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ALTERNATIVE TAX TREATMENT OF THE FAMILY: SIMULATION METHODOLOGY AND RESULTS

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ABSTRACT

A number of suggestions have been made to reform the tax treatment of the family. None of these proposals has heen accompanied by careful estimates of their effects on the income distribution, revenue collections, and labor supply. The purpose of this paper is to provide such information.

Our analysis is based upon a series of simulations using the TAXSIM file of the National Bureau of Economic Research, which contains information from a sample of tax returns filed in 1974. Substantial attention is devoted to the problem of imputing data that are absent from TAXSIM. The simulations assume that wives' labor supply behavior depends upon the tax system.

The tax reforms simulated include various exemptions and credits for secondary workers, as well as changes in the rules governing filing status. In a number of cases we find that allowing for even a modest behavioral response leads to substantial changes in the revenue implications of the proposals.

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I. Introduction

The choice of a unit of taxation is a fundamental one in any tax system. In most cases, this boils down to the question of whether the tax schedule will be applied to the income of the individual, or of the family. Since the personal income tax was introduced into the United States in 1913, the selection of the taxable unit has been a source of controversy.[1] The choice has fluctuated over time, and even now there is no strong societal consensus.

Currently, single and married people face different tax schedules, with the tax liability of married individuals being based upon the couple's joint income.[2] Consequently, tax burdens change with marital status, although one cannot predict *a priori* whether tax liabilities will increase or decrease when an individual marries. The answer depends in part upon the closeness of the incomes of the spouses. The general tendency is that the closer the incomes, the more likely that tax liabilities will increase [Munnell, 1978].

This state of affairs has been criticized for a number of reasons. Some observers, noting that the tax system often provides financial disincentives for marriage, have argued that the current regime encourages immorality. (See Rich [1979], Washington Post [1979]). Economists have tended to focus on possible inefficiencies induced when tax liability is based upon family income ("joint filing"). As Boskin and Sheshinski [1979] note, since the labor supply elasticities of husbands and wives differ, economic efficiency

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1 The pros and cons of various choices are discussed by Rosen [1977], Brazer [1978] and Munnell [1978].

2 The family was established as the principle unit of taxation in 1948. The system of separate schedules for singles and marrieds was introduced 1969.

would be enhanced if their earned incomes were taxed at different rates. Yet under a system of joint filing, spouses face the same marginal tax rate on the last dollar. A closely related criticism is that the current tax regime tends to discourage married women from entering the marketplace. This is because under joint filing, the wife's marginal tax rate is a function of the husband's earnings.[3]

In light of these and other criticisms, a number of suggestions have been made to reform the tax treatment of the family. None of these proposals has been accompanied by careful estimates of their effects on the income distribution, revenue collections and labor supply. The purpose of the present paper is to provide this information.

The vehicle for our analysis is the TAXSIM file of the National Bureau of Economic Research.[4] TAXSIM contains virtually all the information from a sample of 2339 tax returns filed in 1974.[5] (The returns, however, are "aged" so that all magnitudes reported are in 1979 levels[6].) The file includes information on the taxable earnings of both spouses, interest, dividends, capital gains, rents, etc. Our basic plan is to simulate the effects of alternative tax regimes by computing for each the associated tax liabilities. In this way, one can determine the gainers and losers as the tax system is modified.

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3 This argument implicity assumes that a husband's labor supply is not sensitive to tax rate changes generated by his wife's earnings.

4 TAXSIM is described in detail in Feldstein and Frisch [1977].

5 The sample includes one return in 80 for returns showing no wife's labor income, and one return in 20 with positive wife's labor income.

6 In order to bring all figures to 1979 levels we increase all dollar amounts by the proportional change in taxable income from 1974 to 1979, and increase the number of returns according to the growth of population.

An important complication arises because much economic behavior depends upon the tax system, so that pre-tax values of (say) earnings may be a function of the tax regime. More specifically, a number of econometric studies have indicated that although husbands' hours of work are independent of the tax system, the labor force behavior of married women is quite responsive to the net wage (see, e.g., Rosen [1976] or Hall [1973]).[7] Thus, ignoring the labor supply response of married women is likely to lead to biased estimates of the effects of tax reform proposals. Our simulations explicitly incorporate endogenous work decisions for wives.

Unfortunately, even a rather complete set of variables relating to a household's tax situation does not include all of the information needed to predict the effects of taxes on labor supply. For example, standard theoretical considerations suggest that an important determinant of labor supply is the wage rate, but since it is not entered on the tax return, the wage is absent from TAXSIM. Section II of this paper consists of a careful discussion of the statistical issues surrounding the problem of imputing such missing data. The reader who lacks interest in this methodological question may wish to skip directly to section III, which explains the behavioral assumptions built into the simulations. Section IV contains the results. The alternative tax regimes considered run the gamut from eliminating joint filing altogether, to retaining joint filing, but granting tax subsidies to secondary workers. A concluding section includes some caveats and suggestions for future research.

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[7] The evidence is reviewed more carefully in Section III below.

II. Methodological Issues

A behavioral simulation requires data on individuals' tax situations and on their economic and demographic characteristics. The tax information is required to make careful predictions of the revenue implications of alternative tax regimes. The economic and demographic information is needed to estimate the impact of tax changes upon economic behavior.

The fundamental methodological problems of this study are consequences of the fact that no publically available data set has all this information. The data sources typically used by economists to estimate behavioral equations have virtually no federal income tax data. (See, for example, Institute for Social Research [1974].) On the other hand, data sets that are rich in tax information tend to tell us little else about members of the sample. For example, because individuals do not report wage rates and hours of work on their federal income tax returns, TAXSIM has no information on these crucial magnitudes. Clearly, then, one must bring together information from (at least) two different data sources in order to perform tax simulations with endogenous labor supply responses.

A popular technique for combining information is statistical matching.[8] The first step in this procedure is to isolate a set of variables that is common to both data sets. Then a search is made to determine which observations of each data set are "close" on the basis of these variables.[9] The close observations are pooled in order to form a "synthetic" observation, which is then treated as if it were generated by a single behavioral unit.

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[8] It has been used, for example, to create the Brookings MERGE file. See Pechman and Okner [1974]

[9] Criteria for doing the matching are discussed by Kadane [1978] and Barr and Turner [1978].

In addition to suffering from statistical problems,[10] the matching procedure is enormously expensive in terms of computer time for data sets of even moderate size. In this section we develop an imputation procedure that we think dominates matching on both statistical and cost grounds. We begin by discussing the general problem of predicting tax revenue collections in a simulation model with endogenous behavior. This turns out to provide a useful framework for generating a rigorous data imputation technique, which is done in the second part of this section. In the third part, the procedure is applied to the problem of estimating missing wage data.

A. Predicting Tax Revenues

Let y be a vector of variables endogenous to the tax system. Included are items such as taxable income, which depends directly upon provisions of the tax code, as well as variables like pre-tax earnings, which depend upon the tax system only to the extent that the latter influences economic behavior. Let x be a vector of exogenous variables such as age. If the tax code at a given time is represented by the parameter B, then we can think of the tax system as a function $t(x,y,B)$ which determines the amount of taxes owed by an individual given both the relevant exogenous and endogenous variables. Our problem is to determine how revenues change when there is a change from the current tax regime, denoted B', to some new tax regime, B''.

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[10] These are explained by Sims [1978].

Call the joint distribution of the exogenous and endogenous variables in the population $f(x,y\ B')$. Then total tax revenue under the current regime B' is

$$(2.1) \qquad T(B') = N\int_x\int_y t(x,y,B')f(x,y|B')dydx ,$$

where N is the total number of tax paying units.

The analytic integration implied by (2.1) cannot in practice be performed. An obvious alternative to (2.1) is its discrete analogue,

$$(2.2) \qquad \hat{T}(B') = N \sum_{i=1}^{I} t(x_i,y_i,B')P_i ,$$

where y_i and x_i $(i=1,...,I)$ are I sample observations from the universe of N tax-paying units, and P_i is the sample weight of the ith observation. (In the absence of deliberate stratification, $P_i = 1/N$ for all i.)

Under tax regime B'' tax revenues are

$$(2.3) \qquad T(B'') = N\int_x\int_y t(x,y,B'')f(x,y|B'')dydx .$$

Unfortunately, even knowledge of $f(x,y\ B')$ does not in general give us $f(x,y\ B'')$, the joint distribution of x and y under the new regime. Only with the restrictive assumption that y is inelastic with respect to the change in tax regimes can we estimate new tax revenues as

$$(2.4) \qquad \hat{T}(B'') = \frac{N}{I} \sum_{i=1}^{I} t(x,y,B'')P_i .$$

For changes in tax regimes of the sort being analyzed in this paper, the exogeneity assumption is untenable.

