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FAMILY LABOR SUPPLY WITH TAXES

Jerry Hausman

Paul Ruud

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ABSTRACT

Over the period 1960 - 1983 the proportion of federal tax revenue raised by taxation of labor supply has risen from 57-77 percent. In this paper, we specify and estimate a model of family labor supply which treats both federal and state taxation. Husbands and wives labor supply are treated jointly rather than in a separate manner as in previous research. A method to calculate the virtual wage for nonworking spouses is used within a utility maximizing framework to treat correctly the joint family labor supply decision. Joint family efforts are found to be important. The efficiency cost (deadweight loss) of labor taxation is estimated to be 29.6% of tax revenue raised. The effect of the new 10% deduction to ease the marriage tax for working spouses leads to a prediction of 3.8% increase in wives labor supply and a .9% decrease in husbands labor supply. Overall taxes paid are predicted to decrease by 3.4%.

Jerry Hausman
Department of Economics
M.I.T.
Cambridge, MA 02139

Paul Ruud
Department of Economics
University of California
at Berkeley
Berkeley, CA 94720

Taxes on labor supply raise the largest proportion of federal tax revenue. Over the period 1960-1983, this proportion has increased from 57 to 77 percent. While the income tax has increased moderately as a proportion of federal tax revenue, the payroll tax has more than doubled as a proportion of all taxes. In 1980, approximately 50 percent of federal tax revenues was raised by the individual income tax. The individual income tax is a progressive tax on labor and non-labor income which is based on the notion of 'ability to pay'. We finance Social Security by the payroll tax, FICA, which is a proportional tax with an upper limit. As both the tax rate and upper limit have grown rapidly in recent years, FICA taxes have become the subject of much controversy. In 1980, FICA taxes represented 28 percent of total Federal tax revenue. In Table 1, the income tax and payroll tax revenues are given for the period 1960-1980. It is interesting to note that over the same period while the marginal income tax of the median taxpayer remained constant, the FICA tax rate more than doubled. At the same time, the earnings limit rose about 220% in constant dollars. Over the same 20 year period, the corporate income tax has decreased from 24% to 13% of Federal tax revenues. Likewise, excise taxes have decreased from 13% to 5%. Thus, taxes on labor supply currently amount to about 3/4 of Federal taxes raised.[1] The potential effects on labor supply and economic welfare are important because of the large and increasing reliance on direct taxation.

In Table 2, we provide a summary of marginal tax rates for the period 1950-1980. These rates are for married households filing jointly. 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 1950-1980 was only imperfectly indexed for inflation. The median income family faced a marginal tax rate of 17% in 1950, but multiplied by the change in the CPI, this amount faced a marginal rate of 21% in 1980. Similarly $10,000 of earned income in 1950 had a marginal tax rate of 24% in 1950, but adjusted for inflation, the marginal tax rate

TABLE 1

Revenues from Income and Payroll Taxes (billions)

Year	Income Tax Revenues	Payroll Tax [1] Revenues	Income Tax % of Federal Revenues	Payroll Tax % of Federal Revenues	Tax Rate for Payroll Tax	Earnings Limit for Payroll Tax
1960	$ 40.7	$ 11.3	45%	12%	3.0%	$ 4,800
1965	48.8	17.6	43	15	3.6	4,800
1970	90.4	39.5	47	21	4.8	7,800
1975	122.4	75.6	45	28	5.9	14,100
1980	244.1	139.3	49	28	6.0	25,900

1. Includes old-age, survivors, disability, hospital insurance, and railroad retirement taxes.

TABLE 2

Federal Income Tax: Selected Marginal Rates for Married Couples

Taxable Income (1000's)	1950 (11.0,3.3)[3]	1960 (1.23,5.6)	1970[1] (1.61,9.8)	1980 (3.42,21.0)	1984[2]
2-4	17	20	17	14	11
6-8	20	22	19	16	12
10-12	24	26	23	21	16
16-18	31	34	29	24	18
20-22	35	38	33	28	22
28-32	43	47	40	*37	28
40-44	51	56	49	43	33
56-60	56	62	54	49	38
64-70	59	65	56	*50	42
76-80	63	69	59	*50	42
90-100	66	72	62	50	45
120-140	71	78	66	50	49
180-200	79	87	71	50	50
400+	84	91	72	50	50

