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Abstract

The welfare impact of the 2001 income tax reform is assessed across dual-earner families with different characteristics. A household labor supply model is estimated to account for variable behavioral responses by family type. It was found that while higher education families received a larger share of the welfare gain generated from lower marginal tax rates, it was the lower education families that provided the bulk of the additional labor supply motivated by the tax reform. Differing welfare gains across families with different numbers of children were also found, highlighting the importance of allowing responses to vary across family characteristics when assessing the welfare impact of a policy change.

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I. Introduction

The purpose of this paper is to estimate differences in family labor supply decisions across different dual earner family types. Thorough assessment of the impact of policy on behavior, thus the impact of policy on the economy, requires that we have an accurate understanding of how a policy change affects behavior and how behavior varies across families. This is especially true when the impact of the policy depends on characteristics of a family.[1] The analysis in this paper estimates utility function parameters in the context of a neoclassical joint utility framework to assess the impact of the 2001 tax reform on families distinguished by the educational level of the husband and by number of children in the family. The focus of the analysis is on the impact of the tax reform on the labor supply decisions and welfare of dual-earner families only. The analysis illustrates that accounting for differences in preferences and behavioral responses across family characteristics is necessary to obtain a thorough understanding of the distributional impact of a policy change on family welfare.

II. Background

In June 2001, the Economic Growth and Tax Relief Reconciliation Act of 2001 (2001 tax reform) was the first major tax reform since the Tax Payer Relief Act of 1997. The primary features of the 2001 tax reform were the reductions in the highest income tax brackets (from 28, 31, 36 and 39.6 percent to 23, 28, 33, and 36 percent, respectively); a new lowest tax bracket of 10 percent (the former lowest bracket was 15 percent); expansion of the child credit and the

[1] Hotchkiss and Moore (2002) show that even for a policy that is expected to have uniformly positive economic impact, the implications for family welfare can vary across income groups.

Earned Income Tax Credit. There were other changes that affected the Alternative Minimum tax, personal exemptions, and itemized deductions.[2] All in all, the change in the tax code was extremely complicated and spawned a host of analyses that investigated the practical significance of the changes on family net income across the income distribution (for example see Gale and Potter 2002, Citizens for Tax Justice 2002, Johnson et al. 2006).

The conclusions of those analyses differ based on which side of the political spectrum the investigator resided. While differing in their conclusions, the one thing all of these assessments have in common is that they exclusively look at the impact on income and/or consumption, not accounting for any potential changes in labor supply behavior.[3] A unique contribution of this paper is that it allows for changes in labor supply decisions that might result from changes in the net wage family members expect to earn as a result of the tax reform. Taking these behavioral changes into account, the impact of the tax reform on family welfare can be assessed and compared across families with different characteristics.

III. Methodology

The goal of this paper is to quantify changes in family welfare, rather than account specifically for how decisions are made within the family. Therefore, we model family labor supply decisions in a neoclassical joint utility framework. This model can be thought of as a reduced-form specification of family decision making. The model yields a clean-cut expression of family welfare that allows for cross wage effects on each member's labor supply decision.

[2] The 2001 tax reform was followed closely by the Jobs and Growth Tax Relief Reconciliation Act of 2003 which had the effect of accelerating some of the 2001 provisions and reducing capital gains taxes even more. The Working Families Tax Relief Act of 2004 accelerated the full phase-in of the child tax credit.

[3] Auerbach (2002) explores the savings behavior implications and feedback impact of the 2001 tax reform.

Bargaining models do not reveal parameter values for a *family* utility function because the family is not the unit of analysis (rather each spouse in the family is).[4] In addition, there is some evidence that the choice of structure for household decision making has very little implication for conclusions regarding labor supply responses or impact on welfare of tax policy changes (see Bargain and Moreau 2003).

Within the framework of the neoclassical family labor supply model, a family maximizes a utility function that is a function of the husband's leisure, the wife's leisure, and their joint consumption, subject to a single budget constraint:

$$\begin{aligned} &\underset{(L_1,L_2,C)}{Max}\ U = U(T-h_1, T-h_2, C) \\ &\text{subject to } X = w_1 h_1 + w_2 h_2 + Y \end{aligned} \tag{1}$$

T is total time available for an individual, $L_1 = T - h_1$ is the husband's leisure, $L_2 = T - h_2$ is the wife's leisure, h_1 is the labor supply of the husband, h_2 is the labor supply of the wife, X is total money income (or consumption with price equal to one), w_1 is the husband's after-tax market wage, w_2 is the wife's after-tax market wage, and Y is after-tax unearned income. Although we refer to L_1 and L_2 as the "leisure" of the husband and wife, respectively, they actually correspond to all uses of non-market time, including home production activities. In order to abstract from decision making on the extensive margin (that is, entry into and exit from the labor market), evaluation of the impact of the tax reform of 2001 will be undertaken for dual earner families only.

The implications of limiting the analysis to dual earner families only will likely be most pronounced at the lower end of the income distribution. Expansion of the EITC has been found

[4] See McElroy (1990: 560) for a description of neoclassical and Nash-bargained models of household behavior. Also see Hotchkiss, Kassis, and Moore (1997) and Friedberg and Webb (2006).

to have a greater impact on labor force participation than on hours of work decisions (Eissa and Liebman 1995).[5]

The solution to the maximization problem in equation (1) can be expressed in terms of the indirect utility function, which is solely a function of the wages of the husband and wife and unearned income of the family:

$$V(w_1, w_2, Y) = U\left\{\left[T - h_1^*(w_1, w_2, Y)\right], \left[T - h_2^*(w_1, w_2, Y)\right], \left[w_1 h_1^*(w_1, w_2, Y) + w_2 h_2^*(w_1, w_2, Y) + Y\right]\right\} \quad (2)$$

where $h_1^*(w_1, w_2, Y)$ and $h_2^*(w_1, w_2, Y)$ correspond to the optimal labor supply equations for the husband and wife, respectively. In order to capture the total effect of the change in after-tax income resulting from the 2001 tax reform, the indirect utility function is totally differentiated:

$$dV = -U_1 dh_1 - U_2 dh_2 + U_3 dX \quad (3)$$

where U_1 is the family's marginal utility of the husband's leisure, U_2 is the family's marginal utility of the wife's leisure, and U_3 is the family's marginal utility of consumption. Equation (3) makes it clear that the change in welfare not only depends on the labor supply response, but also on the family's marginal evaluation of a change in leisure and income. Theoretically, labor is supplied to the extent that the marginal utility of leisure is equal to the market wage, suggesting that, within a family, if husbands are paid more than wives, that $U_1 > U_2$. In addition, lower estimates of the marginal utilities of leisure would be consistent with greater values of labor supply, ceteris paribus. As the additional utility gained from an additional dollar of income increases at a decreasing rate, we would expect U_3 to be smaller for higher income families. It is

[5] Noonan et al. (2005) also identify a strong impact of increasing EITC generosity on the labor force participation of single mothers. Also see Eissa et al. (2004).

because of these theoretically expected differences across family characteristics (namely, wages and preferences) that the utility function parameters will be estimated separately by family type.