In order to predict taxes under B", the first step is to specify a behavioral relationship that gives y as some function of x, the tax code, and an error term independent of x :

$$(2.5a) \qquad y_i' = y(x_i, B') + u_i'$$

$$(2.5b) \qquad y_i'' = y(x_i, B'') + u_i'' ,$$

where u_i' is the random error for the ith individual under regime B', and u_i'' is defined analogously. (The errors have means of zero.) Note that independence between u_i' and u_i'' is not assumed; indeed, one expects that typically they will conceal a substantial individual "fixed effect" and hence be correlated.

If we substitute equation (2.5b) into (2.3) we find

$$(2.6) \qquad T(B'') = \int_x \int_y \left[\int_{u_i''} t(x, y(x, B'') + u_i'', B'') \phi(u_i'') du_i \right] f(x, y\ B') dy dx$$

where $\phi(u_i'')$ is the density of u_i''. The discrete analogue to (2.6) is

$$(2.7) \qquad \hat{T}(B'') = N \sum_{i=1}^{I} \left[\int_{u_i''} t(x_i, y(x_i, B'') + u_i'', B'') \phi(u'') du_i'' \right] P_i \quad .$$

If the distribution of u_i'' is known,[11] then (2.7) consists entirely of observables. It turns out, however, that both defining $\phi(u_i'')$ and integrating over u_i'' can be avoided by taking advantage of a simple

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[11] For example, u_i'' might be the normal error from a regression, whose mean and variance are computed along with the regression coefficients.

trick. Define

(2.8) $\hat{y}''_i = y(x_i, B'') + (y'_i - y(x_i, B'))$.

In words, $\hat{y}''_i$ is the expected value of y under the B" regime plus the error term associated with regime B' . If, as might reasonably be expected, u'_i and u''_i are highly correlated, then $\hat{y}''_i$ should be a better estimator of y''_i than $y(x_i, B'')$, because the latter ignores the error in the behaviorial equation. More precisely, $\hat{y}''_i$ and y''_i have identical distributions under the assumption that u'_i is drawn from the same distribution as u''_i , a fairly mild condition. These considerations suggest the following estimator:

$$(2.9) \qquad \hat{T}(B'') = N \sum_{i=1}^{I} t(x_i, \hat{y}''_i) P_i \quad ,$$

which can also be written (using the definition of $\hat{y}''_i$) as

$$(2.10) \qquad \hat{T}(B'') = N \sum_{i=1}^{I} t(x_i, y(x_i, B'') + u'_i, B'') P_i \quad .$$

Since y''_i and $\hat{y}''_i$ have the same distribution , $\hat{T}(B'')$ is an unbiased estimator of tax revenues.

It is useful to compare (2.10) with (2.6). In effect, the integral over u''_i of (2.6) has been replaced in (2.10) by a sample mean from an identical distribution. (Of course, the sample mean is calculated with one observation, but it is nevertheless an unbiased estimator, and hence performs the same function as would a mean calculated over several observations.)

$\hat{T}(B'')$ should be contrasted with an estimator which uses only the predicted value of y''_i for each observation,

$$(2.11)\quad \tilde{T}(B'') = N \sum_{i=1}^{I} (x_i, y(x_i, B''), B'')_i \ .$$

One expects that $\tilde{T}(B'')$ will be less satisfactory than $\hat{T}(B'')$ because in general the distribution of the expectation of a random variable differs from the distribution of the variable itself.

To summarize: We have developed carefully a method for estimating tax revenues under alternative tax regimes. Similar procedures have been used before (see, e.g., Feldstein and Taylor [1976]), but with a more intuitive statistical justification. Of course, the discussion so far has ignored the possibility that some variables in the x or y vectors may be missing from the TAXSIM file. The theory we have developed in this section, however, turns out to provide a useful framework for thinking about data imputation problems.

B. Imputing Baseline Data: Theory

Most plausible theories of labor supply suggest that it is necessary to know something about individuals' wage rates and hours of work in order to predict how alternative tax regimes affect revenues. But federal tax returns include only the product of hours and the wage rate, that is, earnings. In this section we show how external information concerning the joint distribution of earnings and hours can be used in conjunction with tax return data in order to impute the missing variables.

For expositional purposes, we specialize the model developed in section II.A. above. Let the vector y of endogenous variables have two elements, e (earnings) and m (total taxable income).[12] Let the vector x of exogenous variables consist of one element w, the pre-tax wage rate. The tax calculator is then $t(e,m,w,B)$.

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[12] We ignore for the moment that fact that the household may have more than one earner.

Although TAXSIM has e and m, it does not have w. A number of data sets have information on e and w, but not m. Because there is no data set which includes e, M, <u>and</u> w, $f(e,y,w|B')$ cannot be inferred straightforwardly. But if we are willing to make some additional assumptions, $f(\cdot)$ is estimable.

The key assumption is that m and w, <u>conditional</u> on e and B, are independent. This seems quite reasonable in that once we know earnings, knowledge of the wage probably contributes little to predicting taxable income. Of course, the independence assumption is not <u>necessarily</u> true. It might be the case, for example, that high non-labor incomes are associated with high reservation wages, <u>ceteris paribus</u>. This would generate conditional dependence of m and w even given e. In this context, it should also be noted that in actual application there are several variables common to both data sets. Increasing the number of variables upon which independence is conditioned makes the assumption even more reasonable.

Re-writing equation (2.2) for our special case, we have

$$(2.12) \qquad T(B') = N\int_w\int_m\int_e t(e,m,w,B')f(e,m,w|B')\, dedmdw.$$

Taking advantage of the usual identities concerning the distributions of independent variables,[13] (2.12) can be re-written as

$$(2.13) \qquad T(B') = N\int_w\int_m\int_e t(e,m,w,B)\int_w f(\cdot|B)dw \frac{\int_m f(\cdot|B)dm}{\int_m\int_w f(\cdot|B)dwdm} dedmdw .$$

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13 See, for example, DeGroot [1975, p. 119]

Now, $\int_w f(\cdot|B)dw$ is the distribution of earnings and income, and is estimable from the TAXSIM file. $\int_m f(\cdot|B)dm$ is the distribution of wages and earnings, and may be estimated from any data set with information on both w and e. Finally, $\int_m \int_w f(\cdot|B)dwdm$ is the distribution of earnings and may be estimated from either or both files. Therefore, T(B) is identified by the existing unmatched files.

There still remains, of course, the problem of estimating the relevant distribution functions. As noted above, it is impractical to find closed form expressions for $f(\cdot|B)$ and its marginal distributions. Sims [1978] has suggested that e, m, and w space be partitioned into a large number of cells, and that the marginal cell counts be used as estimates of the three integrals over $f(\cdot|B)$. However, given that in our problem we are dealing with a number of continuous variables, this approach does not seem operational.

We therefore propose the following alternative. Let $(e_i, m_i;\ i=1,\ldots,I)$ be a set of I observations from TAXSIM. Then the discrete probability analogue to equation (2.13) is

$$(2.16) \qquad \hat{T}(B') = \sum_{i=1}^{I} \left[\int_w t(e_i, m_i, w, B') \frac{\int_m f(\cdot|B')dm}{\int_m \int_w f(\cdot|B')dwdm} dw \right] P_i$$

where the term enclosed in brackets is the expected value of taxes owed by the ith taxpayer given the joint distribution of wage rates with the other variables.

(Note that P_i plays the role that $\int_w f(\cdot|B')dw$ had in (2.13).)

The ratio

$$\frac{\int_m f(\cdot|B')dm}{\int_m\int_w f(\cdot|B')dmdw}$$

that appears in (2.16) is just the distribution of wage rates conditioned on earnings and B'. As noted above, it can be estimated from a number of available data sets. It appears, then, that the only stumbling block to evaluating (2.16) is integrating over w. A Monte-Carlo approach seems promising here.[14] Essentially, this procedure involves the replacement of the integral over w with a sample mean.

We proceed more formally by defining

$$q_i(w) \equiv t(e_i,m_i,w,B')\frac{\int f(\cdot|B')dm}{\int_m\int_w f(\cdot|B')dwdm}\,dw^{P_i} .$$

Then (2.16) can be re-written

(2.17) $$\hat{T}(B') = N\int_w \sum_{i=1}^{I} q_i(w)dw$$

For any density function $g(w)$, (2.17) is

(2.18) $$\hat{T}(B') = N\int_w \sum_{i=1}^{I} \frac{q_i(w)}{g(w)}\,g(w)dw .$$

Observe that if w is distributed as $g(w)$, then (2.18) is the expected value of $\sum_{i=1}^{I} \frac{q_i(w)}{g(w)}$.

