Evidence of Tax-Induced Individual Behavioral Responses

Thomas J. Kniesner
Center for Policy Research & Department of Economics
Syracuse University
Syracuse, NY
tkniesne@maxwell.syr.edu

James P. Ziliak
Department of Economics & UK Center for Poverty Research
University of Kentucky
Lexington, KY
jziliak@uky.edu

November 18, 2006

Prepared for presentation at the conference *Is it Time for Fundamental Tax Reform?: The Known, the Unknown, and the Unknowable* at the James A. Baker III Institute of Public Policy, Rice University, April 27–28, 2006. We are grateful for the helpful comments of the audience members, Emmanuel Saez, Robin Sickles, and George Zodrow.

"*The Clinton revenue estimates are based on the fallacy that taxpayers will not change their behavior in response to a 37% jump in their marginal tax rates...*" Martin Feldstein (1993)

Estimating the effect of income taxes on individual behaviors such as labor supply, compensation, saving, and taxable income have been focal points of economic research for several decades. Because income taxes account for nearly 80 percent of all federal revenues collected, their effects on individual behaviors and the attendant tax collections figure prominently in tax policy debates. For example, in 1993 the Clinton administration proposed increasing marginal tax rates by about one-third for the highest income Americans. In estimating how much revenue the tax increase would produce, they assumed hours worked by American taxpayers would change little and that tax collections would then rise by an amount directly proportional to the rate hike. Feldstein (1993) countered that the tax increase would substantially lower work effort by encouraging primary workers to reduce their hours of work and encouraging secondary workers in high-income households to leave the labor force, and that the tax increase would induce high-income workers to alter the form and timing of their compensation. Feldstein concluded that the combined negative behavioral responses of work effort and compensation would raise tax revenues much less than predicted, and that revenues might even fall. Whether because of or in spite of the Clinton tax policies, actual tax collections went well above both the Administration's and Feldstein's forecasts in the late 1990s, re-emphasizing our limited understanding of the behavioral consequences of income taxes. We describe here what is known, knowable, and likely unknowable about the effects of income taxes on individual and household decisions.

Knowledge of the empirical consequences of income taxation on labor supply, consumption, and saving is of first-order importance not only to inform policy about the magnitudes of the possible behavioral and distributional consequences of fundamental tax reform, but also to inform policy on the direction of the response. Consider first the case of labor supply. Supporters of replacing current graduated marginal tax rates with a flat tax typically cite positive labor supply consequences of a flat tax. Economic theory does not provide a definitive answer on the effect of a flat tax on labor supply over much of the income distribution. The ambiguity is from possible offsetting substitution and income effects when the after-tax wage rate changes. Suppose moving to a flat tax lowers the marginal tax rate for the typical worker. Decreasing the marginal tax rate raises the price of leisure, inducing a substitution effect away from leisure and toward market work. Reducing the marginal tax rate also increases effective income so that the person generally wants more leisure and less work after the net wage rises. The total effect on labor supplied is ambiguous a priori due to offsetting income and substitution effects. Additional ex ante complexity of the effects of taxes on labor supply or other dimensions of individual behavior occurs if persons inaccurately perceive the tax system or are concerned with their economic situation relative to others (Saez 2006, Sickles 2006), which is discussed comprehensively in the paper by McCaffery (2006) in this volume.

Consider too the effects on saving of a flat tax proposal. The lower marginal tax rate raises income available to save. It also raises the after-tax return to saving, which raises the relative price of current consumption and induces a substitution away from consumption. Simultaneously, the lower tax rate causes an income effect toward consumption. The overall effect of tax reform on saving is also ambiguous.

Predictions of the behavioral effects of tax reform also become complicated to disentangle theoretically if one relaxes the common assumption of separability between consumption and labor supply decisions (Heckman 1974a). Empirical research is the key to determining whether tax policy will have its intended effects when consumption and labor supply interact in the person's utility function, particularly where the issue is the effect on the tax base or the efficiency cost of taxation with an eye toward a so-called optimal personal income tax.

We mainly organize our description of the individual and household behavioral effects of income taxes around a canonical life-cycle model of consumption and labor supply under uncertainty (Ziliak and Kniesner 2005). The general framework permits us to depict the two primary sets of parameters of interest for tax policy: (1) the parameters that govern intratemporal decisions that provide estimates of compensated, uncompensated, and nonlabor income elasticities of consumption and labor supply, and (2) the parameters that govern intertemporal decisions that provide estimates of the elasticity of substitution of consumption and labor supplied over time.

From the two-part conceptual framework we use as an organizational tool, we can discuss a number of configurations that yield estimating equations commonly found in the literature, such as static models of taxation and labor supply (Hausman 1981) and saving (Boskin 1978), as well as life cycle models of taxation and consumption (Zeldes 1989) and labor supply (Ziliak and Kniesner 1999). We also demonstrate how nested inside our model of the individual's behavior are specifications found in the recent literature on the elasticity of taxable income (Giertz 2004). It is then straightforward to characterize exact measures of deadweight loss to facilitate discussion of the efficiency cost of distortionary taxation (Auerbach 1985). Our main goal is to leave the reader with a clear picture of what we know, what we do not know, and what we are unlikely to know about micro-econometric estimates of taxation and labor supply, consumption, saving, and how generic tax reform proposals would affect economic well-being.

It is important to note that we focus on microeconometric estimates from U.S. data involving cross-sectional and time-series differences in the federal income tax. We are largely silent concerning possible estimates from macro country data (Alesina, Glaeser, and Sacerdote 2005, Davis and Henrekson 2004, Prescott 2004) or from data on idiosyncratic occupations (Camerer et al. 1997, Farber 2005, Oettinger 1999). Not only are the microeconometric estimates we discuss of interest on their own, but they are also commonly used (1) as inputs into partial equilibrium calculations of deadweight loss and optimal taxation and (2) as inputs into computable general equilibrium models of the economy as found in Altig et al. (2001) and the accompanying paper by Diamond and Zodrow (2006) in this volume.