Expressed in terms of changes in wages and unearned income, and re-arranging terms to illuminate the contribution of those changes to family welfare through their impact on husband's labor supply, wife's labor supply, and total family income, the total derivative in equation (3) becomes:

$$\begin{aligned} dV = & -U_1\left(\frac{\partial h_1}{\partial w_1}dw_1+\frac{\partial h_1}{\partial w_2}dw_2+\frac{\partial h_1}{\partial Y}dY\right) \\ & -U_2\left(\frac{\partial h_2}{\partial w_1}dw_1+\frac{\partial h_2}{\partial w_2}dw_2+\frac{\partial h_2}{\partial Y}dY\right) \\ & +U_3\left[\left(w_1\frac{\partial h_1}{\partial w_1}+h_1+w_2\frac{\partial h_2}{\partial w_1}\right)dw_1+\left(w_1\frac{\partial h_1}{\partial w_2}+h_2+w_2\frac{\partial h_2}{\partial w_2}\right)dw_2\right. \\ & \qquad \left.+\left(w_1\frac{\partial h_1}{\partial Y}+1+w_2\frac{\partial h_2}{\partial Y}\right)dY\right] \end{aligned} \tag{4}$$

The 2001 tax reform had the effect of changing workers' after-tax wages (dw_1 and dw_2) and families' after-tax unearned incomes (dY). The impact of these changes on family welfare can be calculated using simulated wage and income changes and estimated utility function parameters. In order to determine the impact of the 2001 tax reform on family welfare, utility function parameters are estimated for the sample of families in 2000, given their net, after-tax wages and (virtual) unearned income in 2000. We then calculate what each member's 2000 after-tax wage and unearned income would be under the 2005 tax code. The difference in these wages and income are then used to calculate the difference in welfare that the family experiences under the 2005 tax regime compared with the tax regime prior to the 2001 tax reform. The

advantage of this simulation exercise (as opposed to merely calculating observed changes in hours pre- and post-tax regime change) is that everything except the tax regime is held constant.[6]

The complication of endogenous wages and income and appropriate vertical intercept for the budget constraint in estimation of labor supply in the presence of a progressive tax system is well-known (see Burtless and Hausman 1978). As Ransom (1987) points out, neither fully incorporating endogenous wages nor instrumental variables techniques are practical solutions for the specification here, given the highly nonlinear way in which wages enter the labor supply functions. Unearned income, however, will be adjusted as suggested by Hall (1973) to reflect "virtual" unearned income in order to fully linearize the budget constraint on which the family is optimizing. The procedure amounts to subtracting after-tax earnings from after-tax total income to yield virtual unearned income. As Ransom points out, the implication of not fully parameterizing the budget constraint is that the wage elasticities are likely to be downward biased and the income elasticities are likely to be biased upward.

IV. Empirical Strategy and Data

The direction (sign) of the change in utility at the optimal leisure choices that results from changes in the husband's and wife's after-tax wages, and family after-tax unearned income cannot always be determined analytically; it depends on the direction of the wage changes and the size of labor supply responses of the husband and wife to own and to spouse wage changes, as well as on the relative size of the additional utility the family attains from the leisure enjoyed by the husband and wife and from additional unearned income.

In order to obtain estimates of the pieces of the total derivative in equation (4) a family

[6] Wages and income in 2000 are not inflated to 2005 values in order to keep the impact of tax regime changes from being confounded by the effects of inflation.

labor supply model is estimated empirically, necessitating that a specific form of utility be assumed. We estimate a quadratic form of the utility function:

$$U(Z) = \alpha(Z) - (1/2)Z'\mathrm{B}Z \tag{5}$$

where Z is a vector with elements $Z_1 = T - h_1$, $Z_2 = T - h_2$ and $Z_3 = w_1h_1 + w_2h_2 + Y$; α is a vector of parameters and B is a matrix of parameters. This utility function belongs to the class of flexible functional forms in the sense that it can be thought of as a second order approximation to an arbitrary utility function when B is positive definite.[7]

The outgoing rotation groups from the Current Population Survey (CPS) in March, April, May, and June 2000 were used to construct the sample for which the family labor supply model is estimated. Detailed unearned income was obtained by matching each family to the March survey, which is the month in which this information is collected.[8] Multiple months of outgoing rotation groups were used in order to expand the sample size. Only respondents who reported hourly or weekly wages were included in the sample to ensure a more accurate reporting/construction of the hourly wage. Table 1 contains the means and standard deviations of the variables for the sample.

[Table 1 here]

The families are split into four categories based on the education of the husband in the family. These group formations are highly correlated with total family income; separating families based on family income itself was not conducive to obtaining separate group-specific

[7] The first order conditions, the labor supply equations, and the likelihood function estimated to obtain structural parameter estimates are found in Ransom (1987: 467-8) and also used in Hotchkiss and Moore (1997). These are repeated in Appendix A for the convenience of the reader. Appendix A also contains details on obtaining estimates for equation (4).

[8] Since the CPS only allows for identification of unearned income in the previous year, it must be considered a proxy for current family unearned income.

utility function parameters (the model was too unstable).[9] The differences in means across family type are not surprising. The representation of blacks is lowest among families with the highest education; the number of children is highest in the lowest education group and lowest among families with the highest income; hours of work, wages, and unearned income all increase with family education.

Information on the detailed sources of family income, number of children, and earnings available from the CPS is used to calculate the marginal tax rate on earnings (wages) and the total tax liability (in any year of interest) using the National Bureau of Economic Research (NBER) TAXSIM tax calculator (http://www.nber.org/~taxsim/, also see Feenberg and Coutts1993). The calculator is more complete than we have information for from the CPS, so we made assumptions for the missing values as recommended by the managers of the tax calculator. For example, there is no information in the CPS that would allow one to calculate itemized deductions (mortgage payments, charitable contributions, etc.), so values of zero are entered for the missing information. Although this means we don't have as accurate a calculation of the family's actual tax liability as we would like, it is important to remember that the assumptions for each family do not change across years of comparison.

The bottom rows of Table 1 present comparisons of the families' marginal tax rates, after-tax total annual family incomes, after-tax wages, and after-tax weekly unearned incomes between 2000 and 2005. These are calculated by evaluating the 2000 gross values under the tax regimes in 2000 and in 2005 (rather than confound the influence of inflation on tax liability, the actual 2000 dollar amounts are used to calculate tax rates in 2005). The average marginal tax rate decreased among all family education types, with the greatest decline going to families with

[9] Evidence of assortive mating suggests that one will find husbands and wives with similar skill and education levels in the same family (see Hernstein and Murray 1994).

the highest education. Husbands enjoyed a bigger gain in their after-tax wage than wives (which actually has implications for gender wage inequality which will not be explored here), and families with the highest education levels also experienced the largest absolute (and percentage) increase in hourly pay and unearned income. This greatest (absolute and percentage) benefit of the 2001 tax reform going to the highest income groups has been the source of much controversy and criticism of the policy change.[10]

V. Results and Policy Implications

Table 2 contains the maximum likelihood parameter estimates of the utility function parameters corresponding to equation (5). The regressors that affect labor supply typically do so in expected ways. Generally, the presence of children significantly decreases the labor supply of wives and increases (or doesn't affect) the labor supply of husbands. The labor supply of wives who's husbands have at least a college degree is most sensitive to changes in the number of children in the family and to having a very young child. In addition, college educated women typically work more hours than women with less than a college degree. Black husbands tend to work fewer hours than their white counterparts, whereas black wives typically work more hours. Ceofficients for families in which the husband has less than a high school degree are very imprecisely estimated.