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14 For a general discussion of Monte-Carlo techniques see Shreider [1966].

Suppose that we have available a device for producing random numbers with distribution $g(w)$. Let $\hat{w}_{ij}$ by the jth such random number generated for the ith individual. Then the basic Monte-Carlo strategy suggests replacing integral (2.18) with

$$(2.19)\qquad \hat{\hat{T}}(B') = \frac{N}{J}\sum_{j=1}^{J}\sum_{i=1}^{I}\frac{q_i(\hat{w}_{ij})}{g(\hat{w}_{ij})} ,$$

where J is the number of random drawings.

Suppose now that we let $g(w)$ be the conditional distribution of wages given earnings. Then (2.19) becomes

$$(2.20)\qquad \hat{\hat{T}}(B') = \frac{N}{J}\sum_{j=1}^{J}\sum_{i=1}^{I} t(e_i,m_i,\hat{w}_{ij},B')\frac{\int_m f(\cdot|B')\,dm\,dw}{g(w_{ij})\int_m\int_w f(\cdot|B')\,dw\,dm}P_i ,$$

When the definition of $g(\cdot)$ is substituted into (2.20), it collapses to

$$(2.20')\qquad \hat{\hat{T}}(B') = \frac{N}{J}\sum_{j=1}^{J}\sum_{i=1}^{I} t(e_i,m_i,\hat{w}_{ij},B')P_i .$$

To appreciate the meaning of (2.20') it is useful to contrast it with the alternative expression

$$(2.21)\qquad S(B') = N\sum_{i=1}^{I} g(e_i,m_i,E(w_i|e_i,m_i))P_i ,$$

where $E(w_i|e_i,m_i))$ is the conditional expectation of w_i . To compute $\hat{\hat{T}}(B')$ we must take the average of J values drawn from the conditional distribution of w , while for $S(B')$, w is imputed using simply the conditional mean. To the extent $t(\cdot)$ is nonlinear, $S(B')$ yields biased estimates.

The only remaining question is how to choose J, the number of random drawings from the distribution. A rigorous examination of this question would require optimally trading off the (substantial) computational costs of increasing J against the efficiency gains from doing so. Such an exercise is beyond the scope of this paper. We settle upon $J=1$ as an inexpensive solution that has all the desirable statistical properties of (2.20').

We have come by a rather indirect route, then, to a rigorous yet straightforward solution to the problem of imputing wage rates to the TAXSIM file. Using a separate data file, estimate a regression of the form $w = g(Z) + \varepsilon$, where Z is a vector of variables in common between TAXSIM and the data set, and ε is a random error. Then for the ith observation in TAXSIM, impute the wage as $g(Z_i) + \varepsilon_i$, where ε_i is a random drawing from the distribution of ε.

C. Imputing Baseline Data: Application to the Wife's Wage

We now apply our statistical theory to the problem of imputing wives' wages.[15] The first task is to select a suitable data set that includes the wage rate. The University of Michigan Panel survey of Income Dynamics (PSID) was chosen because it was the only data set we could locate which included both wage rate and annual income data for a sample from the general population.

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15 Husbands' wages are not required for reasons given in Section III below.

The much larger Current Population Survey [U.S. Department of Labor] asks for income in March and the wage rate in May; while these could in principle be matched, we did not attempt to do so. The National Longititudinal Survey [U.S. Department of Labor, 1970], covers only specific age groups. The major disadvantage of the PSID is the absence of any families with very large incomes. While these families are relatively rare in the population, they are an important source of tax revenue. It would have been useful to have a recent data set in which the rich are oversampled, but none such exists.

The next step is to estimate with the PSID data a regression of the wife's wage on some function of those variables that are common to the PSID and TAXSIM. The set of common variables consists of: wife's earnings, husband's earnings, a dummy to indicate whether or not the wife is over 65, and the number of exemptions. A regression of the wife's wage rate on a set of variables that includes her earnings may at first seem rather strange. After all, since earnings is just the product of wage rate and hours worked, it is an endogenous variable. This observation, although correct, is quite beside the point. The statistical theory developed in the preceding section dictates only that we describe the joint distribution of the wage rate and the common variables, <u>not</u> that we estimate a valid structural equation.

After some experimentation, we selected a function second-order in both husband's and wife's earnings. The results are presented in the first column of Table II.1. A glance at the table indicates that the standard errors of the earnings variables are somewhat large relative to the size of the coefficients.

This is a consequence of multicollinearity among the five earnings variables, and is not a cause for concern, because it does not render the predictions biased.

The possibility remains that even given the common variables, other factors influence significantly the wife's wage. In order to see whether or not this was the case, we augmented the list of regressors with the following variables from the PSID: wife's education, wife's labor market experience, race, and wife's age.

As can be seen from the results in the second column of Table II.1, except for years of education, none of the variables adds significantly to the explanatory power of the equation. Will, then, the fact that education is not available for the imputation process lead to an important bias in our calculations? We think that any such bias will be minimal. Education is, after all, not available in the tax model precisely because it is not required to calculate taxes. To the extent that education is correlated with some variable in TAXSIM that is not in the PSID, there will be some bias, but it is reasonable to expect such correlations to be small.

There turned out to be a problem with the first regression of Table II.1 that lead us to reject it as a basis for our wage imputations -- the residuals were not homoscedastic. It was therefore difficult to specify the distribution of the residuals, a step which is required in order to assign the random component of the imputed wage. To remedy this difficulty we estimated separate regressions for each of three earnings categories. These results, which are reported in Table II.2, provided a considerably more homogeneous set of residuals,

Table II. 1

Wife's Wage Regressions*

	(1)	(2)
Constant	1.883 (.1725)	-.2926 (.3415)
Wife's Earnings	.2007 (.03188)	.1840 (.03174)
$(\text{Wife's Earnings})^2$	.01194 (2.295×10^{-3})	.009699 (2.278×10^{-3})
Husband's Earnings	.03551 (.01400)	.02049 (.01399)
$(\text{Husband's Earnings})^2$	1.144×10^{-4} (2.787×10^{-4})	7.0706×10^{-5} (2.7699×10^{-4})
(Wife's Earnings) x (Husband's Earnings)	01.734×10^{-5} (1.488×10^{-3})	.001016 (.001478)
Wife over 65**	.1389 (.3269)	-.1363 (.3488)
Number of Children	7.843×10^{-4} (.03203)	.02593 (.03226)
Wife's Education		.1668 (.02077)
Black**		-.09957 (.1610)
Wife's Age		.007086 (.004138)
Wife's Years of Labor Market Experience		.002968 (.003302)
S.E.E.	10.24	10.06
N	1808	1791

* Estimated from PSID. Earnings variables are measured in thousands of dollars. Variables in parentheses are standard errors.

** Dichotomous variables.

Table II.2

Wife's Wage Regressions By Earnings Class*

	$0 < e < 2500$	$2500 < e < 7500$	$7500 < e$
Constant	1.939 (.3485)	2.5599 (.7340)	-3.743 (1.695)
Wife's Earnings	.8703 (.4363)	-.1721 (.2937)	1.055 (.2542)
(Wife's Earnings)^2	-.3306 (.1618)	.0502 (.02883)	-.01547 (.01050)
Husband's Earnings	.001795 (.02599)	.07768 (.03021)	.1943 (.06958)
(Husband's Earnings)^2	-2.482×10^{-4} (3.886×10^{-4})	.001348 (3.7431×10^{-4})	-.001079 (.001529)
(Wife's Earnings)x (Husband's Earnings)	.03098 (.01484)	-.01612 (.005626)	-.009877 (.006135)
Wife over 65	-.1699 (.4563)	.8497 (.4739)	-.5405 (1.2119)
Number of Children	-.02310 (.05126)	.06594 (.03865)	-.1034 (.1073)
S.E.E.	10.69	7.95	13.03
N	703	810	295

* See footnotes to Table II.1

although not of an identifiable distribution. Therefore, the random component of the wage imputation was found by making a random selection from the set of estimated residuals. The imputed wage, then, is the sum of this residual and the conditional expected mean estimated from the appropriate equation from Table II.2.