Summary. Economists know reasonably well the effects of personal income taxes on labor supply and taxable income, including quantity effects and the attendant excess burden implications. Existing estimates along with improvements in computing technology permit detailed numerical simulations of tax reform proposals, including point estimates and confidence intervals of likely effects. A key topic that is currently poorly known but could be knowable is the overall saving effects of personal income taxes. To examine saving more precisely we would need more agreement on the appropriate life-cycle model to estimate, particularly the form of future discounting, plus better data on total saving. What we are unlikely to know any time soon are the details of a comprehensive optimal personal income tax. A truly optimal tax system takes account of three avenues through which income taxes affect economic well being: efficiency costs of collecting the tax (including administrative and compliance costs), social equity concerns regarding the distribution of net income, and consumption smoothing as income fluctuates due to events not insurable privately. In addition to having to examine the three dimensions simultaneously, there is the complication of whether families make group or unitary decisions and whether there are interfamily social interactions in behavior. It seems unlikely to us that economists will any time soon compute the quantitative properties of a comprehensive optimal tax structure.

2. What We Know About Taxes and Men

A result that has appeared regularly in traditional empirical research on male labor supply is that intratemporal uncompensated wage and intertemporal substitution effects are small and imprecisely estimated. There was little agreement on whether the estimated compensated wage effects were positive or if the Slutsky matrix conditions held empirically (Hausman 1981; Pencavel 1986; MaCurdy, Green, and Paarsch 1990; Triest 1990; Blundell and MaCurdy 1999). A positive compensated wage effect means that a revenue-neutral move to a flatter tax induces more hours worked and reduces deadweight loss, but a negative compensated wage effect produces outcomes opposite to those intended by proponents of tax reform.

Hausman (1981) estimated an uncompensated wage effect near zero, but a large negative income effect, resulting in a relatively large positive compensated wage effect. Triest (1990), using similar methods to Hausman but with data from a different year (1983 instead of 1975 in Hausman), was unable to reproduce Hausman's large income effect and thus concluded that both the uncompensated and compensated wage effects for men were near zero. MaCurdy et al. (1990), using more robust econometric techniques described below and the same year as Hausman, found, like Triest, no evidence of a large compensated wage effect. The lack of consensus on the magnitude and sign of compensated wage effects has muddied discussions of the welfare implications of a flatter tax structure.

A focal debate in the labor supply and tax literature has been on how to incorporate the economic nuances of the piecewise-linear budget constraint into model estimation. The seminal work by Burtless and Hausman (1978) and Hausman (1981) applied a maximum likelihood procedure that rested on strong behavioral assumptions: that a worker has complete knowledge of all tax brackets ex ante, that the Slutsky condition is satisfied at all internal kink points of the budget constraint, and that the pre-tax wage and nonwage income are exogenous to labor supply.

Pre-tax wage exogeneity is unlikely because researchers have most often used average hourly earnings. If hours worked are measured with error then so is average hourly earnings, which then becomes endogenous. MaCurdy, Green, and Paarsch (1990) noted that maximum likelihood models such as Hausman's force a nonnegative estimated wage effect and a nonpositive estimated income effect; that is, the piecewise-linear budget constraint models guarantee Slutsky integrability. Because of the econometric complexity and stringent ex ante restrictions that the maximum likelihood estimator used in the well-known and heavily cited papers of Hausman place on estimated labor supply parameters, MaCurdy et al. (1990) advocated an alternative instrumental-variables estimator.

The alternative instrumental variables approach first approximates the piecewise linear budget set with a smooth, continuously differentiable budget constraint and then instruments for the endogenous after-tax wage and virtual nonlinear income terms. Using the more flexible instrumental variables estimator, MaCurdy et al. (1990) find that male labor supply is largely unresponsive to the economic environment, including taxes.

Although there was an abundance of papers on the effects of taxes on labor supply in the 1970s and 1980s, empirical research on the joint effects of income taxes on labor supply and consumption/saving outcomes -- both within and across periods -- is virtually nonexistent. Much of the research on labor supply and taxation has been conducted with static models on cross-sectional data, and all previous empirical work on taxes and labor supply in a life-cycle setting maintains the assumption of additive separability between consumption and leisure (Blundell et al. 1998; Ziliak and Kniesner 1999). Existing research on consumption and taxation mostly examines how distortionary income taxation affects efforts to smooth consumption (Auerbach and Feenberg 2000; Kniesner and Ziliak 2002; Low and Maldoom 2004; Strawczynski 1998; Varian 1980). Estimates of labor-supply tax effects in the context of a flexible framework also reveal saving effects, which are critical to more informed tax policy, especially if government agencies such as the Congressional Budget Office score tax revenue effects dynamically (Mankiw and Weinzierl 2006). In recent research (Ziliak and Kniesner 2005) we extended the labor supply and taxation literature by estimating a life-cycle model of consumption, saving, and labor supply under uncertainty with nonlinear wage income taxation that relaxes the standard assumption of strong separability in consumption and labor supply choices within periods.

Organizing Model. We use the model in Ziliak and Kniesner (2005) as an organizing vehicle for the remainder of the discussion of male labor supply. Consider a consumer choosing consumption/saving and labor supply in an environment of economic uncertainty. The uncertainty comes from unknown future paths of wages, prices, taxes, and interest rates. For tractability inter-temporal preferences are taken as time separable, as are budgets. Intertemporal separability rules out consumption or labor supply habits wherein current utility from consumption or labor supply depends on their history and rules out budget non-separabilities due to possible endogenous human capital (Shaw 1989; Imai and Keane 2004) or joint nonlinear taxation of wage and capital incomes (Blomquist 1985; Ziliak and Kniesner 1999), which in many cases enlarge the labor supply response so that the estimates we emphasize here are for the most part conservative. Most importantly, we enrich the empirical specification by introducing non-separabilities in within-period preferences over consumption/saving and labor supplied, which makes them jointly determined.