[Table 2 here]

The parameter estimates in Table 2 are used to calculate marginal utilities of leisure and income, as well as labor supply and income elasticities; these are reported in Table 3. The largest own (uncompensated) wage elasticities are found among both wives and husbands in

[10] For example, see Hashemzadeh and Saubert (2004).

families where the husband has a high school degree only. The smaller own wage elasticity among husbands with at least some college is consistent with the labor supply elasticities found by Moffitt and Wilhelm (2000) in their investigation of the effect of taxation on the labor supply decisions of affluent men. Moffitt and Wilhelm speculate that this low labor supply response to wage changes could be because high income men are already working a lot of hours and have little or no room left to respond to wage changes. The very small response of men with less than a high school degree may be a function of an absence of opportunity or motivation consistent with their low education levels. Among all families, wives are estimated to have similar or smaller responses to own-wage changes than their husbands. This is not what we would typically expect; the result could be a function of the joint estimation of labor supply, the restriction of the analysis to dual-earner families, or the time period in which the elasticities are estimated.[11]

[Table 3 here]

Across education groups, wives are more responsive to changes in their husband's wages, than husbands are to changes in their wife's wages. In addition, husbands are more responsive to changes in their own wage than to changes in their wife's wage. Wives, on the other hand are generally more responsive to changes in their husband's wage than to changes in their own wage. These estimates are consistent with a the traditional view of the husband being the primary wage earner. Both husbands and wives have the expected low, negative income elasticity. The estimated positive cross-wage elasticities indicate that husbands and wives view their leisure time as complimentary.

[11] Ransom (1987) estimated own wage elasticities of 0.70 for married women and -0.04 for married men in 1976; Hotchkiss and Moore (1997) estimated own wage elasticities of 0.12 (0.07) for married women (men) in 1995; and Blau and Kahn (2005) estimated own wage elasticities for married women of about 0.83 in 1980, 0.61 in 1990 and 0.39 in 2000.

The differences in estimated wage elasticities across groups indicate that behavior does differ across family characteristics. To be fair, each of the group estimates, except those of high school only families, fall within the boot-strapped 95 percent confidence intervals of the full sample results, but the expectation is that larger sample sizes would make these estimates more precise and statistically different from one another. The implication of parameter estimates that differ across family characteristics is that any analysis of tax (or other) policy on the welfare of families should take into account how families will respond differently to incentives and constraints. The lower marginal utilities of leisure and income among high education families will further exacerbate the difference in behavior in the evaluation of differences in the welfare effect. The lower additional utility that high education families receive from additional units of leisure is consistent with a preference structure that would lead to family members working long hours. In addition, given a higher level of income to start with, an additional dollar of income does not yield as much utility to high education families.

In the middle of Table 3 are the simulated impacts on family welfare of the 2001 tax reform, accounting for the labor supply response that would be expected, given the change in marginal tax rates. The representative low education family is expected to have reduced its supply of labor to the market. Although the higher net wage would have provided the incentive to work more hours (indicated by the positive own wage elasticity), the relatively large expected increase in unearned income, and resulting incentive to decrease labor supply, overpowered the expected impact of the higher net wage.[12] In contrast, the consumption of families in which the husband had a high school degree received a significant income boost from the strong positive

[12] All utility function parameters and simulations are performed for the representative family within each income group. The calculations are highly non-linear, thus one has to be careful to keep all characteristics (except the policy parameters in question) the same when simulating different policy changes.

labor supply response to the wage changes. In spite of the apparent much larger welfare gain among high school families, the marginal utility of income is also much higher among high school families, making the dollar-equivalent value of the utility gain (in brackets) less than what is experienced by families with some college and beyond.

A. Distribution of Welfare Gains across Educational Groups

Figure 1 plots the average pre-tax annual income along with the dollar equivalent welfare gain accruing to the representative family in each husband education group. The higher education groups (also the higher income groups) reap higher dollar equivalent welfare gains. This positive relationship between family income and welfare gain is exactly what has drawn a fair amount of criticism of the 2001 tax reform (Kamin and Shapiro 2004). However, the tax reform supporters counter than this relationship is perfectly appropriate given that the higher income families pay a higher proportion of the total tax bill (Bartlett 2005).

[Figure 1]

The share of the welfare gain accruing to higher education families can be seen by dividing the proportion of the total welfare gain accruing to each education group by the education group's population share. These values are plotted in Figure 2. A value less than one means that the group is receiving less than it's population share of the additional welfare gain; a value greater than one means the group is getting more than it's population share.[13] The figure

[13] The group's share of the welfare gain relative to it's population share is calculated as: $\frac{N_i dV_i}{\sum N_i dV_i} \div \frac{N_i}{\sum N_i} = dV_i \frac{\sum N_i}{\sum N_i dV_i}$, where N_i is the number of families in education group *i*, and dV_i is the welfare gain of the representative family in education group *i*. This transformation shows that the group's share relative to it's population share (plotted in Figure 2) is merely a scaled version of the welfare gain plotted in Figure 1 (dV_i).

indicates that the college family group is getting more than it's population share of the total welfare gain from the 2001 tax reform, whereas all the other education groups are getting less than their population shares.

[Figure 2 here]

Figure 2 also plots the representative family's welfare gain as a percent of its pre-tax family income. As a share of income, the welfare gain actually declines slightly with education. So, depending on whether the distributional policy goal is more heavily weighted to equity or efficiency preferences, the 2001 tax reform could be considered to have had a disproportionate impact across income groups with the largest benefits accruing to the highest income families (evaluated with more emphasis on equity preference); or, the benefits of the 2001 tax reform could be seen as generating a proportionally equal welfare gain across families of different income levels (evaluated with more of a balance of equity and efficiency preference).[14]

One of the expectations of the 2001 tax reform is that lower marginal tax rates would motivate people to work more. In Table 3 we saw that labor supply was expected to have increased in each representative family, except those in which the husband has less than a high school degree. Toward the bottom of Table 3 the share of total welfare gain accruing to each education group is reported, along with each group's share of the total increase in labor supply. A striking disparity appears in comparing the share of welfare gain and share of additional labor supplied by college families. College families are expected to have enjoyed about 43 percent of the total tax reform welfare gain, yet only to have supplied 17 percent of the additional labor supply generated by the reform. This result has potential implications for the expected economic growth to be generated from such a tax policy change. If worker productivity is heterogeneous

[14] See Moore (1996) for a fuller discussion of equity versus efficiency preference in distributional policy goals.

across education, with more value-added output being generated by college graduates than high school graduates per hour of input, then a policy that induced higher-educated workers to supply a greater proportion of the additional labor supply would generate greater output. Of course the cost of such incentives would have to be considered.

B. Welfare Gain and Number of Children

One of the most popular features of the 2001 tax reform was the expansion of the child tax credit. The per-child credit was scheduled to increase gradually from $500 to $1000 by the year 2010. The Jobs and Growth Tax Relief Reconciliation Act of 2003 advanced families the $1000 credit per child for 2003 and 2004 then was supposed to revert back to the original phase-in. Then, the Working Families Tax Relief Act of 2004 extended the $1000 credit per child for each year until 2010. This is an additional fixed dollar amount accruing to families with children. However, the credit is limited for families with income over certain thresholds. Because of this special tax treatment of children, it is of interest to determine how the tax policy change is expected to have affected families with different numbers of children.[15] Of course, number of children is only one characteristic of a family that figures into determining tax liability.