Of course, for non-working wives this procedure could not be implemented because of the absence of a wage variable to serve as a regressand. Instead, a procedure was followed similar to that suggested by Hall [1973]. We estimated for the sample of working wives a regression of the wage rate on husband's income, number of dependents and an over 65 dummy variable, and used the results to impute wages to the non-workers. As is well-known, this procedure does not correct for the possible effects of selectivity bias. (See, e.g., Heckman [1979].) Given our paucity of explanatory variables, it seemed to us pretentious to attempt this rather subtle correction. Moreover, Hausman [1980, pp. 47,48] has pointed out that in cases like ours, the correction usually makes no practical difference anyway.

III. Behavioral Assumptions

We now turn to the question of how, given our figures on wages rates and hours of work, we can simulate the effects of various tax changes on work effort and the distribution of family income. In effect, our task is to specify the function $y(\cdot)$ of equation (3.5) that relates hours of work to exogenous variables and the tax code. The framework used is the standard microeconomic theory of the leisure-income choice.[16] The theory views the hours

16 For a comprehensive discussion of the theory the reader is referred to Heckman, et. al., [1979].

of work decision as an outcome when the individual maximizes a utility function subject to a budget constraint. This suggests an obvious way to organize our exposition: in part A of this section we discuss the budget constraint generated by the personal income tax system, and in part B we explain how preferences are modelled.

A. The Budget Constraint

Consider first the budget constraint faced by an untaxed individual with a wage w and unearned income I. The constraint can be represented graphically on a diagram with income plotted on the vertical axis, and hours of leisure on the horizontal. In Figure III. 1, if the individual's time endowment is OT hours, then the budget constraint is a straight line MN with slope $-w$ and vertical intercept $I(=TN)$. Behind the linear budget constraint are the assumptions that the fixed costs associated with working are negligible, and that the gross wage does not vary with hours of work. These assumptions are common to most studies of labor supply. Although the consequences of relaxing them have been discussed,[17] there is no agreement on whether or not they are important empirically. In this study, we retain the conventional assumption that the pre-tax budget constraint can be represented as a straight line.

Assume now that the individual is subjected to a proportional tax on both earned and unearned income. Then the effective budget constraint facing

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17 Hausman [1980] analyzes a model with fixed costs of work, and Rosen [1976] discusses a model in which full and part time workers receive different hourly wages.

Figure III.1

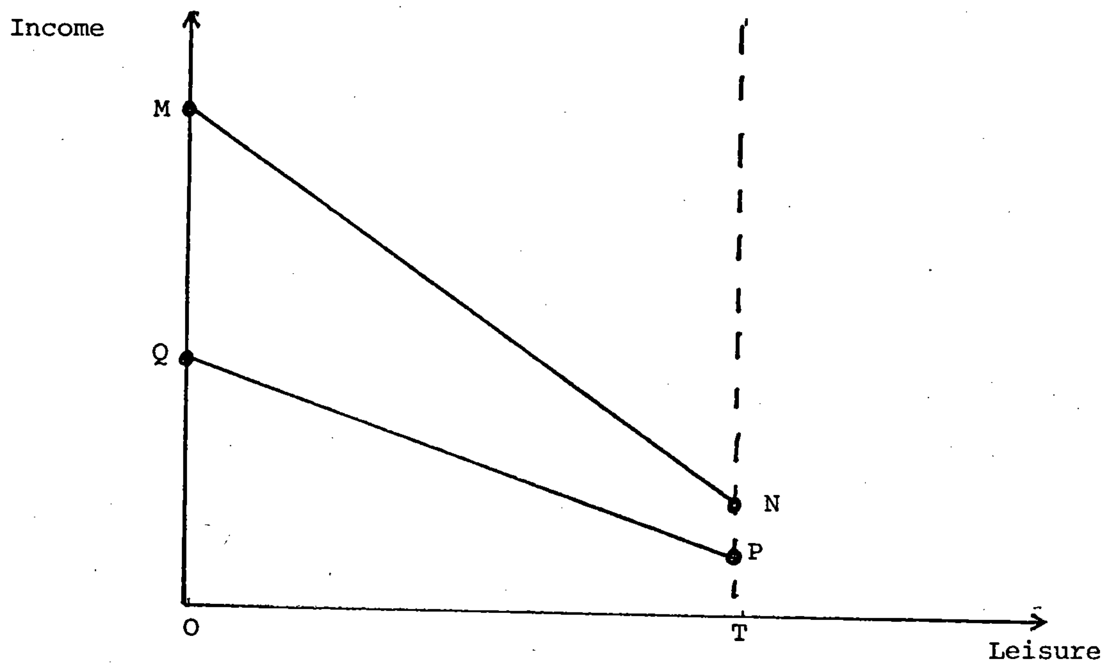
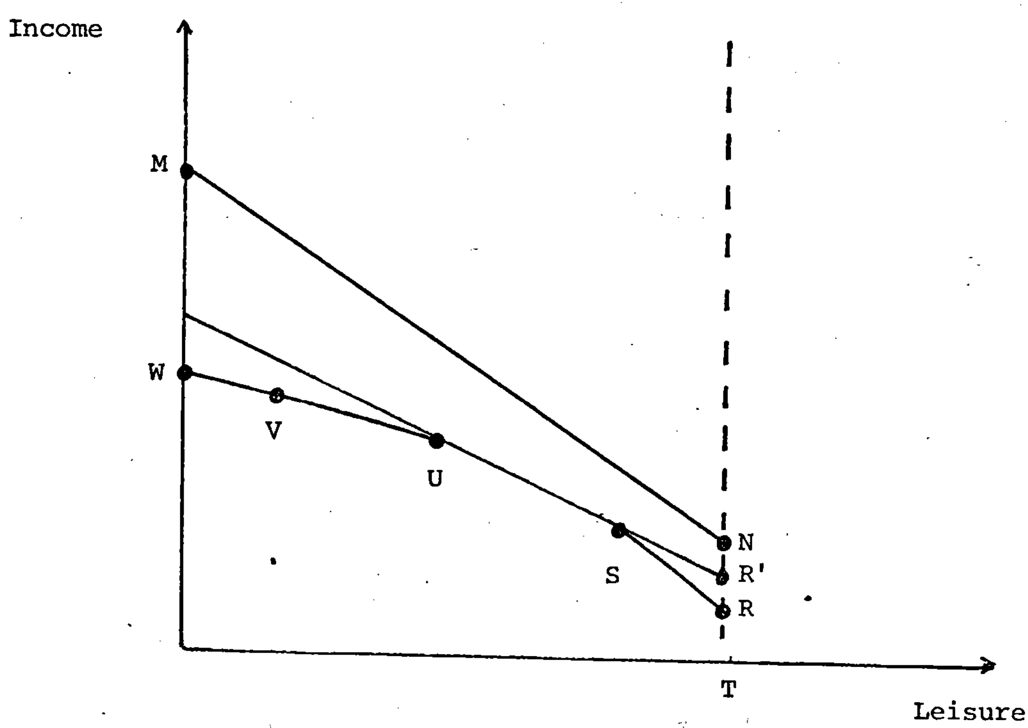


Figure III.2



the individual in figure III.1 is PQ, with the tax rate being NP/NT. Note that even with such a simple tax system, one would have to know both the uncompensated elasticity of hours with respect to the wage and the income elasticity in order to predict the impact of taxes upon hours of work.

Of course, the U.S. tax system is progressive with respect to taxable income, not proportional. As an individual's income bracket changes, she generally faces a discrete increase in the marginal tax rate. This leads to a kinked budget constraint like RSUVW in figure III.2. Observe that if the individual's optimum is along (say) segment US, then she behaves exactly as if optimizing along a linear budget constraint with the same slope as US, but with intercept OR'. This fact, which has been observed by Hall [1973] and others is extremely useful, because it allows us to characterize the individual's opportunities as a series of straight lines. The distance OR' will be referred to as "effective" non-labor income.

Included in the tax code are a complicated set of exemptions, deductions, and credits. Conceptually, it is not difficult to include their effects in the budget constraint -- all that is required is that we be able to compute net income at any given number of hours of work. It should be noted, however, that some tax provisions actually lead to non-convexities in the budget constraint. An important consequence of non-convexities is that there may be several points at which indifference curves are tangent to the budget constraint. In theory, then, the utility function must be evaluated along each segment of the budget constraint in order to find a global maximum. The specification of a complete utility function -- not just a labor supply curve -- thus becomes a necessity.