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

increased to 37% in 1980. Similar increases in marginal tax rates occurred over the period 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 although the marked increase in tax preference items would lead to lower actual progressivity. Another interesting finding which emerges from Table 2 is the significantly higher marginal tax rates faced by the median family over the period. The marginal tax rate increased from 17% in 1950 to 28% in 1980. Note that under the tax reform of 1981, marginal rates will drop substantially by 1984 due to the 25% tax reduction. Much of the 'bracket creep' of the past decade will be eliminated. Under current legislation, the income tax system is scheduled to be indexed beginning in 1985. Also, beginning this year, a 10% deduction for two earner couples up to a limit of $30,000 exists. This deduction reduces the effects of the 'marriage tax' which arises due to the progressive structure of the income tax. We estimate the effect of this new

deduction on the labor supply of families given our results in the current paper. Appropriate economic techniques to measure the effect of taxation need to treat the non-linearity of the budget sets which arises due to the non-constancy of the marginal after tax wage.[2] Recent econometric research has developed techniques which takes account of this non-linearity and the related situation that the marginal wage rate is jointly determined with the amount of labor supply. In this paper, we extend the recent work to account for the interdependent nature of family labor supply decisions, rather than treating husbands and wives separately. The effect of taxation has potentially important effects here since the labor supply of the husband affects the marginal tax rate of the wife and vice versa. Fixed costs of work may also have an important role here, especially as they interact with the tax system. Therefore, we combine joint family decisions with the effects of the tax system. When we combine these approaches, an additional theoretical and econometric problem arises. For non-working spouses, the appropriate 'virtual' wage must be estimated since this wage enters the labor supply function of the working spouse. The notion of the 'virtual' wage arises in the theory of rationing and is analogous to the notion of virtual income, previously used in models of labor supply with taxes.[3] That is, the 'virtual' wage is that wage which would cause the individual to choose to work exactly zero hours with a tangency of the family indifference curve and the budget set which is determined by the net after tax wage of the working spouse, the 'virtual' wage of the non-working spouse, and the virtual income of the family. The treatment of joint family labor supply with taxation and with the use of the correct virtual wage for non-working spouses is the main contribution of this paper.

The plan of the paper is as follows: In the next section, we describe our econometric model of joint family labor supply with taxation. In Section 3, we describe our treatment of both federal and state taxation. We also present our empirical results and estimate the effect of the recent change in the taxation of two earner families. In Section 4, we consider the problem of what labor supply curve is being estimated. We also indicate how our model can be extended to an intertemporal context which is the focus of our on-going research.

I. Econometric Specification

We have specified a new indirect utility function for the multiple good case. Specifications that have been previously used impose constraints on the supply functions across goods that are improbable in the joint labor supply of husbands and wives. In our sample, almost all of the men work but only half of the women do. Wives who do work, work approximately half as many hours as working husbands. Clearly, the supply behavior is very different among husbands and wives and the parametric specification must be able to accommodate this.

Our indirect utility function has the following functional form:

$$(1)\quad V(w_1,w_2,y) = \exp\,(\beta_1 w_1+\beta_2 w_2)(y+\theta+\delta_1 w_1+\ \delta_2 w_2+.5(\gamma_1 w_1^2\ +\ \gamma_2 w_2^2\ +\ \alpha\, w_1 w_2))$$

or more simply,

(2) $V(w_1, w_2, y) = \exp(\beta_1 w_1 + \beta_2 w_2) y^*(w_1, w_2, y)$

where $\Theta, \beta_1, \beta_2, \delta_1, \delta_2, \gamma_1, \gamma_2$, and α are parameters of the indirect utility function, the w's are the respective net wages, and y is the virtual income. Direct application of Roy's identity yields the labor supply equations.

(3) $h_1 = \delta_1 + \beta_1 y^* + \gamma_1 w_1 + \alpha w_2$

$h_2 = \delta_2 + \beta_2 y^* + \gamma_2 w_2 + \alpha w_1$.