The same methodology to estimate welfare gains across families of different educational categories was used to obtain parameter estimates for family groups differentiated by the number of children: no children, one child, two children, three or more children. All of the results and

[15] The Child and Dependent Care Tax Credit was also increased over this time period, but since the CPS does not report child care expenditures, the specific impact of that provision can not be incorporated into the present analysis. Since this tax credit is underutilized by low-income families (Forry and Anderson 2006), its omission is expected to mostly influence the welfare estimates among higher income families.

sample means are found in Appendix B. As one might expect, families with no children are older, more educated, and have the highest family income. Husbands in childless families work less and wives in childless families work more on average than families with children. In the families with three or more children, wives work the least number of hours on average, husbands work about the same, but average family income is significantly lower than among other family types.

Figures 3 and 4 repeat the graphical depiction of results depicted in Figures 1 and 2, but for families differentiated by number of children. Figure 3 shows that the added benefit of having more children (through the child tax credit) can overcome the lower reduction in marginal tax rates (as a result of earning lower wages). The dollar equivalent utility gain is higher for families with more children. Figure 4 shows that all groups except those without children are expected to have gotten more than their population share of the tax reform welfare gain. And, since average income is lower among the families with more children, the welfare gain as a percent of pre-tax family income is also greater for larger families.

[Figures 3 and 4 here]

C. Caveats

While the relative welfare impacts presented in this paper are valid within the scope of the assumptions made, it's important to keep in mind the potential implications of those assumptions. First of all, the results are generalizable only to families in which both husband and wife are working; labor supply responses are allowed only along the intensive margin. This is likely to have the greatest impact on the welfare assessment of lower income families since the increases in the generosity of the EITC is the feature of the 2001 tax reform likely to have the

greatest impact on labor force participation decisions (for example, see Eissa and Liebman 1995 and Noonan et al. 2005). The implication is that the welfare estimates presented in this paper for dual-earner lower income families likely underestimate the welfare impact for the population of low-income families (see Eissa et al. 2004).

In addition, Kniesner and Ziliak (2002) estimate the welfare cost of the Economic Recover Act of 1981 and the Tax Reform Act of 1986 as measured by their impact on consumption stability. They estimate that these two tax reforms enhanced consumption stability among low-income households, but generated substantial welfare costs for most middle- and upper-income families as a result of a reduction in their consumption stability by 50 percent. The implication for the welfare change estimates presented in this paper is that the estimates for low-income families are likely lower and those for higher income families higher than would result if the model accounted for risk-aversion and changes in consumption stability.

VI. Concluding Remarks

The purpose of this paper was to assess the impact of the 2001 tax reform on family welfare and to investigate how that impact could have varied across family characteristics. In particular, separate family utility function parameters were estimated for groups of families differentiated by the education of the husband and by number of children in the family. The analysis provided estimates of income elasticities of labor supply, marginal utilities of leisure and unearned income, as well as the overall welfare impact of the marginal tax rate and other tax policy changes resulting from implementation of the 2001 tax reform.

The analysis found that the dollar equivalent welfare gain of the tax reform increased with the education of the husband, which is highly correlated with total family income.

However, the welfare gain as a percent of total income was essentially distributed equally across family education groups. In addition, while 43 percent of the total welfare gain from the 2001 tax reform was expected to accrue to the high education families, those families were only expected to supply 17 percent of the additional total labor supply. If more highly educated individuals are also more productive, this sort of marginal tax rate reduction may not be an efficient way to increase supply-generated economic growth. However, since high education people are already working long hours, any incentives to generate a larger labor supply response from this more productive group could prove to be too costly.

An additional example illustrated that merely having the highest income did not necessarily mean that a family type would reap the greatest gain from the 2001 tax reform. By estimating separate utility function parameters across families with different numbers of children, it was found that while families with no children had the highest income on average, they were the only family type differentiated by number of children that received less than their population share of tax reform welfare gain. The per-child tax credit made up for the lower marginal tax rate cut experienced by lower-earning families with children. In all, the results in this paper illustrate that understanding the behavioral response to a policy change and understanding that behavior varies across family characteristics is important in a thorough assessment of the welfare impact of that policy change.

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Figure 1. Pre-tax family income and dollar equivalent utility gain by husband education group.

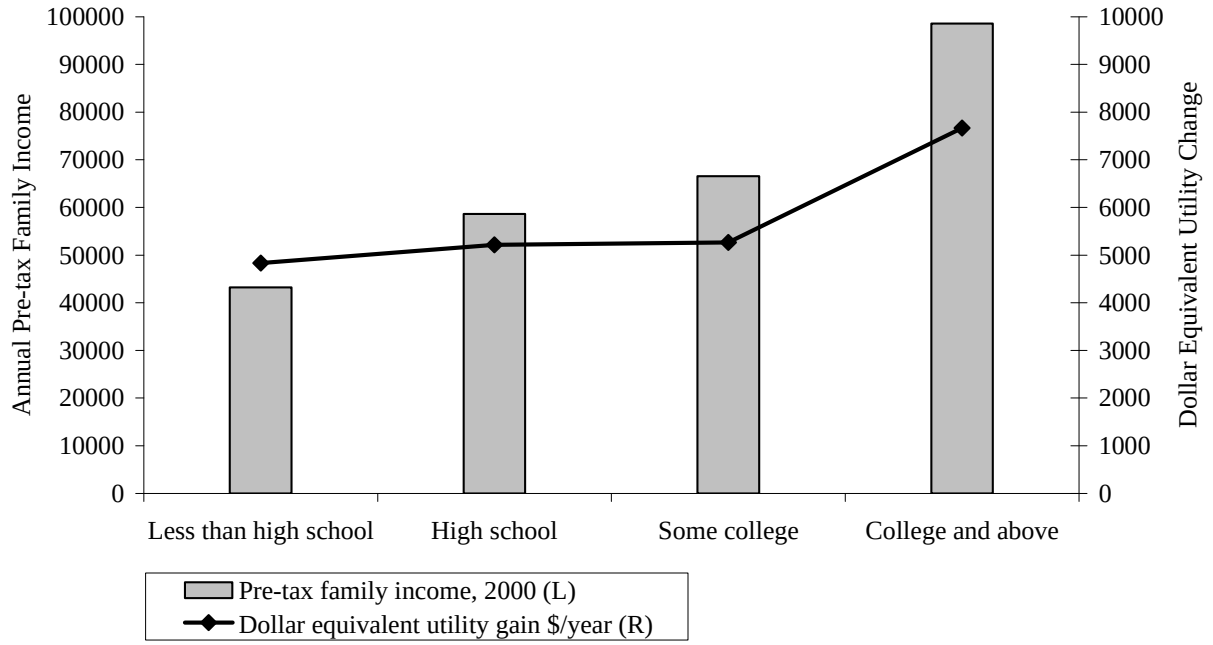

Figure 2. Welfare gain as percent of pre-tax family income and each education group's share of total welfare gain relative to the group's population share.