The familiar necessary condition for an equilibrium solution with consumption, saving and labor supply equates the marginal rate of substitution (*MRS*) of market hours for consumption to the after-tax wage rate, $\omega_t \equiv w_t(1-\tau_t)$,

$$-U_{h,t}/U_{C,t} = \omega_t, \tag{1}$$

where C_t is composite non-durable consumption, h_t is annual hours of work, w_t as the gross hourly wage rate, $U_{C,t}$ is the first derivative of within-period utility with respect to consumption, $U_{h,t}$ is the first derivative of utility with respect to hours of work, and $\tau_t = \partial T_t(\cdot)/\partial h_t$ is the marginal tax rate. Given a parametric or nonparametric specification of preferences, cross-sectional data are sufficient to identify intra-temporal preferences, which in turn reveal the familiar compensated and uncompensated wage elasticities of labor supply and common measures of the efficiency cost of income taxes and tax reforms.

The allocation of wealth over time is determined by the Euler condition

$$\lambda_A^t = \beta E_t[(1+r_t)\lambda_A^{t+1}], \tag{2}$$

where $\lambda_A^{t+1} = \partial V^{t+1}/\partial A_{t+1}$ is the marginal utility of wealth, $\beta = 1/(1+\rho)$ is the time discount rate, E_t is the expectations operator conditional on information available at time *t*, and r_t is a risk-free interest rate. Identifying inter-temporal preferences requires data with a time dimension to estimate the allocation of wealth over time as governed by the Euler condition in (2).

A key parameter in life-cycle models of consumption/saving is the inter-temporal substitution elasticity (*ISE*), which is the proportional change in consumption expenditure across periods necessary to keep the marginal utility of wealth constant given an anticipated one-percent change in relative consumption prices. Related is the Frisch (marginal utility of wealth constant) specific-substitution elasticity between any two goods *j* and *k*

$$e_{jk}^{F} = e_{jk}^{U} + e_j e_k s_k \Phi \, , \tag{3}$$

where e_{jk}^{F} is the Frisch elasticity, e_{jk}^{U} is the compensated (cross) price elasticity, e_j and e_k are expenditure (income) elasticities, s_k is the share of good *k* in the household budget, and Φ is the *ISE* (Browning 2005). Under simple specifications where consumption is independent of the path of wages, $e_{jk}^{F} = e_j \Phi \approx e_{jk}^{Y}$, where e_{jk}^{Y} is the income-constant Marshallian cross-price elasticity of demand. Because Φ, and in turn e_{jk}^{F}, are not generally identifiable with cross-sectional data, recovering lifetime preference parameters requires panel data (MaCurdy 1983) or cohort data (Blundell, Browning, Meghir 1994).

Our empirical strategy is a two-stage estimation method where in the first stage we estimate the intra-temporal (*MRS*) equilibrium condition, $-U_{h,t} / U_{C,t} = \omega_t$, by specifying a direct translog functional form for within-period preferences that permits interdependent marginal utilities of consumption (saving) and labor supply. Demographics come into the model via the method of demographic translating where the utility parameters are explicit functions of demographic characteristics. Given estimated within-period preference parameters, we construct the period-specific utility and marginal utility functions and assume a Box-Cox transformation governs the utility related functions to estimate the inter-temporal preference parameters from equation (2). The inter-temporal preference parameters in our model permit variation in risk aversion and the *ISE* according to time-varying demographic characteristics. In general, estimation of the *MRS* and the evolution of lifetime wealth are complicated both because they are nonlinear in the parameters and because the regressors are endogenous (hours of work and leisure, consumption/saving, and wages in the *MRS* equation and both utility and marginal utility in the intertemporal wealth equation).

Data Issues. To identify the tax effects on work incentives and consumption/saving in Ziliak and Kniesner (2005), we used household-level data on male heads of household from the 1980–1999 waves of the Panel Study of Income Dynamics (1979–1998 calendar years).

Our data span multiple tax reforms in the United States: the Economic Recovery Tax Act of 1981, the Tax Reform Act of 1986, the Omnibus Reconciliation Tax Acts of 1990 and 1993, and the Taxpayer Relief Act of 1997. Together, the tax reforms of 1981 and 1986 reduced marginal tax rates across the board, reduced the number of tax brackets from 16 to four, and expanded the taxable income base. Although the tax reforms of the 1990s reversed the trend of the 1980s' reforms by adding two new higher marginal tax rates on upper-income Americans, the tax reforms of the 1990s also significantly expanded the Earned Income Tax Credit among low-income working families.

Focusing on prime-age male heads of household allowed us to ignore issues associated with labor force nonparticipation (discussed below in the context of female labor supply). When constructing annual taxable income we assume that married men filed joint tax returns and unmarried men filed as head of household. Adjusted gross income is the sum of labor earnings, cash transfers, and property income. To approximate the actual marginal tax rate facing the household we included property income in AGI, inclusive of wife's earnings in cases where married men have working wives. For tractability we abstracted from the fact that an inclusive property income measure may generate interdependencies both within-periods in spousal labor supply choices, and across periods in intertemporal labor supply, as discussed in Ziliak and Kniesner (1999).

Estimated Effects of Taxes on Consumption/Saving and Labor Supply. Table 1 presents the main results from Ziliak and Kniesner (2005) expressed in concepts most useful for labor-market and tax policy: namely, income elasticity, compensated and uncompensated wage elasticities for within-period preferences, and the *ISE* and Frisch specific substitution elasticities for inter-temporal preferences. Here we focus on labor supply and consumption effects. In a later section we translate our estimated effects of taxes into implications for the effects of tax policy on saving. In Ziliak and Kniesner (2005) we find that consumption and work hours are direct complements so that consumption and leisure are direct substitutes.