B. The Utility Function

In order to model preferences we must select both a functional form and specific numerical values for its parameters. One possibility is to choose a reasonable functional form, and then estimate the parameters ourselves. The most obvious problem with this approach is that in the TAXSIM model, there are simply not enough data to estimate a convincing labor supply function. As we have already noted, many of the important demographic and economic variables are absent.

Another option is for us to do the estimation using a more appropriate data base, and then assign the parameter values to the members of the TAXSIM sample. After considerable thought, this option was rejected. The evidence indicates that the substantive results of labor supply studies are quite sensitive to functional specification and econometric technique.[18] It is therefore unlikely that anyone would have viewed our results as definitive.

Instead, we choose to cull from the literature 'consensus' estimates of the wage and unearned income elasticities. Then, assuming some specific form for the utility function and taking advantage of duality theory, we work backwards to find the implied utility function parameters. Instead of confining ourselves to one set of parameters, we use several in order to determine the impact upon our substantive results. We discuss first the functional form selected to characterize preferences, and then explain how its parameter values are set.

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18 See the excellent survey by Heckman, et. al., [1979].

1. Functional Form

The standard static theory of labor supply behavior starts with a family utility function which depends upon family income and the amounts of leisure time consumed by each spouse. The labor supply of each spouse depends upon the net wages of both spouses and effective unearned income. Using several fairly reasonable assumptions, however, one can specify a family utility function with only two arguments: wife's leisure, and net family income. This simplification is permissible if the husband's labor supply is perfectly inelastic. In fact, many econometric studies of the labor supply behavior of married men have tended to show that both wage[19] and income effects are small in absolute value.[20] We therefore adopt the simpler model as a reasonable first approximation to reality.

Now that we have decided upon the arguments for the utility function, we turn to the question of its functional form. In making a selection, two criteria are important: (i) It should be simple, both to limit computational costs and to facilitate intuitive understanding of the results; and (ii) It should be broadly consistent with econometric estimates of labor supply.

Recently, Hausman [1980] has suggested that one way to satisfy these criteria is to start with a labor supply function that fits the data fairly well, and then take advantage of duality theory to find the underlying (indirect) utility function. More specifically, Hausman observes that the linear labor

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19. This includes own and cost wage effects. For households in which the wife is the primary earner, i.e., her earnings exceed the husbands, the wife's labor supply is assumed to be perfectly inelastic.

20 See, for example, Heckman, et. al., [1979, pp. II. 28, II. 34). Hausman [1980] also finds a small wage effect, but a fairly substantial income effect.

supply function has proved very useful in explaining labor supply behavior:

$$H = aw + bA + s \tag{3.1}$$

where H is annual hours of work, w is the net wage, A is effective income, and a, b, and s are parameters. Using Roy's Identity, which relates various derivatives of the indirect utility function to H, Hausman shows that the indirect utility function, $v(w,A)$, underlying (3.1) is

$$v(w,A) = \left(A + \frac{a}{b}w - \frac{a}{b^2} + \frac{s}{b}\right)e^{bw} \quad . \tag{3.2}$$

Given the ranges over which a particular individual's w and A will vary in our simulations, equations (3.1) and (3.2) seem to be adequate approximations, and they are adopted for use in this paper. We assign each family a set of utility function parameters calculated so that current behavior is perfectly predicted by equation (3.1). Specifically, assume that the hours elasticity with respect to the wage for the ith family is η_i^w, and the unearned income elasticity is η_i^A. Then a_i, b_i and s_i are the solutions to the system:[21]

$$\eta_i^w = \frac{w_i}{H_i}a_i \tag{3.3a}$$

$$\eta_i^A = \frac{w_i}{A_i}b_i \tag{3.3b}$$

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[21] Clearly, this procedure cannot be implemented for non-workers. For these individuals, the following <u>ad hoc</u> procedure is used: calculate the average H, w, and A for members of the individual's group who work between zero and one hundred hours. Substitute these means into system (3), and use the implied values of a, b, and s for the non-workers.

(3.3c) $s_i = H_i - a_i w_i - b_i A_i$

Up to this point we have discussed only the behavior of married couples. There are, of course, a substantial number of households headed by men and women without a spouse present. Not a great deal is known about the labor supply patterns of such people.[22] We assume in our simulations that the work behavior of these individuals is unaffected by the income tax. This assumption enables us to focus upon problems in the tax treatment of married couples. It also builds a conservative bias into our estimates of the aggregate behavioral response to change in the economic environment.

2. Elasticity Estimates

In order to solve equations (3.3), estimates of wage and unearned income elasticities for married women are required. The literature suggests fairly high values for the wage elasticity. The studies reviewed by Heckman, et. al, [1979] report values between 0.2 and 1.35 (pp. II.28, IV.3) and some investigators have proposed even larger estimates (See, e.g., Block [1973] or Rosen [1976].) There is virtually no guidance with respect to how the wage elasticity varies with income level. Indeed, due to the thinness of all statistical samples in very high income groups (i.e., family income greater than $35,000 in 1974) essentially nothing is known about the labor supply response of the women at the top end of the income scale.

Since we do not know with any confidence how η_i^w varies with income,

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Hausman [1980, p. 53] reports one study in which female heads of households have a substantial labor supply response, and another in which it is nil.

in a given simulation we simply assign all wives the same value. One set of simulations is performed with a value of 0.5, and another with 1.0 . The results are contrasted to those which emerge when it is assumed that there is no behavioral response whatsoever to the tax system.

Turning now to the setting of values for η_i^A , we find that here also the literature provides less than firm guidance. This is due in part to the problems involved in measuring correctly family unearned income. (Difficulties arise due to under-reporting, estimating imputed income from durable goods, etc.) In addition, unearned income is usually treated as an exogenous variable in hours equations, although theoretical considerations suggest that in a life cycle context, it is endogenous. Heckman and Killingsworth [1979] report that most investigators have found values of η_i^A between -.002 and -.0.200. We use a value of -0.100 in our simulations.

IV. Results

In this section we simulate the effects of four alternative approaches to the tax treatment of the family: (a) an exemption of 25% of the first $10,000 of secondary workers'earnings from taxation, (b) a tax credit of 10% on the first $10,000 of secondary workers' earnings, (c) taxation of the husband and wife as single individuals, with the tax base of each being half of total family income ("income splitting"), (d) choice between (i) taxation of the husband and wife as single individuals, with the tax base of each spouse being his or her own earnings plus one-half of family unearned income; or (ii) the <u>status quo</u>.

Regimes A and B maintain the existing general framework for taxation of the family. They can be viewed as attempts to ameliorate what some observers consider to be an unduly high tax burden on secondary earners.[23] Regimes C and D represent more serious departures from the status quo. Under regime C, the tax unit is the individual, but tax liability is half of family income. In effect, then, all family income is split. Regime D represents a substantial attempt to make individuals rather than families the units of taxation, because only unearned income is split.

There are, of course, an essentially unlimited number of ways in which the tax treatment of the family could be changed. We think that these four are of considerable interest both for policy purposes and for demonstrating the capabilities of our simulation model.

Because there appears to be considerable concern about the impact of alternative tax regimes on wives' labor supplies, the simulations of this section focus only on the population of married couples. Appendix B contains results for simulations with married and single people together. In order to keep the number of tables manageable, we present in this section only results for the case where η^w, the uncompensated supply elasticity for wives, is 1.0. Appendix C has results for the more conservative estimate of 0.5.

Each tax regime naturally induces a change in revenue collections. It is possible that in practice legislators might want to introduce additional adjustments to keep tax revenues constant. However, one cannot know what form these

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23 See, for example, Munnell [1978].

adjustments would take--changes in the rate schedules, deductions, and/or tax credits are all possibilities.[24] Indeed, at recent Congressional hearings, it was suggested that revenue shortfalls generated by changing the tax treatment of families be made up by a "windfall profits" tax on oil. In light of this ambiguity, we decided not to attempt here any revenue adjustments, although in future work we hope to develop some constant tax revenue estimates.

The current tax regime provides the benchmark to which the various tax reform proposals are compared. The key information is given in Table IV.1. For each adjusted gross income class, the table shows averages[25] of adjusted gross incomes, federal income tax liabilities, marginal tax rates, and hours of work per year supplied by wives. (Negative tax liabilities and marginal tax rates can rise because the 10% earned income credit is refundable.) As we expect, average and marginal tax rates tend to rise with AGI class. The number of hours worked tends to rise with income, but the relationship is not strictly increasing. As "other family income" increases, there is an income effect which tends to decrease the number of hours that wives work.[26] However, there is

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[24] And of course, there is no assurance that there would be a desire to maintain the tax collections associated with the <u>status quo</u>. Legislators might want to accompany the tax reform with a general increase or decrease in revenues.