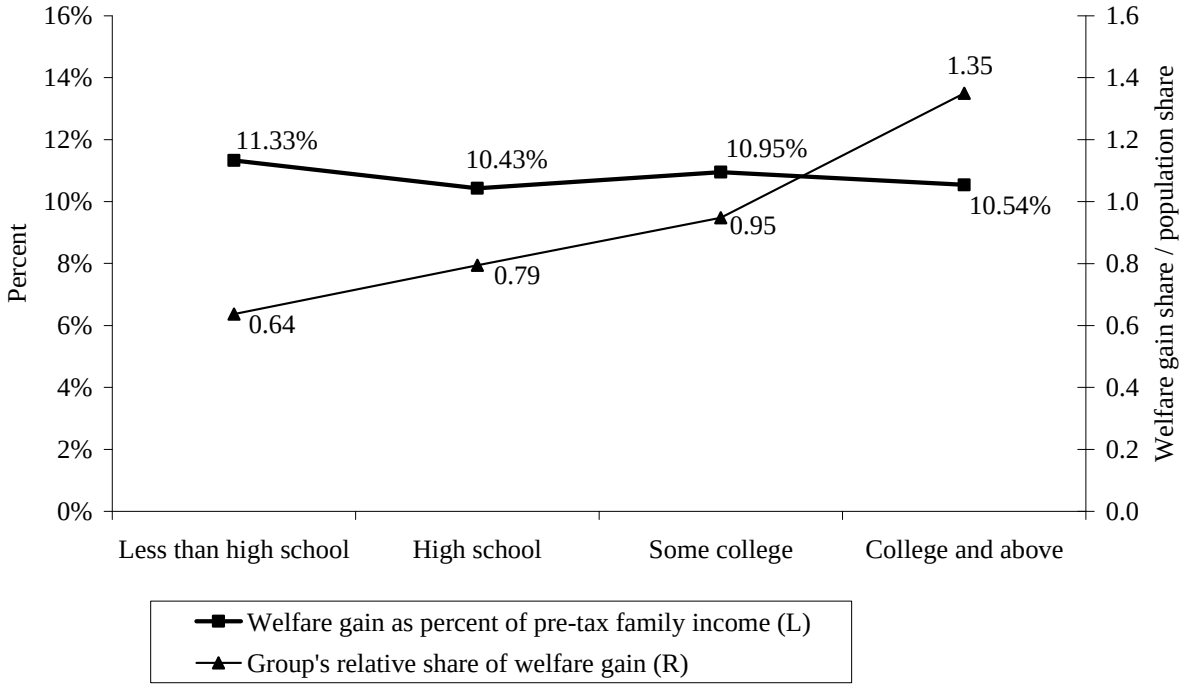

Figure 3. Pre-tax family income and dollar equivalent utility gain by number of children group.

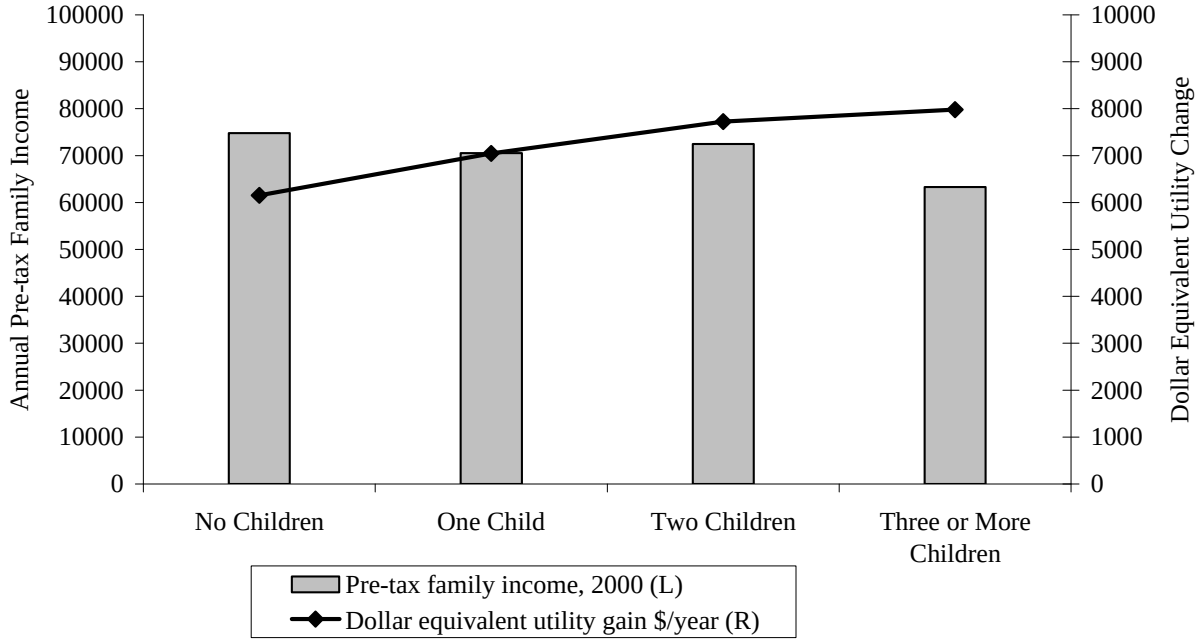

Figure 4. Welfare gain as percent of pre-tax family income and each family size group's share of total welfare gain relative to the group's population share.

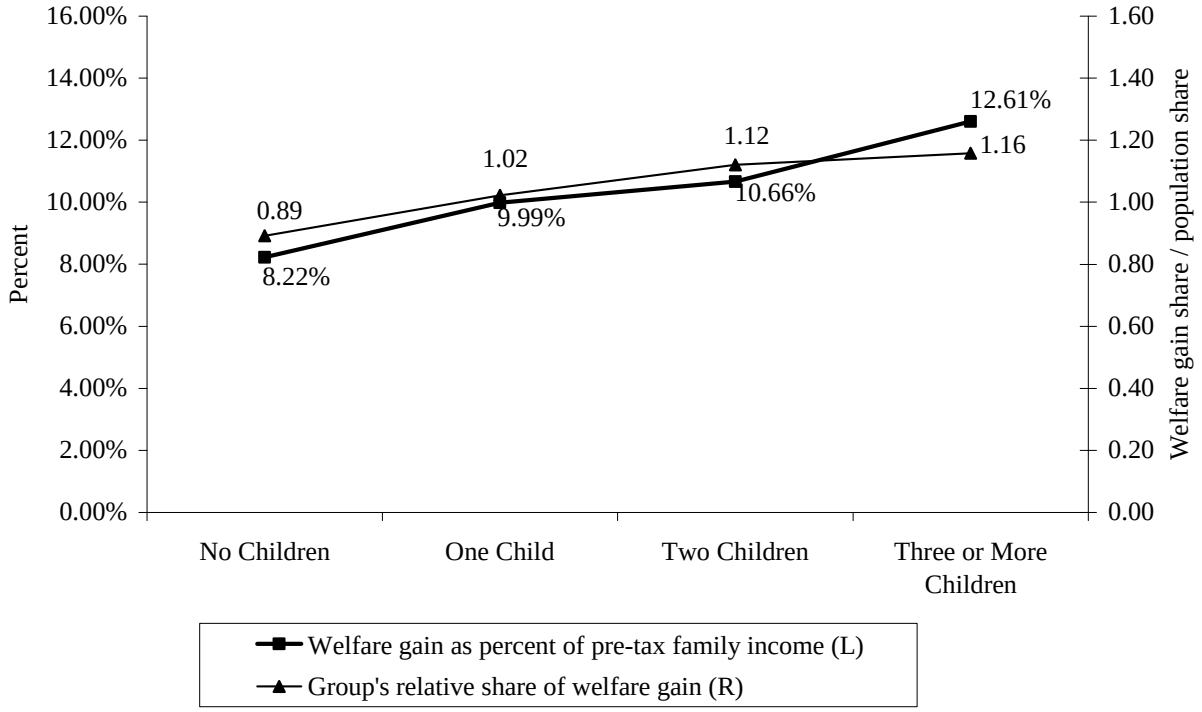

Table 1. Sample means by family education type, families in 2000.