These supply equations have the simple form of being linear in virtual income and quadratic in wages, where the quadratic terms appear in y^*. Furthermore, this functional form allows each equation to have its own intercept and income coefficient. The equations are second order flexible and have the convenient property that non-linearity arises only in products of coefficients which makes econometric estimation considerably easier than with other flexible functional forms.

Nevertheless, their derivation from an indirect utility function places constraints on these supply equations. That is, our model of family labor supply assumes maximization of a joint family utility function so that the restrictions imposed by economic theory apply. Because the indirect utility function must be non-decreasing in wages, and both compensated supply equations must be upward sloping despite the quadratic wage terms that allow backward bending labor supply. One should note that although the supply equations appear conventional, the individual parameters in these equations do not have conventional functions of only eight parameters. For example, the derivative of h_1 with respect to w_1 is

(4) $\beta_1 \delta_1 + \gamma_1 + \beta_1(\gamma_1 w_1 + \alpha w_2)$

which depends on parameters that one might associate soley with income or w_2. Combining the supply equations with the budget constraint

(5) $x = y + w_1 h_1 + w_2 h_2$

completely characterizes the behavior of the household. The direct utility function can be derived by solving these three equations for h1, h2, and x as functions of w_1, w_2, and y and direct substitution into the indirect utility function. The direct utility function is needed to predict behavior when one or both spouses are not working or in the presence of fixed costs. It is convenient to express the direct utility function implicity as follows: Given h_1, h_2, and x, both y and w_2 can be expressed as linear functions of w_1. Substituting these linear relationships into the first supply equation yields a quadratic function in w_1 that is easily solved: one chooses the root that corresponds to an upward sloping supply. Recursive solution for w_2, y, and, finally, utility yields the direct utility function.

The labor supply functions of equation (3) yield the hours that maximize the direct utility function if the budget frontier is linear. This occurs when the net wages are constant for all hours worked and there are no fixed costs incurred by working. But the introduction of taxes leads to a non-linear budget set. It is necessary to know the direct utility function in order to determine the hours of the husband and the wife predicted by utility maximization over a non-linear budget frontier because simple revealed preference arguments cannot determine global maxima in utility. The exception to this rule occurs when the budget frontier is globally convex. The argument in Hausman (1979) continues to work for the multiple good case.

For the tax schedules faced by couples the maximization of utility can be broken up into maximization over convex subsets of the budget frontier followed by maximization of utility over the entire set of solutions. Each income bracket is a convex subset of the budget frontier that has a relatively simple utility maximum. Within an income bracket, net wages and, consequently, virtual (non-labor) income are constant so that locally the budget frontier is the conventional linear budget constraint. This budget constraint must include, however, non-negativity constraints on hours worked by each member of a couple and income constraints that define the tax bracket.

The utility maximum on such convex sets as an income bracket of the tax schedule does not require the utility function. First, we compute the unconstrained solution using the supply equations. If this solution falls within the income bracket, then this solution is obviously the constrained maximum, too. Otherwise, the utility maximum occurs on a boundary. One, two, or three of the constraints may be violated. Let us examine each case in turn. If only one constraint is violated by the supply equations, then convexity of the direct utility function and the budget set ensures that the constrained solution lies on the corresponding linear boundary. The boundary solution can be found by substituting the boundary constraint directly into the system of supply equations and the budget constraint and solving for the virtual wages and income in the same manner as we described for deriving the utility function. The constrained solution corresponds to the unconstrained hours supplied at these virtual wages and income.

On a boundary corresponding to zero hours, the wage for the working spouse and the virtual income correspond to the observed ones. Therefore, one solves the quadratic in the virtual wage of the person not working formed by their supply equation to obtain the constrained maximizing point. On the income bracket boundary, the ratio of the virtual wages must be equal to the slope of the hours trade-off and total consumption is fixed by the total income constraint. These two constraints also lead to a quadratic equation in a virtual wage that leads to the constrained optimal hours. These closed form solutions are a special feature of our parameterization. Other choices of functional forms for labor supply can lead to extremely difficult systems of equation for which no closed form exist.

If the boundary solutions do not satisfy one of the other constraints, then the constrained solution lies at the vertex where the constraints are simultaneously satisfied. When two constraints are violated by the unconstrained solution, then the constrained solution may rest on either boundary or the common vertex. Again, convexity ensures that only one boundary solution will be feasible. Finally, three constraints will be violated by the unconstrained solution if both supply equations yield negative hours. The constrained solution will lie on the lower income boundary or one of the couple will not work. One must examine all three cases to find the single, feasible solution.