Evaluated at the sample means of hours, net wages, and non-durable consumption, the non-labor (property) income elasticities for consumption and labor supply are 0.035 and –0.517, indicating that both consumption and leisure are normal goods. Note that the non-labor income elasticity of consumption is not the same as the total income elasticity often reported in consumption studies. The corresponding utility-constant compensated wage elasticities of consumption and labor supply are 0.086 and 0.328.

Our estimated compensated wage elasticity of labor supply exceeds that typically reported in the literature and implies a sizable deadweight loss of taxation. Specifically, in a model based on linear preferences and additive separability between consumption and hours, we find a compensated wage elasticity about one-half that reported here. Below we discuss whether the difference is driven more by functional form differences than by the possibility of non-separability between consumption and labor supply. Because of the sizable non-labor income effect relative to the compensated wage effect, we find that the uncompensated wage elasticity of labor supply is negative. Male labor supply bends backward. Although the income elasticity of labor supply is large, it is in the range of previous estimates reported in the literature, as is the finding of backward-bending male labor supply (Blundell and MaCurdy 1999; Pencavel 1986). Important for estimates of the economic efficiency of the tax system is that we do find an upward-sloping compensated labor-supply supply function.

The estimate of the *ISE* at the means is about –1.0 for nondurable expenditures, which is consistent with strictly concave inter-temporal preferences. Given the *ISE* and compensated wage elasticities, the Frisch-specific substitution elasticity of labor supply is 0.54. The parallel Frisch net wage elasticity of consumption is 0.072. Our basic estimates imply that consumption and leisure are substitutes within periods. Intertemporally, the elasticities in Table 1 confirm that with an anticipated increase in the real after-tax wage, hours of market work increase, leisure falls, and consumption rises. Collectively the elasticity estimates in Table 1 indicate possible welfare gains from increased labor supply and consumption from revenue-neutral tax reforms that raise after-tax wages.

In Ziliak and Kniesner (2005) we also considered a number of specification checks on our base-case results in Table 1. To avoid mixing stocks and flows we primarily measure consumption as total non-durable consumption expenditures for the family. For completeness we also present estimates replacing imputed non-durable expenditures with food expenditures as the measure of consumption.

Food is the prevalent measure of expenditures used in consumption-based analyses in the PSID, though more by default than choice because food may be a poor proxy for the preferred non-durable consumption measure. The property income effect for food consumption is about 0.5; because the point elasticity involves multiplying the marginal effect by the ratio of property income to food consumption, the elasticity is also about 0.5 because average food spending is of comparable magnitude to average property income. Using food consumption leads to a significantly larger uncompensated wage elasticity of consumption. As in the case of non-durables, the Frisch specific substitution elasticity is positive, reflecting that food consumption and leisure are substitutes. Indeed, the coefficient on the food consumption-leisure interaction term is 15.14 with a standard error of 0.90, as compared to the base case estimate of 4.26 (0.43). The implications for labor supply elasticities in the case of food consumption are to cut the estimated property income elasticity in half and to cut the compensated wage elasticity by about two-thirds. Although the qualitative results remain unchanged when we switched from non-durable consumption to food consumption, the magnitudes clearly depend on the consumption measure.

A final robustness check we performed in Ziliak and Kniesner (2005) was to impose the common assumption of additivity between consumption and leisure to examine how important allowing for non-separabilities in within-period preferences is for key parameters used in policy evaluation. Focusing on the labor supply results, imposing separability between consumption and leisure produces significantly larger non-labor income, compensated wage, and Frisch wage elasticities of labor supply, and a correspondingly smaller (in absolute value) uncompensated wage elasticity of labor supply.

The pattern of results reveals something akin to the classic omitted variable bias problem when consumption and labor supply are not allowed to interact econometrically in marginal utility. Consumption and hours of work are not separable and are direct complements. Given that consumption and property income covary positively, as do consumption and labor supply, omitting consumption imparts a downward (negative) bias on the non-labor income elasticity of labor supply and an upward bias on the compensated wage elasticity of labor supply. Allowing for non-separability between consumption and labor supply is important economically. Models that ignore consumption-hours interactions likely provide upper bounds on labor supply elasticities.

To explore the non-separability issue further we examined whether a similar pattern emerges in the standard linear labor supply model with and without consumption. We regressed annual hours of work on the log of the real net wage, virtual non-labor income, and demographics, with versus without consumption. The linear labor supply model with consumption is conceptually similar to the conditional demand framework described in Browning and Meghir (1991) where consumption is not formally modeled but simply serves as a conditioning variable for labor supply outcomes. Although the magnitudes of the elasticities are significantly lower in the linear case, which highlights a further potential cost of choosing an inflexible specification of preferences yielding the linear labor supply model, the estimated compensated wage elasticity of labor supply without consumption is 0.024 and with consumption is 0.020. The 20 percent larger linear labor supply wage elasticity without consumption emphasizes that imposing additivity between consumption and leisure has important consequences for estimates of labor-market behavior.