Family Type:	Full Sample	Husband Less Than High School	Husband High School	Husband Some College	Husband College or More
Age_1	42.913 (10.386)	42.977 (11.909)	42.534 (10.431)	42.558 (10.224)	43.607 (9.999)
Age_2	40.828	40.645	40.537	40.365	41.548
$Black_1 = 1$	0.075	0.086	0.080	0.087	0.057
$Black_2 = 1$	0.072	0.084	0.077	0.081	0.055
$White_1 = 1$	0.880	0.856	0.888	0.873	0.885
$White_2 = 1$	0.880	0.853	0.890	0.876	0.881
Other $Race_1 = 1$	0.045	0.058	0.032	0.041	0.058
Other $Race_2 = 1$	0.048	0.063	0.033	0.043	0.065
$LESSHS_1 = 1$	0.083	1.000	0.000	0.000	0.000
$LESSHS_2 = 1$	0.062	0.415	0.059	0.026	0.005
$HS_1 = 1$	0.318	0.000	1.000	0.000	0.000
$HS_2 = 1$	0.326	0.383	0.556	0.282	0.117
$SOMECOLL_1 = 1$	0.284	0.000	0.000	1.000	0.000
$SOMECOLL_2 = 1$	0.299	0.154	0.262	0.471	0.219
$COLL_1 = 1$	0.316	0.000	0.000	0.000	1.000
$COLL_2 = 1$	0.313	0.048	0.122	0.220	0.659
NKIDS	1.008 (1.111)	1.210 (1.293)	1.019 (1.105)	1.204 (1.117)	0.929 (1.050)
PRESCHL = 1	0.231	0.298	0.232	0.225	0.218
Husband's weekly hours	43.094 (8.741)	40.826 (7.525)	42.196 (7.882)	42.799 (8.738)	44.861 (9.527)
Wife's weekly hours	36.839 (10.076)	36.581 (8.273)	36.867 (9.201)	36.313 (10.017)	37.352 (11.307)
Husband's pre-tax wage	18.56 (11.24)	11.40 (5.23)	15.41 (7.20)	17.26 (9.11)	24.90 (14.17)
Wife's pre-tax wage	14.11 (9.30)	9.42 (5.02)	12.05 (6.78)	13.21 (7.51)	18.21 (11.94)
Family's pre-tax weekly non-labor income	107.48 (267.74)	44.00 (128.47)	69.37 (172.41)	99.59 (232.08)	169.64 (371.62)
Total annual pre-tax income ($)	72,206 (39,700) [3,440-553,879]	43,229 (19,719) [10,760-190,701]	58,629 (24,934) [10,300-231,602]	66,575 (30,776) [3,440-325,461]	98,557 (47,821) [12,982-553,879]
Total annual after tax income ($)	47,456 (18,253)	34,258 (10,942)	41,803 (12,573)	45,720 (15,108)	58,180 (21,552)
Change in marginal tax rate on wages[a] (%age points)	-3.890 (6.806)	-2.545 (9.380)	-3.427 (7.220)	-4.055 (6.951)	-4.589 (5.158)
$dW1$[b] ($ per hour)	0.804 (1.171)	0.300 (0.979)	0.648 (1.139)	0.810 (1.195)	1.087 (1.153)
$dW2$[b] ($ per hour)	0.617 (0.947)	0.271 (0.848)	0.505 (0.912)	0.616 (0.945)	0.820 (0.963)
dY[b] ($ per week)	71.937 (86.893)	64.945 (69.209)	56.888 (76.164)	61.336 (81.681)	98.467 (98.937)
Number of Observations	9,393	778	2,988	2,663	2,964

Notes: The "1" subscript corresponds to the husband's values of the variable and the "2" subscript corresponds to the wife.
[a] Includes state and federal taxes; average change between 2000 and 2005.
[b] These correspond to how after-tax wages, virtual non-labor income, and total annual family income and would be different in 2005 compared with 2000, changing only the tax regime under which the wages and income are received.

Table 2. Maximum likelihood parameter estimates and utility function parameters, families in 2000.

	Full Sample	Husband Less Than High School	Husband High School	Husband Some College	Husband College and Greater
Elements of $\boldsymbol{\alpha}_1^*$					
Intercept	41.159*** (1.442)	-5.928 (13.427)	24.809*** (2.595)	37.655*** (3.126)	36.230*** (3.539)
$Black_1 = 1$	-1.511*** (.438)	.017 (1.841)	-1.387* (.726)	-2.726*** (.919)	-2.444*** (.890)
$COLL_1 = 1$	3.485*** (.220)	--	--	--	--
AGE_1	-.067*** (.009)	-.023 (.022)	-.044*** (.017)	-.040** (.020)	-.027 (.018)
NKIDS	.543*** (.105)	.604 (.394)	1.022*** (.209)	.914*** (.210)	.911*** (.229)
PRESCHL = 1	-0.850*** (.284)	-1.626 (1.148)	.598 (.511)	-1.190** (.578)	-.171 (.593)
Elements of $\boldsymbol{\alpha}_2^*$					
Intercept	22.884*** (2.282)	44.831* (24.318)	8.745** (3.709)	7.246** (3.663)	22.769*** (6.165)
$Black_2 = 1$	1.549*** (.377)	-.483 (3.00)	2.247*** (.743)	1.536*** (.479)	2.240** (1.085)
$COLL_2 = 1$	1.797*** (.245)	2.713 (2.615)	1.410*** (.410)	1.132*** (.292)	2.979*** (.688)
AGE_2	-.030*** (.009)	-.007 (.046)	-.022 (.017)	.005 (.011)	-.006 (.022)
NKIDS	-.714*** (.100)	-.712 (.765)	-.829*** (.195)	-.639*** (.129)	-1.374*** (.308)
PRESCHL = 1	-1.569*** (.243)	2.509 (2.270)	-1.903*** (.497)	-.700** (.312)	-2.722*** (0.727)
$\boldsymbol{\alpha}_3^*$	.431*** (.019)	0.325 (.249)	.916*** (.110)	.467*** (.042)	.393*** (.052)
$\boldsymbol{\beta}_{11}$	--	--	--	--	--
$\boldsymbol{\beta}_{22}$	.685*** (.062)	2.643*** (.804)	.842*** (.108)	.482*** (.062)	.877*** (.161)
$\boldsymbol{\beta}_{33}$	.00021*** (.00001)	-.00018 (.00014)	.00021*** (.00004)	.00010*** (.00002)	.00025*** (.00003)
$\boldsymbol{\beta}_{12}$	-.084*** (.030)	-1.324*** (.335)	-.544*** (.054)	-.241 *** (.066)	-.212*** (.079)
$\boldsymbol{\beta}_{13}$	-.0013*** (.0002)	-.0034 (.0026)	-.0070*** (.0008)	-.0044*** (.0006)	.00005 (.0004)
$\boldsymbol{\beta}_{23}$	-.0009*** (.0003)	-.0044 (.0041)	-.0023*** (.0007)	-.0012** (.0006)	-.0003 (.0004)
$1/\boldsymbol{\sigma}_1$	.110*** (.001)	.084*** (.016)	.104*** (.002)	.104*** (.001)	.100*** (.001)

$1/\boldsymbol{\sigma}_2$	.142*** (.013)	.044*** (.013)	.117*** (.014)	.194*** (.025)	.101*** (.019)
ρ	-.011 (.069)	-.966*** (.062)	-.720*** (.067)	-.431** (.173)	-.236 (.159)
Log-likelihood function	-33515.5	-2521.87	-9971.89	-9489.19	-11115.7
Number of Observations	9,393	778	2,988	2,663	2,964

Notes: Standard errors are in parentheses. *, **, *** denote significance at the 90, 95, and 99 percent confidence levels, respectively.

