wT + Y)$$

4. Hausman derives his labor supply specification from the expenditure function

$$e(w,u) = u e^{-\beta w} - \frac{\alpha}{\beta}w + \frac{\alpha}{\beta^2} - \frac{\gamma}{\beta}$$

where the expenditure function here is the minimum unearned income, Y, needed to reach utility level u. Hausman does not indicate how the price of the consumption good enters the expenditure function. Note that Hausman's version of the expenditure function is defined in terms of the minimum Y, rather than $Y + wT$, needed to reach utility level u. Differentiation with respect to w and multiplication by -1 yields the Hicksian labor supply function:

$$H(w,u) = u \beta e^{-\beta w} + \frac{\alpha}{\beta}$$

From the expenditure function,

$$u = e^{\beta w}\left[e(w,u) + \frac{\alpha}{\beta}w - \frac{\alpha}{\beta^2} + \frac{\gamma}{\beta}\right]$$

$$= e^{\beta w}\left[Y + \frac{\alpha}{\beta}w - \frac{\alpha}{\beta^2} + \frac{\gamma}{\beta}\right]$$

Substituting for u in the Hicksian labor supply function:

$$H(w,Y) = \gamma + \alpha w + \beta Y$$

Thus, Hausman's β is equivalent to $-\frac{1}{b}$, α to $\frac{a - T}{b}$, and γ to $(T - a + \frac{c}{b})$. Since Hausman specifies β to be stochastic and α and γ fixed, his specification is consistent with Deaton and Muellbauer's only if $(a - T)$ and c are both fixed multiples of b.

5. $$\frac{\partial H}{\partial b_d} = \frac{\left[\frac{\partial H}{\partial c_d}\right]}{\left[\frac{\partial H}{\partial c_n}\right]} \frac{\partial H}{\partial b_n}$$

6. Since the sum of tax payments and tax credits is a one-to-one function of taxable income, the slope of that function, the marginal tax rate, is a function of the sum of tax payments and tax credits. Tax credits, exclusive of credits for personal exemptions, were approximately 3.1 percent of income tax revenue before credits on returns filed in 1980 (IRS, 1981, p. 78). Some of the tax credits included in this figure, such as the retirement income credit, are not likely to have been taken by individuals in the sample used for estimation. Thus, the error resulting from ignoring tax credits in imputing the marginal tax rate is likely to be very small.

    There is some additional measurement error in the marginal tax rate resulting from categorization of the tax payments variable in the public use version of the ISDP data. Moreover, the calculation of the Social Security tax rate still depends on hours of work. Since the Social Security tax has a constant rate up to the maximum taxable earnings level ($22900 in 1979), one must know earned income in order to correctly impute the tax rate.

7. The small number of observation with zero hours of work makes it unlikely that a significant bias results from excluding these observations.

8. Nonlinear estimation was also attempted. However, due to problems of non-convergence the results are not reported here.

9. As Hausman (1983) demonstrates, in actually simulating labor supply responses to tax changes, one must allow for the possibility of agents switching from one bracket to another. The example here is meant to be suggestive of the magnitudes of the estimated effects rather than a simulation of an actual policy proposal.

APPENDIX: CONSTRUCTION OF THE DATASET

Data for estimation came from the version of the 1979 Income Survey Development Program (ISDP) available in the SIPP - ACCESS database ISDPRUN. The volume edited by David (1982) is a good source of general information about ISDP. This appendix indicates how the variables used in the estimation were constructed from this database (which is publicly available). The variable names in quotation marks are column names of tables (relations) in ISDPRUN.

The ISDP data was collected in six waves, spaced three months apart. Interviewing occured over the February 1979 to June 1980 period, while the data pertains to the November 1978 to May 1980 time period. The sample was split into three rotation groups. One feature of the sample design which makes the data somewhat difficult to use is that the calendar time period covered in each wave differs by rotation group. Due to this, in order to aggregate a variable (for example, hours of work) over a given span of calendar time (say, 1979), one must sum the values of the variable over a set of survey months that varies by rotation group. For example, to compute hours worked in 1980, one sums the hours of work variable over (wave one, month three) to (wave five, month two) for rotation group A, but sums over (wave one, month one) to (wave five, month three) for rotation group C. An additional complication is that information was not collected for rotation group C in wave four.

Construction of the pre-tax variables:

HHOURS: Hours of work was first calculated for each month by summing (over jobs held by a given individual) the product of columns "weekspaid" (from table "ppmjob") and "weeklyhours" (from table "ppwjob"). The monthly hours figures for the twelve months of 1979 were then summed to produce annual hours of work.

HGWAGE: The gross wage was calculated by taking an average of the hourly wage ("wagerate" in table "ppwjob") over waves in which it was reported. If the wage was not reported in any wave (if, for example, a sample member was paid on a salaried basis), then a wage was calculated by dividing annual labor earnings (the sum of "earnings" in table "ppmjob" over the months in 1979) by annual hours of work (HHOURS).

UNERN: Asset income was calculated for each individual by summing dividend payments ("sc0353", "sc0343", and "sc0346" in table "ppw6div"), rental income ("sc0381", "sc0365", and "sc0376" in table "ppw6rentinc"), interest from savings accounts ("sc0270", "sc0276", "sc0284", "sc0290", and "sc0293" in table "ppw6savings"), other interest income ("sc0315", "sc0318", and "sc0321" in table "ppw6othint"), capital gains income ("sc2358" in table "ppw6taxes"), and other asset income ("sc0471" in table "ppw6othast"). Asset income for each couple was then calculated by summing over the two spouses. Since the capital gains data were categorized by the Census Bureau, the mid-point of the cell was used to impute the dollar amount.

Demographic Variables: The demographic variables were taken from tables "ppconstant" and "ppwave6".

Construction of the tax variables:

Marginal tax rate: Since the marginal tax rate is a function of taxes paid ("sc2368" in table "ppw6taxes"), it could be imputed based on this variable. Since tax payments were categorized by the Census Bureau, some measurement error may be generated by this imputation. Tax credits were ignored in this imputation due to lack of data.

ITEMIZER: The itemizer dummy variable was set to one if the couple reported itemizing deductions on their tax return ("sc0493" in table "ppw6taxes").

VIRINC: Virtual income was calculated by first summing asset income for the couple (UNERN) and earnings of the wife. The next step was to add the $(t_j - R(I_j))$ adjustment shown in table 5.1. For workers with income over the maximum amount subject to social security taxation, $1403 (the maximum FICA payment) was then subtracted. The marginal tax rate times $2000 times two plus the number of chidren (the imputed value of exemptions) was then added (this is the t_jE term in the text). Finally, for those who used the standard deduction, the marginal tax rate times the value of the standard deduction ($3400) was added (this is the t_jS term in the text).

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