Summary. Labor supply elasticities are key to understanding the distribution of income as well as the efficiency and equity dimensions of an individual income-based tax. Later sections emphasize the direct relationship between the compensated net wage effect and the efficiency loss, which implies a lower optimal tax rate. Although it has often been the case in policy simulations to use small elasticity values for U.S. men, recent research has re-examined the conclusion that men’s elasticities are close to zero. Richer econometric specifications include allowing intertemporal non-separabilities in the budget constraint (Ziliak and Kniesner 1999), semiparametric forms for the labor supply function (Blomquist, Eklöf, and Newey 2001;

Blomquist and Newey 2002), possible social interactions that are labor supply synergies across workers (Grodner and Kniesner 2006a,b), and the joint intertemporal choices of consumption and labor supply that we have focused on here (Ziliak and Kniesner 2005). The additional generality of recent research on male labor supply has yielded larger estimates of the effects of income taxation on labor supply. The results in Table 1 find a compensated labor supply elasticity for men of as much as 0.33. The effects of taxes on men is undergoing re-evaluation due to recent econometric advances such that policy intended to minimize deadweight loss and set optimal taxes may require lower tax rates than previously thought based on possibly underestimated effects of income taxes on the labor supply and consumption of U.S. men.

Table 1
Selected Intra-temporal and Inter-temporal Elasticities

Real Changes in After-Tax Income (Y_t) or Wages (ω_t)	Consumption	Labor Supply
Income Elasticity	0.035	–0.517
	(0.015)	(0.078)
Compensated Elasticity	0.086	0.328
	(0.014)	(0.064)
Uncompensated Elasticity	0.232	–0.468
	(0.080)	(0.098)
Inter-temporal Substitution Elasticity	–0.964	—
	(0.009)	
Frisch Specific Substitution Elasticity	0.072	0.535
	(0.010)	(0.124)

NOTE: The elasticities, which are based on the parameter estimates in Tables 1 and 2 of Ziliak and Kniesner (2005), are evaluated at the mean values of the functions. The standard errors are based on 1000 bootstrap replications of the *MRS* and Euler equations.

3. What We Know About Taxes and Women

The early literature either characterized labor supply via the labor-force participation decision, or via hours of market work with non-workers either discarded or retained but their missing wages imputed by the wages of workers. Each procedure yields biased estimates of the wage elasticity of labor supply, and limiting the scope to the participation decision also makes the research of no use for understanding the consequences of income taxes for the tax base or economic well-being.

Heckman (1974b) modeled participation, wages, and hours of work in a simultaneous equations system using a sample of working and non-working married women in a way that yields economically and statistically coherent parameter estimates of the labor supply of women. Heckman and MaCurdy (1980, 1982) extended the static model to the life-cycle case. The issues of sample selection bias induced by non-workers apply to all subgroups, not just married women. Nonparticipation is typically ignored when considering prime-aged male labor supply because most prime-aged men work for pay unless disabled. Despite its importance to labor supply research, the Tobit-type model of Heckman (1974b) imposes a proportionality relationship between the coefficients on the participation and hours-worked margins and does not easily accommodate the presence of fixed costs of work. A more econometrically general approach is to estimate the two labor supply dimensions separately (Heckman 1993; Zabel 1993).

In addition to allowing more flexibility for fixed money and time costs of holding a job, estimating the participation and hours-worked margins separately helps us better understand optimal tax and transfer policy. Saez (2002) demonstrates via simulation that if the bulk of the labor supply response is at the hours-worked margin then the optimal transfer policy is a negative income tax (NIT) with a large guarantee and high phase-out rate. If, instead, the response is concentrated at the participation margin, and the elasticity is at least 1.0, then the optimal policy is an Earned Income Tax Credit (EITC) that has a smaller guarantee coupled with a negative marginal tax rate at low incomes.

There is surprisingly little research providing structural estimates of the wage elasticity of women's labor supply at both the participation and hours worked margins (Kimmel and Kniesner 1998; Heim 2005a,b; Ziliak 2005). Kimmel and Kniesner (1998) use data from the Survey of Income and Program Participation to estimate wage elasticities separately for men and women by marital status, but do not model the tax system because their data are sub-annual. Ziliak (2005) models the labor supply of single mothers in the presence of income taxes and transfers, while Heim (2005a,b) models the labor supply of married women in the presence of income taxation. Hausman (1981), Triest (1990), and Keane and Moffitt (1998) examine women's labor supply in a Tobit-type framework with taxes and the simultaneous choice of hours of work and budget constraint segment (marginal tax rate); consequently, their parameter estimates yield convolutions of extensive and intensive margin elasticities. Meyer and Rosenbaum (2001) did model the tax and transfer system but restricted attention to the participation margin and did not provide a direct estimate of the wage elasticity. Finally, a number of studies have attempted to identify the response of women's labor supply to tax changes from reforms to the EITC (Hotz and Scholz 2003; Eissa and Hoynes 2005). Most of the EITC studies either used reduced form methods or employed difference-in-difference estimators to control for confounding factors so that the estimates do not reveal structural behavioral parameters useful for complex policy evaluation.

Organizing Model. To fix ideas, consider the canonical individualistic static model of labor supply in the presence of nonlinear income taxes as adopted in Ziliak (2005). In any period

t the i^{th} woman is assumed to have preferences $U(C_{it}, L_{it})$ over a composite consumption good C_{it} and leisure time L_{it}. She maximizes utility subject to the time constraint $\bar{L} = L_{it} + h_{it}$, where $\bar{L}$ is total time available and h_{it} is hours of market work, in light of the current-period budget constraint $C_{it} = w_{it}h_{it} + N_{it} - T_t(Y_{it})$. As before, w_{it} is the real before-tax hourly wage rate, N_{it} is real taxable nonlabor income, $I_{it} \equiv w_{it}h_{it} + N_{it}$ is real total taxable income, and $T_t(I_{it})$ is real tax payments. Similarly, $\tau_{it} \equiv T_t'(I_{it})$ is the marginal tax rate so that the resulting after-tax wage rate is $\omega_{it} = w_{it}(1-\tau_{it})$. Although the individualistic framework is most applicable to single women, it is also useful for thinking about married women's labor supply.