[25] Sample population weights are used to compute these and all other averages.

[26] This is under the assumption that leisure is a normal good, which is consistent with both casual observation and econometric evidence.

Table IV.1

The Status Quo--1979

AGI Class	Number of Returns	Average AGI	Tax Liability	Marginal Tax Rate	Hours Worked Per Year
< 5000	1,177,081	2,973	-49	-0.03	235
5-10000	4,441,634	7,669	41	0.15	481
10-15000	8,431,342	12,424	965	0.17	568
15-20000	8,446,110	17,469	1,818	0.26	613
20-30000	15,239,496	24,329	3,055	0.26	829
30-50000	8,915,744	36,548	6,424	0.34	1037
50-100000	1,662,893	66,211	16,480	0.41	658
> 100000	66,002	178,427	68,729	0.55	833
Means		24,184	3,831	0.241	732
Totals	48,780,302	1.180×10^{12}	1.869×10^{11}		$3,573 \times 10^{10}$

also a tendency for the wife's pretax wage to be positively correlated with other family income, which encourages work in the market (assuming a positively sloped supply of hours schedule). One cannot say *a priori* which effect will dominate.

We now examine how each proposal would change the *status quo*.

A. Exemption of 25% of Secondary Worker's Earnings[27]

Table IV.2 shows the effects of allowing the family to deduct 25% of the first $10,000 of the wife's earnings. In order to allow comparability with Table IV.1, the adjusted gross income classes are those associated with the *status quo*.

The exemption has a substantial impact on labor supply. As comparison of the last column with table IV.1 suggests, on average wives supply 34 more hours per year than they do under the current system. The increases are most marked in the higher income brackets. For example, in the $50-100,000 AGI class, annual hours increase by slightly more than 50. This is because the wives in the higher tax brackets experience the greatest increase in the net wage, *ceteris paribus*.

On average, tax collections from couples fall by about 5%. In the middle income ranges there is a tendency for the percentages decrease in tax liability to increase with income. For the sake of comparison, we have noted in the second column of IV.2 what the revenue predictions would have been had we

27 This is similar in spirit to the Conable bill, H.R. 6822, which gives a 10% exemption to the first $20,000 of the lower earner's income, but only if the couple is subject to the marriage penalty. See Sunley [1980].

Table IV.2

Exempt 25% of First $10,000 of Secondary Worker's Earnings

AGI Class	Tax Liability (Exogenous Behavior)	Tax Liability ($\eta^w = 1.0$)	Marginal Tax Rate	Hours Worked Per Year
< 5000	-49	-49	-0.03	235
5-10000	17	20	0.14	488
10-15000	919	920	0.16	572
15-20000	1705	1717	0.23	637
20-30000	2776	2817	0.22	874
30-50000	5877	5992	0.29	1100
50-100000	15922	16114	0.36	712
> 100000	68539	68647	0.52	853
Means	3594	3637	0.20	766
Totals	1.753×10^{11}	1.774×10^{11}		3.737×10^{10}

postulated perfectly inelastic labor supplies for wives. The figures suggest that about one-fifth of the shortfall in tax revenues is restored as a consequence of the increased tax base associated with higher labor supply. Although this is a far cry from the claims of some that tax reductions on earned income will be self-financing, it is enough of a difference to demonstrate the importance of allowing for endogenous behavioral responses.

B. Tax Credit for 10% of Secondary Workers' Earnings

Under this regime, the family can deduct from its tax bill an amount equal to 10% of the secondary worker's earnings up to a maximum of $10,000. The results are shown in Table IV.3. Interestingly, there are only very small changes in hours of work, and these tend to be in a negative direction. For some individuals in the sample, the credit leads to decreases in marginal tax rates, tending to increase labor supply. For others, the credit has no impact on marginal earnings, and thus generates only an income effect, which tends to decrease labor supply. The two effects just about cancel each other. We had anticipated that the tax credit would have a substantial positive effect upon labor supply. The fact that it did not convinces us further of the dangers of intuiting behavioral responses to changes in a complicated tax system.

Because the tax credit generates only a small change in labor supply, there is essentially no difference between the tax liabilities associated with exogenous and endogenous behavior. It is interesting to note, however, that the credit costs more than the exemption (in terms of foregone tax revenues), despite the fact that the former induces less labor supply than the latter.

Table IV.3

Tax Credit of 10% on First $10,000 of Secondary Worker's Earnings

AGI Class	Tax Liability (Exogenous Behavior)	Tax Liability ($\eta^w = 1.0$)	Marginal Tax Rate	Hours Worked Per Year
<5000	-61	-60	-0.03	235
5-10000	-8	-9	0.15	480
10-15000	876	873	0.17	565
15-20000	1649	1647	0.26	610
20-30000	2719	2713	0.26	824
30-50000	5940	5931	0.34	1033
50-100000	16139	16133	0.41	656
>100000	68631	68632	0.55	832
Means	3576	3572	0.252	729
Totals	1.744×10^{10}	1.742×10^{11}		3.557×10^{11}

C. Complete Income Splitting

As we noted earlier, there is now considerable sentiment for the view that, at least for income tax purposes, married people should be treated as much as possible like single people. In this and the succeeding section, we consider the effects when both spouses face the tax schedule that is currently faced by single individuals. In this section, we assume that the tax base for each spouse is one-half of total family income, both earned and unearned. Although we characterize this as "income splitting," note that it differs from the conventional use of that term, because we not only divide income, but apply a different rate schedule as well (i.e., the schedule that single persons currently face). In section D, we assume that only unearned income is split.

The income splitting results are in Table IV.4. As one would expect, tax revenues go down compared to the status quo -- the shortfall for couples is about $28 billion. On the average, hours of work by secondary workers increase by about 40, but interestingly, for some income groups, work effort actually falls. Despite the fact that income splitting generally leads to a substitution effect that increases labor supply, there is also an income effect which tends to reduce it. Apparently, the substitution effect dominates in the upper income groups, while in some of the lower income groups the income effect dominates. Even given very simple assumptions on the structure of preference, it is not safe to assume that labor supplies for different groups will change in the same direction.

Because the current tax system tends to benefit married couples with only one earner, it is of some interest to examine how the tax burdens of

Table IV.4

Split All Income

AGI Class	Tax Liability (Exogenous Behavior)	Tax Liability ($\eta^w = 1.0$)	Marginal Tax Rate	Hours Worked Per Year
<5000	-54	-54	-0.03	235
5-10000	-338	-319	0.00	575
10-15000	312	290	0.20	539
15-20000	1459	1449	0.25	619
20-30000	2714	2799	0.22	910
30-50000	5583	5663	0.29	1066
50-100000	13875	14202	0.33	751
>100000	62192	62195	0.53	840
Means	3210	3258	0.214	771
Totals	1.566×10^{11}	1.589×10^{11}		3.761×10^{10}

one versus two earner families[28] would change under this tax regime. The results are shown in Table IV.4a. Columns (2) and (3) show how income taxes change for two-earner families, and (6) and (7) give the same information for single earner families. On average, tax liabilities for single earner families fall by a slightly greater proportion than those for two earner families. This somewhat surprising result occurs because the single earner families benefit especially from the splitting of non-labor income.

D. Optional Single Filing

This regime gives married couples two options. The first is for each spouse to file as an individual and face the same rate schedule as a single person. Each spouse's tax base is the sum of his or her earned income, plus one-half of family unearned income. Deductions and exemptions are allocated in proportion to income.[29] In principle, proponents of individual taxation would probably want to include in a given spouses' tax base only the income deriving from his or her property. This would be impractical, however, because: (a) much property is jointly owned, and (b) spouses might transfer property to each other in order to minimize the family tax burden. It seems to us that imposing equal division of unearned income is a reasonable way to proceed.[30]

The family's second option is to continue filing jointly as it

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[28] To make this distinction operational, we define a single earner as one in which the minimum of the earnings of the two spouses is less than $1000.

[29] The Fenwick bill would allocate each itemized deduction to the spouse who actually makes the payment. As Sunley [1980] points out, this would lead to great complications in tax planning.

[30] In contrast, the Fenwick bill, H.R. 3609, allocates unearned income on the basis of ownership. (See Sunley [1980].)