Table 3. Estimated utility function parameters and labor supply elasticities and simulated change in family welfare resulting from the 2001 tax reform, by education of husband, families in 2000.

	Full Sample	Husband Less Than HS	Husband High School	Husband Some College	Husband at least College
U_1	1.59^	1.39^	3.96^	1.72^	1.14
U_2	1.23^	1.13^	3.08	1.31	.89^
U_3	.14^	.15^	.36^	.14^	.10^
Husband's own wage elasticity	.20^	.16^	.41^	.25^	.26^
Husband's cross wage elasticity	.15^	.06^	.25^	.19^	.17^
Husband's unearned income elasticity	-.010	-.008^	-.019^	-.014^	-.017
Wife's own wage elasticity	.19^	.07	.33^	.25^	.19^
Wife's cross wage elasticity	.15^	.14^	.37^	.21^	.22^
Wife's unearned income elasticity	-.013^	-.006^	-.019^	-.017^	-.020
Husband's labor supply response (hrs/wk)	.64^	-.17^	.93^	.86^	.83^
Wife's labor supply response (hrs/wk)	.45^	-.03^	.88^	.69^	.58^
dV (Total change in utility) [annual dollar-equivalent = $(dV/U_3)*52$]	19.03^ [$6,829]	12.93^ [$4,535]	37.34^ [$5,381]	17.24^ [$6,194]	17.61^ [$9,548]
dV_{H1} (from change in husband's hrs)	-1.02^	.24^	-3.69^	-1.47^	-.95
dV_{H2} (from change in wife's hours)	-.56^	.03^	-2.72^	-.91^	-.52
dV_X (from change in income)	20.61^	12.66^	43.74^	19.62^	19.07^
Welfare gain as percent of total pre-tax family income	10.86%	11.33%	10.43%	10.95%	10.54%
Percent of total (dollar-equivalent) utility generated from the 2001 tax reform accruing to each family type	100%	5.27%	25.28%	26.86%	42.59%
Percent of total labor supply response provided by family type	100%	-0.65%	22.56%	17.17%	17.45%
Number of observations	9,393	778	2,988	2,663	2,964

Note: Estimates obtained for representative family in each group. ^ indicates estimate of utility function parameter is significantly different from zero based on bootstrapped 95 percent confidence intervals. Unearned income elasticities are evaluated at actual unearned income.

Appendix A: First order conditions of utility maximization problem, labor supply equations, and likelihood function estimated.

As presented by Ransom (1987), the first order conditions set equal to zero that result from maximizing the utility function in equation (5) in the text are:

$$m_1 = \alpha_1^* + \alpha_3^* w_1 - \beta_{11} h_1 - \beta_{33} w_1 (w_1 h_1 + w_2 h_2 + Y) - \beta_{12} h_2 + \beta_{13} (2 w_1 h_1 + w_2 h_2 + Y) + \beta_{23} w_1 h_2 \tag{A1}$$

$$m_2 = \alpha_2^* + \alpha_3^* w_2 - \beta_{22} h_2 - \beta_{33} w_2 (w_1 h_1 + w_2 h_2 + Y) - \beta_{12} h_1 + \beta_{23} (w_1 h_1 + 2 w_2 h_2 + Y) + \beta_{23} w_2 h_1 \tag{A2}$$

There is no need to specify a time endowment in order to estimate the labor supply functions because α_1^*, α_2^*, and α_3^* are re-parameterized functions of $T, \alpha s$, and βs. This re-parameterization is necessary for identification of the labor supply equations. It is through these starred parameters that differences in tastes across families are allowed to enter. Specifically,

$$\alpha_1^* = \mathrm{X}_1 \Gamma_1 + \varepsilon_1, \tag{A3}$$

and

$$\alpha_2^* = \mathrm{X}_2 \Gamma_2 + \varepsilon_2, \tag{A4}$$

where X_1 and X_2 are vectors of individual and family characteristics, Γ_1 and Γ_2 are parameters to be estimated, and ε_1 and ε_2 are normally distributed error terms with means zero and covariance matrix Σ.

The likelihood function estimated, for a sample in which both husbands and wives are working, is

$$L = \prod abs(J)\, f(\varepsilon_1, \varepsilon_2) \ , \tag{A5}$$

where,

$$\varepsilon_1 = \mathrm{X}_1 \Gamma_1 + \alpha_3^* w_1 - \beta_{11} h_1 - \beta_{33} w_1 (w_1 h_1 + w_2 h_2 + Y) - \beta_{12} h_2 + \beta_{13} (2 w_1 h_1 + w_2 h_2 + Y) + \beta_{23} w_1 h_2, \tag{A6}$$

and

$$\varepsilon_2 = \mathrm{X}_2\Gamma_2 + \alpha_3^* w_2 - \beta_{22}h_2 - \beta_{33}w_2\left(w_1h_1 + w_2h_2 + Y\right) - \beta_{12}h_1 + \beta_{23}\left(w_1h_1 + 2w_2h_2 + Y\right) + \beta_{13}w_2h_1, \tag{A7}$$

and the Jacobian, J, has the form:

$$J = \left(-\beta_{11} - \beta_{33}w_1^2 + 2\beta_{13}w_1\right)\left(-\beta_{22} - \beta_{33}w_2^2 + 2\beta_{23}w_2\right) - \left(-\beta_{33}w_1w_2 - \beta_{12} + \beta_{13}w_2 + \beta_{23}w_1\right)^2. \tag{A8}$$

The Jacobian is restricted to be positive for internal consistency to ensure that a unique solution exists. Further details can be found in Ransom (1987: 467-8).

In order to obtain estimates for dV (equation 4 in text), we require expressions for the partial derivatives of the labor supply equations (h_1 and h_2) with respect to w_1, w_2, and Y. This is accomplished by setting equations A1 and A2 equal to zero and solving the equations simultaneously for explicit expressions for h_1 and h_2, respectively. These explicit functions are then differentiated accordingly. These manipulations were performed with the help of Mathematica® (Wolfram Research, version 2.2) for the Macintosh. The derivatives are then evaluated at the sample means and the estimated coefficient.

Appendix B: Sample details and results for families by number of children categories, families in 2000.

Table B1. Sample means by number of children, families in 2000.