Considering only the two labor-market states, employed and not employed, the decision to work boils down to a comparison of utility in the employed state, $U(C_{it}, L_{it} < \bar{L})$, to utility in the not employed state, $U(C_{it}, L_{it} = \bar{L})$. If we define the net gain from employment as $\Delta_{it} = U(C_{it}, L_{it} < \bar{L}) - U(C_{it}, L_{it} = \bar{L})$, then the indicator variable $e_{it} = 1$ if $\Delta_{it} > 0$ and $e_{it} = 0$ otherwise. Assuming that the stochastic component of the employment decision is distributed normally, then the probability of working is a structural probit model, $P_{it}^e \equiv P(e_{it} = 1) = \Phi(\bullet)$. Because the example woman chooses to work if and only if the offered after-tax market wage ω_{it} exceeds the reservation wage (which is the inverse of the labor supply function when all time is spent in leisure, $L_{it} = \bar{L}$), the structural equation for the probability of employment has the same covariates as the structural hours-worked equation. The same set of variables determines the structural extensive and intensive labor supply choices (Heckman 1974b).

For women choosing labor market work, equilibrium hours worked at the intensive margin is determined similarly to men where one equates the marginal rate of substitution of market hours for consumption to the real after-tax hourly wage, $-U_{h,t}/U_{C,t} = \omega_t$. When estimating the intensive margin in the presence of nonlinear income taxes one approach is to specify the complete budget frontier and have the worker simultaneously choose the marginal tax rate segment and hours of work conditional on segment choice (Hausman 1981). A drawback of an econometric model that has the worker choosing both the budget segment and point on the segment is that it effectively imposes global satisfaction of the Slutsky condition at all internal kink points, contrary to much evidence (MaCurdy, Green, and Paarsch 1990). A robust alternative is to linearize the (convex) budget constraint by taking the net wage as given and adding a lump-sum transfer of $\tau_{it}W_{it}h_{it} - T_t(Y_{it})$ to nonlabor income to yield so-called virtual nonlabor income, $\tilde{N}_{it}$, which compensates the worker so that statistically she behaves as if facing a constant marginal tax rate at all income levels.

With linearized budget constraints and virtual income, a common specification for hours worked at the intensive margin is $h_{it} = \alpha + \beta \ln \omega_{it} + \gamma \tilde{N}_{it} + X_{it}\varphi + u_{it}$, where X_{it} is a vector of demographic variables affecting hours choices, and u_{it} is a structural error term (Blundell, et al. 1998; Browning, Deaton, and Irish 1985). The intensive-margin wage elasticity of hours worked is then $\hat{\beta}/h_{it}$, which is a declining function of hours worked. Because wages are observed for workers only, and because the marginal tax rate that enters both the net wage and virtual-income variables is a function of hours of work, one treats the net wage and virtual income terms as endogenous while simultaneously controlling for non-random self selection into work. Popular techniques are parametric or semi(non)-parametric control functions such as the Heckman (1979) two-step correction.

Economic theory tells us that the same set of covariates enters both the intensive and extensive margin labor supply decisions so that the corresponding equation for the structural employment-status decision is $P_{it}^{e} = P(h_{it} > 0) = \Phi(\alpha^{e} + \beta^{e} \ln \omega_{it} + \gamma^{e} \tilde{N}_{it} + X_{it}\varphi^{e})$. The superscript *e* denotes that the coefficients describing the extensive margin need not be the same as the coefficient describing the intensive margin. Under normality, the associated participation elasticity with respect to the net wage is $\hat{\beta}^{e} \frac{\hat{\phi}_{it}(\bullet)}{\hat{\Phi}_{it}(\bullet)}$, where $\hat{\phi}$ and $\hat{\Phi}$ are the probability density function and cumulative distribution function of the normal distribution evaluated at the estimated structural parameters for each sample observation.

Because the wage is not observed for non-workers, Kimmel and Kniesner (1998) and Ziliak (2005) estimate a structural wage equation for workers only that controls for self-selection into the labor force. Given the selection-corrected wage function parameters, they predict a wage for all women and replace the predicted log wage in the participation equation. Virtual income is likewise treated as endogenous in the structural participation equation.

Issues of Marital Status. Within the canonical model of labor supply the econometric issues surrounding married women's labor supply do not differ much from issues concerning single mothers. Distinguishing between the extensive and intensive margins is crucial for both groups of women given the large percentage of mothers out of the labor force, as is modeling the effects of the age composition of children.

A key difference between single and married mothers in the canonical model is the appropriate marginal tax rate for constructing the after-tax wage. Because single mothers are the sole income earner the marginal tax rate on the first dollar earned is typically zero because of personal exemptions and deductions. For married women the appropriate marginal tax rate on the first dollar earned depends on whether labor supply decisions of the partners are determined jointly or sequentially. The typical assumption is to model married women's labor supply decisions as sequential to the husband's hours choice, so that the marginal tax rate on the woman's first dollar earned is the marginal tax rate facing the husband on his last dollar earned. An alternative approach in the empirical literature has the hours choice jointly determined, the tax filing status jointly determined, and the marginal tax rate as the family's joint tax rate.

Recent research challenges the canonical model of the family on the grounds that the data usually reject income pooling (Lundberg, Pollack, and Wales 1997). The collective model of labor supply is robust to violations of pooling (Chiappori 1992). Indeed, evaluating tax policy is a key motivation stated by Chiappori for the structure of his model. The canonical family model of labor supply allows tax policy to affect the distribution of income across families, but not the within-family income distribution. The inter- versus intra-family difference occurs because the income pooling assumption implies that a dollar in nonlabor income transferred to the wife (such as the EITC) has the same effect on household consumption demands as a similar-sized transfer made to the husband. The collective model allows the transfer to affect household spending patterns differentially based on which spouse receives the transfer and the relative bargaining power of that spouse in the family. In the base-case collective model each spouse has egoistic preferences over their own consumption and labor supply choices. After bargaining occurs on how to divide the nonlabor income, the labor supply choice is made independently of the other spouse's decision. Given the ex ante division of nonlabor income in the collective model, the econometric model for married women will then be akin to the model for single mothers.