Table IV.4a

One Versus Two Earner Families Under Regimes C and D*

	"Two Earner" Families				"Single Earner" Families			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
AGI Class	Average AGI	Status Quo Taxes	Taxes: Regime C	Taxes: Regime D	Average AGI	Status Quo Taxes	Taxes: Regime C	Taxes: Regime D
<5000	4150	-269	-269	-269	2649	12	5	12
5-10000	8079	224	-139	112	7434	-64	-422	-69
10-15000	12039	799	117	548	12627	1051	380	997
15-20000	17646	1798	1347	1449	17333	1834	1528	1673
20-30000	24531	3230	3008	2764	24116	2872	2580	2743
30-50000	35555	6121	5422	5447	38300	6959	6087	6685
50-100000	62154	14714	12999	12602	69525	17924	15186	14668
>100000	169465	62532	56280	55795	180285	70013	63422	63105
Means	24928	3744	3229	3226	23533	3908	3284	3579
Totals	5.678×10^{11}	8.527×10^{10}	7.355×10^{10}	7.349×10^{10}	6.119×10^{11}	1.016×10^{11}	8.539×10^{10}	9.305×10^{10}

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* Regime C is complete income splitting. Regime D is optional single filing.

does under the current regime. The simulation program computes the utility level associated with each option (using equation (3.2)). The family is assumed to choose whichever option maximizes utility.

The outcomes are shown in Table IV.5. What is most striking about this regime is the enormous amount of labor supply generated -- an average increase of about 80 hours per year. At the same time, tax revenues from couples fall by more than 10% as approximately half the families take advantage of individual filing to lower their tax liabilities.

Again, it is of some interest to compare the effects of this tax regime on one versus two earner families. This can be done by consulting Table IV.4a. Columns (2) and (4) indicate that tax liabilities for two earner families fall by about 13%; columns (6) and (8) suggest that tax liabilities for single earner families fall by only 8%. Although single earner families gain to some extent by the ability to split unearned income, the major advantages go to those couples who no longer have to pay the "marriage tax."

V. Concluding Remarks

In this paper we simulated the effects of alternative tax treatments of the family using a model which allows for the possibility of tax induced changes in labor supply behavior. In order to do so, several methodological problems had to be solved. It was especially important to develop a statistical procedure for imputing values to missing variables. We hope that our "random imputation" technique will be useful to other investigators in a wide variety of applications.

Table IV.5

Optional Single Filing

AGI Class	Tax Liability (Exogenous Behavior)	Tax Liability (η^w=1.0)	Marginal Tax Rate	Hours Worked Per Year
<5000	-49	-49	-0.03	235
5-1000	-29	-3	0.13	522
10-15000	826	843	0.15	592
15-20000	1554	1576	0.19	692
20-30000	2662	2754	0.22	932
30-50000	5708	5895	0.28	1162
50-100000	13392	13739	0.29	829
> 1000000	61480	61850	0.47	872
Means	3327	3414	0.206	815
Totals	1.623×10^{11}	1.665×10^{11}		3.978×10^{10}

Using the statistical methodology, we examined tax reform proposals that represented both minor and major departures from the current regime. These included various types of preferential treatment for the earnings of secondary workers as well as new rules governing the impact of marriage upon filing status. In a number of cases, we found that failure to allow for an endogenous labor supply response would have lead to substantial errors in the revenue estimates. This was true even though the behavioral elasticities we postulated were rather modest in size.

We were often surprised about the directions and magnitudes of the behavioral responses to tax changes. Despite the very simple preference structure that we postulated, "back of the envelope" estimates about what would happen in a given simulation often turned out to be wrong. In a complicated tax structure with discretely changing marginal tax rates, income effects can induce unexpected responses.[31]

In order to point out directions for future research, it is useful to consider some questions that a skeptical reader might raise:

1. What about the labor supply response of husbands?

We have assumed that the labor supply of husbands is perfectly inelastic. As noted in Section III, this assumption is broadly consistent with the econometric literature. However, the possibility remains that for both sexes other dimensions of labor supply -- human capital decisions, time of retirement, choice of occupation -- might be affected by the tax system. Unfortunately, practically nothing is known about whether or not such effects

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31 Hausman [1980] has raised this point in a slightly different context.

exist.[32] As evidence on these issues begins to accumulate, presumably it can be incorporated into TAXSIM.

2. What about life cycle effects?

The foundation of this paper has been the standard static model of leisure-income choice. In theory, it would probably be better to examine labor supply decisions in a life cycle context. To do so, however, would complicate the analysis immensely, as well as increase our data requirements -- longitudinal data would be required. If a life cycle analysis were successfully undertaken, it would allow us to account for changes in the demographic structure of the population, as well as to show how various tax policies affect individuals according to lifetime, rather than current, income classes. Although the lack of a life cycle perspective clearly limits the usefulness of our results for analyzing very long run effects, a shorter horizon is probably more relevant for the current policy discussion.

3. What about general equilibrium considerations?

Our simulations assume that pretax wages and interest rates remain constant despite the presence of some substantial changes in labor supply. It would clearly be desirable to make gross factor returns endogenous. Unfortunately, if we want detailed and careful information on tax burdens by income class, marital status, or virtually any other characteristic, a very large micro data set is necessary. Setting up a useful general equilibrium model in this context presently appears infeasible. It should be noted

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32 See Rosen [1980].

that existing general equilibrium models of tax incidence assume a relatively small number of classes of individuals. (See, e.g., Fullerton, et. al. [1978].)

4. What about macroeconomic considerations?

The previous question concerned how much the gross wage might change if people desired to work more hours; here it is asked whether or not the hours could be absorbed by the economy at all. It is beyond the scope of this paper to develop a complete macroeconomic model of the employment effects associated with tax reform. We merely note that a case can be made that with proper monetary and fiscal policies, additional labor supply could be absorbed by the economy.[33] Similarly, we have made no attempt to assess how the macroeconomic feedbacks due to changing tax revenues might affect our substantive results.

Thus, although we believe that the simulations in this paper are sufficiently careful to be considered seriously in the debate on tax policy, a good deal of work remains to be done.

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[33] See, for example, Feldstein [1972].

Appendix A

About 70% of taxpayers in 1974 did not itemize their personal deductions (medical and dental expenses, interest payments, local taxes paid, etc.), but accepted instead the standard deduction. The standard deduction was then 15% of adjusted gross income with a minimum of $1,300 and a maximum of $2,000. Because some of the tax code changes we study would affect the decision to itemize deductions, it is important that this decision be endogenous to the model. Hence, we must make an estimate of deductible expenses incurred by non-itemizers. The purpose of this appendix is to explain how deductible expenses were imputed to non-itemized returns.

Rather than use some extraneous data source, we have simply assumed that the distribution of deductible expenses follows a log-normal distribution (conditional on income), and that the parameters of this function may be inferred from the truncated sample. With these parameters known, random deviates with the correct conditional distribution may be used as proxies for the unknown expenses. If the distribution is correctly modeled, and reflects the influence of all the variables on the tax return, then our estimates of tax rate (or any other functions of items on the tax return) will be unbiased.

This procedure ignores possible price effects of itemization on expenditure. This is permissible because we require only an estimate of deductible expenses at the prices associated with itemization rather than an estimate of actual deductible expenditures by non-itemizers.

The probability of a joint return showing itemized deductions depends strongly on income, ranging from less than 1% at incomes less than $5,000 to more than 99% at incomes over one million dollars, but it does not seem to relate to any other available variables. For example, our regressions indicated that the number of dependents living at home, which might plausibly influence mortgage interest and medical bills, did not influence significantly either the decision to itemize or the amount of itemized deductions for those who did itemize.

The sample was divided into nine income categories. It was assumed that for each category except the first (AGI less than $5,000) a truncated log normal distribution characterized the observed distribution of deductions. Two alternative means were used to recover the parameters of the untruncated distribution:

1. Where the point of truncation is known, Cohen (1951)[34] provides formulae for estimating the mean and variance of an underlying distribution from the first three moments of an observed truncated distribution. (Remarkably, these are in closed form.) If v_i is the ith moment of the observed distribution and c is the truncation point, then

$$u = c + (2v_1v_2 - v_3) / (2v_1^2 - v_2)$$

and

$$s = (v_1 v_3 - v_2^2) / (2v_1 - v_2)$$

are the estimates of the mean and standard deviation of the underlying normal

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34 The formula for the mean given here differs from that given in Cohen's paper due to a typographical error in that paper. This error is unfortunately perpetuated by Johnson and Kotz [1970].

distribution. Estimates are presented in Table A.1, in the columns labeled "Cohen."