The stochastic specification which we use allows for a truncated bivariate normal distribution to represent the deviation between actual and desired hours and measurement errors. The truncation arises because of the lower limit of zero hours of work. Therefore, the likelihood function is a bivariate Tobit model where none, one, or both of the stochastic terms may be truncated. An individual may not work either because the preferred hours are zero or because the realization of the stochastic term is sufficiently negative to induce zero hours. We include fixed costs to working for the wife as in Hausman (1981a) but we do not allow for preference variation through a distribution of parameters as Hausman did in his earlier work.[4] The parameter estimates are unconstrained as we do not impose the global integrability conditions of economic theory beyond those incorporated into the indirect utility function of equation (1).

II. Estimation Results

Our sample is drawn from the 1976 wave of the Michigan Panel Study of Income Dynamics. It consists of 1991 couples that remained after removing the self-employed and farming families and those observations that were missing data on socio-economic explanatory variables. We eliminated any household which contained an individual who claimed to work in excess of 4,000 hours per year. We also truncated the sample based on the observed wages, requiring wages of both husband and wife to be less than twenty dollars. The missing wages for women who were not working were estimated by a standard sample selection model using the wage data of the working women.[5] For the tax calculations which define the non-linear budget sets the basic federal income tax schedule is parameterized by 13

TABLE 3

Estimates of Joint Family Labor Supply Model (asymptotic standard errors)

	Coefficient	Husband		Wife
1.	δ_j - constant (1000)	1.655 (.006)		1.090 (.133)
2.	β_j - virtual income (1000)	-.147 (.008)		-.316 (.054)
3.	γ_j - net wage	.259 (.004)		.321 (.132)
4.	α - spouse wage		-.548 (.115)	
5.	θ - combined constant		-11.228 (.367)	
6.	Ill health	-.084 (.059)		-.507 (.024)
7.	Children less than 6		.001 (.004)	
8.	Family size		.001 (.019)	
9.	Fixed costs (1000's per year)	—		.755 (.203)
10.	Children less than 6 in FC	—		.002 (.013)
11.	Family size in FC	—		.034 (.043)

LF = -9940.

$$\Sigma = \begin{bmatrix} .224 & --- \\ .040 & .342 \end{bmatrix}$$

income brackets and marginal tax rates. The first bracket is $1,000 wide and succeeding brackets, starting at $4,000 each of which is then $4,000 wide. This representation of the federal tax system is the same parameterization used by Hausman (1981a) for married couples filing joint returns. Unlike Hausman, additional brackets were introduced to the federal scheme to accommodate progressive state taxes on earned income, which were present in 35 states. Five states had taxes strictly proportional to earned income and eleven states had zero marginal tax rates in 1976.

Non-convexities in the budget set appear because of FICA, the earned income credit, and standard deductions. Social Security (FICA) contributions were 5.85 percent up to a limit of $14,110 for 1976 causing the marginal tax rate to fall at that point. The earned income credit rises up to $4,000 of gross income and is exhausted at $8,000. Thus an additional non-convexity appears at $8,000 net of non-labor income. Finally, federal and some state tax schedules allow personal exemptions that have upper and lower limits based on gross income that introduce non-convexities. For example, the federal standard deduction reached a maximum of $2,600 at $16,250. But for married couples filing jointly the standard deduction was $1,900 for incomes less than $11,875 and became 16 percent of income up to $16,250. This creates a non-convexity at approximately $12,000 where the marginal tax rate falls 84 percent. We assumed that every couple filed jointly. For each state, personal exemptions and tax credits for married couples and dependents were allocated when they were available. In addition, the family is assumed to incur fixed costs when the wife works that reflect the costs of child and house care, as well as social convention. This creates additional non-convexities in the budget frontier along the plane of zero hours for the wife.