Estimated Labor Supply Effects. The evidence to date on structural wage elasticities of female labor supply suggest that the elasticity at the extensive margin dominates estimates at the intensive margin. Kimmel and Kniesner (1998), using the tri-annual data from the 1984 panel of the SIPP without controls for income taxation, find participation elasticities on the order of 2.4

for single women and 1.85 for married women, and compensated hours-worked elasticities of about 0.7 for both single and married women.

Ziliak (2005) uses 23 years of data on single mothers from the CPS (1980–2002) and tax data from NBER's TAXSIM program to infer income taxes. To identify the after-tax wage elasticities of participation and hours worked, he adopts a scheme similar to Blundell, et al. (1998), which exploits the fact that the after-tax wage and virtual nonlabor income grew differentially over the sample period. The differential growth in after-tax wages comes from both demand-side factors such as skill-biased technological change and supply side policy reforms such as the ERTA81, TRA86, and expansions in the EITC. The instrumental variables estimator Ziliak uses yields an average participation elasticity of 2.0 and a compensated hours-worked elasticity of 0.15. For single mothers attached to the transfer system, the compensated hours-worked elasticity at the median ranges from 0.4 for women only on the cash welfare program AFDC/TANF to 1.9 for mothers receiving both cash welfare and food stamps. There seems to be substantial heterogeneity in the labor supply response to after-tax wage changes among single mothers.

Heim (2005) uses an econometric model similar to that of Kimmel and Kniesner (1998) and Ziliak (2005), but his research differs in a number of important dimensions. Heim focuses on married women in the CPS over the 25-year period 1979–2003 rather than single mothers, estimates his model year-by-year to yield annual elasticities, defines the after-tax wage rate differently than is typical in the literature, and adopts a different identification scheme. Rather than constructing the after-tax wage rate based on the woman's actual marginal tax rate, Heim uses the NBER TAXSIM program to estimate the marginal tax rate at zero hours of work and at full-time work. For the marginal tax rate applicable to full-time work, Heim imputes a marginal tax rate for each state and year based on the average income of husbands and wives in that state and year. He then applies the imputed state-year tax rate to all working women in each respective state-year cell. The justification is to avoid the endogeneity of the actual marginal tax rate and attendant identification schemes based on exclusion restrictions commonly found in the labor supply literature. Because Heim estimates the elasticities for each year, identification is based strictly on cross-section variation. He finds substantially smaller elasticities for married women at both margins compared to Kimmel and Kniesner (1998), with the participation margin elasticity ranging from –0.09 to 0.7 and the hours-worked elasticity ranging from 0 to 0.4. Heim also finds a significant downward trend in both elasticities over the past 25 years.

Several authors estimate structural wage elasticities that are mixtures of the extensive and intensive margins or refer only to the intensive margin (Hausman 1981; Mroz 1987; Triest 1990; Hoynes 1996; Blundell, Duncan, and Meghir 1998; Keane and Moffitt 1998; Kimmel and Kniesner 1998; Kumar 2005). Models that produce mixture elasticities are generally cross sectional Tobit-type models and estimated via maximum likelihood under the assumption of normally distributed error terms. For example, Hausman (1981), modeling the joint choice of (nonlinear) tax segment and hours of work using data from the 1975 PSID, finds an uncompensated wage elasticity of about 0.9 for married women and about 0.5 for single mothers. In a replication study of Hausman's research, Triest (1990) estimates a range of uncompensated wage elasticities for married women of 0.86–1.12, but when he truncates the sample to working women the elasticities fall to 0.21–0.28. Kimmel and Kniesner (1998) supplement their two-step models with Tobit-type estimators and estimate mixture elasticities of 1.67 for single women and 1.82 for married women. Keane and Moffitt (1998), who model the joint choice of work and participation in food stamps, public housing, and AFDC for single mothers in the 1984 SIPP, estimate a net uncompensated wage elasticity of labor supply of about 1.8.

Kumar (2005) estimates Tobit-type models of married women's labor supply, but differs in three respects from other papers in this literature. First, he models labor supply in a so-called life-cycle consistent framework. All aspects of the static model carry forward full force in the life-cycle consistent framework, but the definition of full income includes changes in the family's asset position from one period to the next; that is, full income is defined as $Y_t^F = r_t A_{t-1} + \Delta A_t + B_t - T(I_t, D, E)$, where B_t is non-asset nonlabor income in period *t* and where ΔA_t controls for the transfer of funds across periods that is absent in the static model. Second, Kumar (2005) supplements standard cross-sectional models with panel-data models to control for unobserved preferences for work. Third, Kumar differs from most in the literature by estimating labor supply using both parametric (Tobit and random effects Tobit) and semi-parametric (censored least absolute deviations (CLAD)) estimators, which not only relax restrictive small-sample distributional assumptions but also are more robust to fixed unobserved heterogeneity in nonlinear panel-data models.

Like Heim (2005), Kumar (2005) presents estimated annual elasticities over the period 1982–1992 using the PSID and finds a range of uncompensated mixture elasticities between 0.5 and 1.26. Also like Heim, Kumar finds a downward trend in the elasticities over his sample period. Kumar's pooled panel-data uncompensated wage elasticities are 0.4–0.7, which are fairly robust across the parametric and semiparametric estimators. Finally, he estimates intensive margin elasticities that are about 0.25, which are about half the size of the mixture elasticities.