2. The second approach is to estimate u and s as parameters of the regression

$$\ln D_j = u + \frac{1}{s}[F^{-1}(P_j)] + e$$

where D_j is the amount deducted by the jth household, $F^{-1}(\cdot)$ is the inverse of the cumulative normal distribution, and P_j is the observed sample probability that $D < D_j$. These results are given in Table A.1 under the headings "Regression."

It is comforting to note that at least in the middle income categories where there is a nearly even split between itemizing and not itemizing, there is reasonable agreement between the results generated by the two procedures. However, neither procedure produced (or was really expected to produce) reasonable results in the lowest income category, and here the values of $u = 6.5$ and $s = 0.5$ were imposed.

With the parameters u and s in hand, the actual imputations are quite straightforward. Let c = the log of the standard deduction. Then the probability of not itemizing is $F(\frac{c-u}{s})$. Now let x be a random variable distributed uniformly on the interval $[0, 1]$. Then $\{F^{-1}(x)s + u\}$ is a normal random deviate with mean u and standard deviation s, and $\{F^{-1}(xF(\frac{c-u}{s}))s + u\}$ is a random deviate from the truncated distribution below the point of truncation. The imputations are found, then, by having the computer generate values for x, and substituting values of u and s from Table A.1. It turned out that the imputations using the parameters from procedure 2 seemed more reasonable than those from Cohen's method so the former were used.

Table A.1

The Distribution of Deductible Expenses by Income Class

Income	Estimated Mean (μ) Cohen	Estimated Mean (μ) Regression	Estimated Standard Deviation(s) Cohen	Estimated Standard Deviation(s) Regression	Median* Itemized Deductions	Mean AGI
5,000					0	3795
5,000 - 10,000	8.01	7,28	.167	.596	0	8199
10,000- 15,000	8.10	7.75	.34	.527	0	12706
15,000- 20,000	8.31	8.21	.2	.373	8.03	17456
20,000- 50,000	8.53	8.40	.133	.497	8.43	27503
50,000-100,000	9.24	9.18	.602	.655	9.22	66562
100,000- 500,000	9.89	9.89	.804	.910	9.88	154225
500,000-1,000,000	11.51	11.28	1.24	1.27	11.53	674093
1,000,000	12.19	12.32	.616	1.38	12.27	1,952,799

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* Median of log of itemized deductions for each income class, computed directly from the data. The value of zero is assigned for classes in which less than half the sample itemized deductions.

Appendix B

In the text, we report simulation results only for the subsample consisting of married couples. This is in order to focus attention on the impact of taxation on wives' labor supply. Of course, for revenue projection purposes, the entire sample is relevant, and these results are presented here. Table B.1 has information for the current system. Table B.2 shows how tax revenues vary by adjusted gross income class for each of the tax regimes described in section IV. We show revenues assuming both: (a) no behavioral response, and (b) wage and income elasticities of 1.0 and -0.1, respectively, for married women.

Table B.1

The Status Quo--1979

(Marrieds and Singles)

AGI Class	Returns	Average AGI	Tax Liability	Marginal Tax Rate
< 5000	6,323,365	2,173	-18	-0.01
5 - 10000	13,520,001	7,595	379	0.18
10- 15000	17,197,557	12,431	1,278	0.21
15- 20000	11,502,705	17,420	1,983	0.27
20- 30000	17,500,605	24,117	3,192	0.27
30- 50000	9,899,335	36,829	6,719	0.35
50-100000	1,800,712	66,166	16,795	0.42
> 100000	510,856	180,072	69,576	0.55
Means		19,530	3,042	.235
Totals	78,255,136	1.528×10^{12}	2.380×10^{11}	

Table B.2

Tax Revenues Under Alternative Tax Regimes
(Marrieds and Singles)

AGI Class	Regime A* Tax Liability (Exogenous Behavior	Regime A* Tax Liability (η^w=1.0)	Regime B* Tax Liability (Exogenous Behavior)	Regime B* Tax Liability (η^w=1.0)	Regime C* Tax Liability (Exogenous Behavior)	Regime C* Tax Liability (η^w=1.0)	Regime D* Tax Liability (Exogenous Behavior)	Regime D* Tax Liability (η^w=1.0)
< 5000	-18	-18	-18	-20	-19	-19	-18	-18
5-10000	372	373	380	364	255	262	357	366
10-15000	1257	1255	1279	1236	959	948	1211	1219
15-20000	1900	1909	1983	1859	1720	1712	1790	1805
20-30000	2949	2985	3193	2900	2895	2970	2850	2930
30-50000	6227	6330	6720	6284	5962	6034	6075	6243
50-100000	16279	16452	16794	16479	14388	14691	13942	14263
> 100000	69403	69502	69576	69487	63613	63617	62964	63301
Means	2893	2920	3042	2882	2654	2684	2727	2781
Totals	2.264×10^{11}	2.285×10^{11}	2.380×10^{11}	2.255×10^{11}	2.077×10^{11}	2.101×10^{11}	2.134×10^{11}	2.177×10^{11}

* Regime A: Exemption of 25% of first $10,000 of secondary worker's earnings.

Regime B: Tax credit of 10% on the first 10% of secondary worker's earnings.

Regime C: Complete income splitting

Regime D: Optional individual filing.

Appendix C

We argued in the text that for married women's hours of work, values of 1.0 and -0.1 are reasonable estimates of the wage and income elasticities, respectively. Nevertheless, it seems worthwhile to re-do the simulations assuming a more conservative value of 0.5 for the wage elasticity. The results are reported in Tables C.1 through C.4. There is an exact correspondence between these tables and Tables IV.2 through IV.5 of the text. Both sets of tables look at the same tax regimes as they affect the subsample of married couples. The only difference is in the assumed value of the wage elasticity.

Of course, by construction the behavioral responses in this appendix are muted compared to their counterparts in section IV. However, it is striking that allowing for even a very mild behavioral response has significant effects on both tax revenues and hours of work.

Table C.1

Exempt 25% of First $10,000 of Secondary Worker's Earnings

AGI Class	Tax Liability (Exogenous Behavior)	Tax Liability (η^w=0.5)	Marginal Tax Rate	Hours Worked Per Year
< 5000	-48	-48	-0.03	235
5-10,000	17	20	0.14	488
10-15,000	919	920	0.16	572
15-20,000	1705	1717	0.23	637
20-30,000	2776	2816	0.22	875
30-50,000	5877	5992	0.29	1100
50-100,000	15923	16115	0.36	712
> 100,000	68539	68647	0.52	853
Means	3593	3637	0.220	766
Totals	1.753×10^{11}	1.774×10^{11}		3.737×10^{10}

Table C.2

Tax Credit of 10% on First $10,000 of Secondary Worker's Earnings

AGI Class	Tax Liability (Exogenous Behavior)	Tax Liability (η^w=0.5)	Marginal Tax Rate	Hours Worked Per Year
< 5000	-61	-60	-0.03	235
5-10,000	-8	-9	0.15	480
10-15,000	876	875	0.17	565
15-20,000	1649	1647	0.26	610
20-30,000	2719	2714	0.26	824
30-50,000	5941	5931	0.34	1033
50-100,000	16140	16133	0.41	656
> 100,000	68631	68631	0.55	832
Means	3576	3572	0.252	729
Totals	1.744×10^{11}	1.742×10^{11}		3.557×10^{10}

Table C.3

Split All Income

AGI Class	Tax Liability (Exogenous Behavior)	Tax Liability (η^w=0.5)	Marginal Tax Rate	Hours Worked Per Year
< 5000	-54	-54	-0.03	235
5-10,000	-338	-333	-0.01	528
10-15,000	312	295	0.20	551
15-20,000	1459	1452	0.25	614
20-30,000	2714	2759	0.22	874
30-50,000	5583	5621	0.29	1051
50-100,000	13876	14038	0.33	704
> 100,000	62191	62191	0.53	835
Means	3210	3233	0.214	752
Totals	1.566×10^{11}	1.577×10^{11}		3.670×10^{10}

Table C.4

Optional Single Filing

AGI Class	Tax Liability (Exogenous Behavior)	Tax Liability (η^w=0.5)	Marginal Tax Rate	Hours Worked Per Year
< 5000	-49	-49	-0.03	235
5-10,000	-29	-13	0.13	503
10-15,000	826	838	0.15	585
15-20,000	1555	1568	0.18	659
20-30,000	2662	2713	0.22	884
30-50,000	5708	5805	0.27	1102
50-100,000	13392	13563	0.28	753
> 100,000	61480	61670	0.47	852
Means	3327	3374	0.202	778
Totals	1.623×10^{11}	1.646×10^{11}		3.796×10^{10}

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