The estimation results for the labor supply functions of equation (3) and the associated indirect utility function of equation (1) are given in Table 3. The method of estimation is maximum likelihood. Person 1 is assumed to be the husband. Note that the coefficients for both virtual income and the own wage effect and cross wage effect are quite precisely estimated. The coefficient for virtual income for husbands equals -.147 and is quite close to the mean of the β distribution estimated by Hausman (1981a) where he estimated husbands labor supply independent of the labor supply behavior of wives.[6] The mean income elasticity in the sample for husbands is estimated to be -.101 which again demonstrates the importance of taking account of taxes in models of labor supply. Since the net wage enters y^* in equation (3), we use equation (4) to calculate the derivative of hours of labor supply with respect to the wage. The mean derivative equals -.016

which corresponds to an elasticity of -.034 which is slightly greater than Hausman (1981a) found. The restriction from economic theory that the compensated demand curve be upward sloping is satisfied for hours greater than 231. This restriction is satisfied for almost all the predicted hours which have a mean of 2140 and for actual hours which have a mean of 2129 hours. The mean derivative of the cross wage effect for men is -.382. However, the estimate is not significantly different from zero. Nevertheless, it is possible that this finding may arise from the correct treatment of virtual wages for non-working wives.

The coefficient for virtual income for wives is estimated to be -.316 which is about 2 1/2 times larger than the results from Hausman (1981a) where husband's labor supply is taken as exogenous in the determination of the wife's labor supply. The mean elasticity estimate of -.360 is quite similar to the Hausman (1981a) result because here family virtual income is used in the elasticity calculation. The average own wage effect is calculated to be .385 which leads to an elasticity of .757 which is below the previous estimate of .906. However, a substantial own wage elasticity still exists for wives. The mean cross wage effect is estimated to be -.104 with an elasticity of -2.36. As with the husband's cross wage effect, this estimate demonstrates the importance of the spouse's wage. It is interesting to note that a 1% change in the mean husbands wage leads to a predicted decrease of 30.9 hours for the average wife while if the wife's response is conditioned on the husbands behavior as in previous Hausman (1981a) models, the predicted reduction would be 47.2 hours. The predictions are of similar size but the response in the joint labor supply model is somewhat less as would be expected.

Since symmetry has been imposed by the specification of the indirect utility function of equation (1), the only other restriction of economic theory is the positive definiteness of the Slutsky matrix. That is, both compensated labor supply curves must be upward sloping which is a restriction found to be violated in many labor supply studies for men which ignore taxes. Also the compensated cross wage elasticity cannot be too large. At the mean of the data both compensated demand curves and the determinant of the Slutsky matrix are all significantly greater than zero when tested at the .05 level. The positivity restrictions are also satisfied at almost all the data points. We conclude that our estimation results do not reject the economic theory of joint household maximization.

We now consider the economic welfare and labor supply effects of the tax treatment of families. Using the indirect utility function of equation (1), we calculate the deadweight (DWL) loss of the taxation of labor income with the approach of Hausman (1981a, 1981b). The ratio of DWL to tax revenues is estimated to be 29.6% which should be compared to 28.7% for males and approximately 58% for wives estimated by Hausman (1981a). Again, we find a rather high cost in efficiency for the progresivity of the tax system. We next consider the effect of the 10% deduction introduced in 1983 to reduce the marriage tax.[7] It should be noted that we apply the 10% reduction to the 1976 tax rates of our sample rather than the actual 1983 situation. We estimate that wives labor supply will increase by 3.8% while husband hours decrease by .9%. Overall taxes paid decrease by 3.4%.

To compare the desirability of the change on efficiency grounds, we would need to know the DWL of marginal tax revenues raised by other means to compensate for the tax reduction here. But, the equity grounds for a reduction in the marriage tax are quite strong.[8]

III. Compensated versus Uncompensated Labor Supply Curves and the Income Effects of Taxation:

Two related arguments sometimes arise in the estimation of labor supply functions. The first argument is that what we measure are actually compensated (Hicksian) labor supply curves which therefore contain only substitution, but no income, effects. The second argument is that a change in income taxation will induce only substitution effects so that the change in labor supply has a determinate direction, rather than being composed of potentially offsetting income and substitution effects. These arguments are usually associated with the analysis of Milton Friedman (1949, 1976, Chapter 3).[9] The basic idea is that the goods and services which the government provides with the tax revenues will need to be replaced by the private economy when the taxes are reduced. The production possibility frontier of the economy thus remains unchanged. The argument is then made that income effects do not exist in this 'general equilibrium' analysis so that only substitution effects are measured or of importance in the analysis of changes in tax policy.