Family Type:	No Children	One Child	Two Children	Three or More Children
Age_1	46.888 (11.634)	40.510 (9.090)	39.240 (7.075)	38.928 (6.606)
Age_2	44.890 (11.318)	38.474 (8.586)	37.060 (6.518)	36.554 (5.518)
$Black_1 = 1$	0.065	0.091	0.067	0.106
$Black_2 = 1$	0.063	0.088	0.062	0.096
$White_1 = 1$	0.897	0.860	0.888	0.829
$White_2 = 1$	0.896	0.859	0.888	0.836
Other $Race_1 = 1$	0.038	0.048	0.045	0.065
Other $Race_2 = 1$	0.041	0.053	0.050	0.068
$LESSHS_1 = 1$	0.075	0.080	0.078	0.136
$LESSHS_2 = 1$	0.055	0.060	0.055	0.120
$HS_1 = 1$	0.313	0.318	0.333	0.308
$HS_2 = 1$	0.336	0.329	0.307	0.315
$SOMECOLL_1 = 1$	0.278	0.296	0.272	0.309
$SOMECOLL_2 = 1$	0.290	0.295	0.313	0.316
$COLL_1 = 1$	0.334	0.307	0.317	0.247
$COLL_2 = 1$	0.320	0.316	0.325	0.249
NKIDS	0.000	1.000	2.000	3.308
PRESCHL = 1	0.021	0.352	0.408	0.497
Husband's weekly hours	42.572 (9.351)	43.268 (8.115)	43.856 (8.272)	43.277 (8.159)
Wife's weekly hours	38.338 (9.485)	36.665 (9.128)	35.291 (10.961)	34.026 (11.356)
Husband's pre-tax wage	18.762 (12.051)	18.361 (10.922)	19.141 (10.519)	17.056 (9.412)
Wife's pre-tax wage	14.164 (9.456)	14.373 (9.904)	14.327 (8.786)	12.692 (8.099)
Family's pre-tax weekly non-labor income	134.115 (297.388)	84.815 (242.283)	89.226 (240.508)	80.768 (227.637)
Total annual pre-tax income ($)	74,826 (40,660) [10,300-346,346]	70,553 (39,793) [3,440-553,879]	72,453 (38,125) [14,375-302,682]	63,319 (37,209) [10,760-301,861]
Total annul after tax income	46,497 (18,932)	46,451 (17,759)	49,852 (17,507)	48,479 (17,356)
Change in marginal tax rate on wages[a] (%age points)	-4.720 (5.069)	-3.677 (6.360)	-2.865 (8.015)	-3.098 (10.306)
$dW1$[b] ($ per hour)	0.917 (1.049)	0.796 (1.154)	0.690 (1.281)	0.571 (1.389)
$dW2$[b] ($ per hour)	0.700 (0.840)	0.622 (0.971)	0.520 (1.013)	0.451 (1.131)

dY^b ($ per week)	49.551 (79.350)	70.008 (80.959)	99.413 (88.594)	114.019 (95.222)
Number of Observations	4,197	2,110	2,180	906

Notes: The "1" subscript corresponds to the husband's values of the variable and the "2" subscript corresponds to the wife.

[a] Includes state and federal taxes; average change between 2000 and 2005.

[b] These correspond to how after-tax wages, virtual non-labor income, and total annual family income and would be different in 2005 compared with 2000, changing only the tax regime under which the wages and income are received.

Table B2. Maximum likelihood parameter estimates and utility function parameters, by number of children, families in 2000.

	No Children	One Child	Two Children	Three or More Children
Elements of $\boldsymbol{\alpha}_1^*$				
Intercept	34.696*** (2.196)	45.857*** (3.972)	41.645** (2.078)	43.314*** (2.904)
$Black_1 = 1$	-1.240* (.696)	-1.044 (.913)	-1.538 (1.177)	-2.040** (.997)
$COLL_1 = 1$	3.008*** (.359)	2.663*** (.453)	4.188*** (.511)	4.2646*** (.751)
AGE_1	-.074*** (.012)	.025 (.022)	.040 (.030)	.077 (.054)
NKIDS	--	--	--	--
PRESCHL = 1	--	--	--	--
Elements of $\boldsymbol{\alpha}_2^*$				
Intercept	16.265*** (2.684)	42.323*** (13.651)	7.334*** (2.731)	9.989** (5.025)
$Black_2 = 1$	.469 (.422)	3.312* (1.821)	1.021* (.523)	1.633* (.888)
$COLL_2 = 1$	1.918*** (.344)	3.064*** (.976)	.338 (.252)	.326 (.364)
AGE_2	-.030*** (.010)	.075** (.035)	.058*** (.020)	.053 (.034)
NKIDS	--	--	--	--
PRESCHL = 1	--	--	--	--
$\boldsymbol{\alpha}_3^*$	.397*** (.022)	.243*** (.054)	.664*** (.078)	.453*** (.126)
$\boldsymbol{\beta}_{11}$				
$\boldsymbol{\beta}_{22}$	.703*** .074	1.129*** (.366)	.363*** (.070)	.311** (.124)
$\boldsymbol{\beta}_{33}$	.000*** (.000)	.000*** (.000)	.000*** (.000)	-.000* (.000)
$\boldsymbol{\beta}_{12}$	-.219*** (.049)	.082 (.110)	-.103** (.041)	-.029 (.061)
$\boldsymbol{\beta}_{13}$	.000 (.000)	-.001*** (.001)	-.007*** (.001)	-.007*** (.002)
$\boldsymbol{\beta}_{23}$	.001** (.000)	.002* (.001)	-.003*** (.001)	-.004*** (.004)
$1/\boldsymbol{\sigma}_1$	.107*** (.001)	.117*** (.003)	.106*** (.001)	.110*** (0.003)
$1/\boldsymbol{\sigma}_2$	.152*** (.016)	(.094)*** (.030)	.220*** (.043)	.244*** (.095)
$\boldsymbol{\rho}$	-.300*** (.104)	.242 (.198)	.0146 (.129)	.177 (.204)
Log-likelihood function	-14918.3	-7247.30	-7812.55	-3278.44
Number of Observations	4,197	2,110	2,180	906

Notes: Standard errors are in parentheses. *, **, *** denote significance at the 90, 95, and 99 percent confidence levels, respectively.

Table B3. Estimated utility function parameters and simulated change in hours, family income, and utility resulting from effects of 2001 tax reform, by number of children, families in 2000.

	No Children	One Child	Two Children	Three Children or More
U_1	1.89^	-0.05	2.39^	1.63
U_2	1.51	-0.05	1.75^	1.14^
U_3	0.18^	0.01	0.18^	0.12^
Husband's own wage elasticity	0.20^	0.10	0.34^	0.20^
Husband's cross wage elasticity	0.12^	0.07	0.34^	0.26^
Husband's unearned income elasticity	-0.013^	-0.005^	-0.013^	-0.008^
Wife's own wage elasticity	0.18^	0.07	0.42^	0.31
Wife's cross wage elasticity	0.16^	0.10^	0.23^	0.09
Wife's unearned income elasticity	-0.014^	-0.005^	-0.022^	-0.018^
Husband's labor supply response (hrs/wk)	+0.77^	+0.27	+0.89^	+0.45^
Wife's labor supply response (hrs/wk)	+0.70^	+0.23^	+0.30^	-0.21
dV (Total change in utility) [annual dollar-equivalent = $(dV/U_3)*52$]	20.96^ [6,152]	1.34 [7,049]	27.12^ [7,726]	17.82 [7.982]
dV_{H1} (from change in husband's hrs)	-1.46^	0.01	-2.12^	-0.74
dV_{H2} (from change in wife's hours)	-1.06^	0.01	-0.53^	0.24
dV_X (from change in income)	23.48^	1.31	29.77^	18.32^
Welfare gain as percent of total pre-tax family income	8.22%	9.99%	10.66%	12.61%
Percent of total (dollar-equivalent) utility generated from the 2001 tax reform accruing to each family type	39.87%	22.96%	26.00%	11.17%
Percent of total labor supply response provided by family type	61.52%	10.47%	25.84%	2.17%
Number of observations	4,197	2,110	2,180	906

Note: Estimates obtained for representative family in each group. ^ indicates estimate of utility function parameter is significantly different from zero based on bootstrapped 95 percent confidence intervals. Unearned income elasticities are evaluated at actual unearned income.