Strictly construed, this argument will only hold in a one consumer economy. In a times series regression of a so-called representative consumer model, it might be argued that the government expenditure exactly duplicates the individuals preferences. But this position is untenable in a cross-setion regression of non-identical individuals. In this situation, note that all individuals receive the public goods provided by the government irrespective of their actual labor supply. Therefore, the statistical experiment being undertaken is to compare sample points which have different after tax net wages and different virtual incomes, but receive identical amounts of public goods.

The presence of an income effect is then immediate because of the different levels of utility that the individuals or families reach. The Friedman argument would seem to require that all families are on the same indifference curve which certainly does not hold here. Therefore, the argument that the compensated labor supply curve is being estimated does not stand examination in the typical context of estimation of labor and supply with taxation.

The second argument is that only substitution effects are relevant in the consideration of changes in income taxation. The key consideration here involves what is being held constant. Richard Musgrave in his classic treatise (1959) discusses the various possibilities and recommends the comparison of "alternative methods of tax financing a given level of real expenditures". (pg. 212). Income effects are clearly of importance in this situation. Hausman (1981a) compares the labor supply effects and welfare effects of a switch from the current tax system to an equal yield progressive linear income tax. The level of public goods provision is being held constant and income effects occur across different individuals as they shift from their current indifference curves to their new indifference curves under the new tax system. The importance of heterogeneity among individuals is ignored in the Friedman-type arguments. The one case where the analysis becomes more difficult is when a tax change with respect to the income tax is being considered without a compensating change in other taxes to hold total revenue constant. But even here the argument that only substitution effects exist is not correct in general. In fact, in the most recent observation of a major tax change, the level of government expenditure has changed by only a small amount with respect to the decrease in government revenues. Again, income effects would be important in the analysis of the income tax cuts, although a confirmed believer of the Barro-Ricardo analysis might argue that no effective decrease in taxes has taken place because of the concurrent increase in the deficit.

IV. Conclusion:

We have estimated a joint model of family labor supply with taxes taking appropriate account of virtual income introduced by the tax system and virtual wages for non-working spouses. We now intend to extend our model to make it consistent within a life cycle framework. Richard Blundell and Ian Walker (1983) have demonstrated how to embed the cross section framework within a life cycle model by the use of a two stage bugdeting approach. To add taxes to the model we would use the labor supply functions of equations (3) with virtual income replaced by virtual income plus the change in assets minus after tax property income. Therefore, the life cycle approach substitutes the change in assets for property income, although the tax system still taxes the latter amount. Preliminary estimates indicate that the general results of Table 3 do not change. Significant income effects continues to appear for both husbands and wives as do own wage effects for wives and cross wage effects for both husbands and wives. But all these results should be taken as first attempt to introduce the U.S. tax system into a joint family labor supply model. Continued research on the influence of functional form and the effect of life cycle decisions is needed.

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FOOTNOTES

1. Of course, not all income tax revenue is a tax on labor supply because of th 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.

2. For recent reviews of research in this field, see Hausman (1983) and Mark Killingsworth (1983).

3. The use of virtual prices in rationing was introduced by E. Rothbarth (1941). Recent treatments are given by Peter Neary and Kevin Roberts (1980) and by Deaton and John Muellbauer (1980). Note that the virtual wage is not the same as the reservation wage in a model with fixed costs and taxes, c. f. Hausman (1980).

4. The presence of fixed costs to working for the wife are the one asymmetrical part of our specification. However, in the absence of preference variation they seem to have an important role in the explanation of the difference in labor force participation between spouses.

5. Further details of the sample selection procedure can be found in Hausman (1981a) since similar procedures were employed.

6. Estimates from other studies are given in Killingsworth (1983).

7. Previous estimates are provided by Daniel Feenberg and Harvey Rosen (1983).

8. Joseph Pechman (1983) discusses the choice of the appropriate basis for income taxation.

9. See also Bailey (1954). Recent treatments include Axelsson, et. al.(1981), Ehrenburg and Smith (1982), and Gwartney and Stroup (1983).