Though more dated than the research just described, it is useful to end with Mroz (1987), who uses a two-step estimator for nonrandom selection into the labor force by married women and estimates an uncompensated after-tax hours-worked wage elasticity that is statistically and economically zero. Mroz (1987, p. 795) concludes that "The range of labor supply estimates that we fail to reject suggests that the labor supply behavior of working married women matched the estimated behavior of prime-aged males." Likewise, Ziliak (2005) concludes that the labor supply of prime-aged men is similar to working single mothers with no attachment to the transfer system (other than the EITC).

Summary. Statistical models of female labor supply, whether in reference to married or unmarried mothers, must account for the large fraction of labor-market nonparticipants and allow the labor-supply response to differ across the participation and hours-worked margins. The few studies to date permitting differential responses across margins suggest that the wage elasticity of labor supply at the extensive margin exceeds the elasticity at the intensive margin, and that the extensive margin elasticity exceeds 1.0, which has implications for the design of optimal tax and transfer programs (Saez 2002). The wage elasticities of hours worked by married and single women with no attachment to the welfare system are small, positive, and not economically or statistically distinguishable from comparable elasticities among prime-age married men. What is still not known is the effect of income taxation on life-cycle decisions of labor supply, marriage, and fertility. Because asset accumulation among single mothers is nearly nonexistent, the static model of labor supply may not be a bad approximation to life cycle behavior for the population of single mothers (Hurst and Ziliak 2006). However, single status for many women is a transitory state, and how the tax and transfer system affects labor supply and marital decisions across a lifetime is still not known, and is not readily knowable without complex structural models with long panels.

4. What We Know About Saving

Much of the early research on the effect of income taxation on saving focused on the effect of the after-tax rate of return to capital on the level of saving -- the so called interest elasticity of saving (Boskin 1978; Bernheim 2002). The interest elasticity comes from time-series models of consumption or saving levels as a function of disposable income, the after-tax rate of return, and other factors, with estimates in the range 0–0.4. Bernheim (2002) makes the important point that the mode estimate of the interest elasticity is zero. Research on intertemporal consumption by Hall (1978) challenged the basic assumptions of models generating the interest elasticity, such as the exogeneity of disposable income and the net rate of return. Lacking good instrumental variables, empirical research on the interest elasticity using aggregate time-series data on consumption or saving largely disappeared.

Subsequent research sought to infer the saving response to income taxation using household panel data applied to Euler equations governing the growth rate of consumption (Zeldes 1989; Runkle 1991). Under additive separability between consumption and leisure, the typical consumption Euler equation model regresses the log change in consumption on the real after-tax rate of return, time effects, and family demographics. In the standard model based on constant relative risk aversion preferences the coefficient on the after-tax rate of return is the intertemporal substitution elasticity (*ISE*). Estimates of the *ISE*, like the interest elasticity, range from 0 in aggregate time-series data (Hall 1988) to over 0.4 in panel data (Runkle 1991). The *ISE* can reveal how consumption, and thus saving, evolves over the life cycle in response to anticipated changes in the after-tax interest rate. Under the assumption of perfect certainty over prices, interest rates, tax policy, and preferences, it is possible to back out the interest elasticity of saving from the shape of the consumption function. Unfortunately, in the more realistic case of uncertainty and utility preferences other than quadratic, it is not possible to say anything general about the level of saving (Bernheim 2002).

Organizing Model and Estimates. It is informative to policy to back out the saving response to changes in after-tax wage rates and nonlabor (property) income using the model of Ziliak and Kniesner (2005). Note that in any given period *t* the uses of disposable income are consumption and saving, $I_t = C_t + S_t$, where S_t is after-tax saving. Focusing on the tax on earned income, disposable income is $I_t \equiv \omega_t h_t + N_t$. The total derivative of the uses of disposable income when the tax rate changes is then $hd\omega + \omega dh + dN = dC + dS$.

To find the uncompensated after-tax wage elasticity of saving we set $dN = 0$, divide both sides by $d\omega$, and rearrange to yield

$$\varepsilon_{\omega}^{S} = (1+\varepsilon_{\omega}^{h})\frac{\omega h}{S} - \varepsilon_{\omega}^{C}\frac{C}{S}, \tag{4}$$

where ε_{ω}^{S} is the uncompensated wage elasticity of saving, ε_{ω}^{h} is the uncompensated wage elasticity of labor supply, and ε_{ω}^{S} is the uncompensated wage elasticity of consumption. The average values for the two elasticities on the right-hand side of (4) are –0.49 and 0.23 in Ziliak and Kniesner (2005). In our data the average real after-tax labor earnings of the husband exceed average household saving by a factor of about nine, and average real nondurable household consumption exceeds average household saving by a factor of about 15 (average consumption is about $48,000 and average saving is about $3000). Substituting the values of earnings and consumption relative to saving, along with the wage elasticities of labor supply and consumption into the expression for ε_{ω}^{S}, yields an uncompensated wage elasticity of saving of about 0.96. Saving levels are quite responsive to changes in the net of tax real wage rate, and thus saving will respond positively to economically beneficial tax reforms.

Summary. During the late 1980s and through the 1990s there emerged a large and contentious literature on the effects of Individual Retirement Accounts on the level of household saving (Bernheim 2002 is a thorough review). With the fiscal strain on public pension-like programs such as Social Security, and the decline in private pension coverage of employees by employers, the role of tax policy in stimulating saving will become increasingly important. More research clearly would seem to be valuable concerning the effects of income taxation on overall personal saving. Our results in Ziliak and Kniesner (2005) refer to within-period decision making, but how saving responds to wage changes and interest-rate changes over the life cycle related to possible unanticipated tax policy is still relatively unknown. Because closed-form solutions are generally not possible with flexible preference structures, the level of saving is often not inferable from life cycle models. However, optimal wealth targets can generally be derived from life cycle models with precautionary and buffer-stock saving (Carroll 1997), and models such as that by Scholz, Seshadri, and Khitatrakun (2006) can be extended to incorporate income taxation more fully.

5. What We Know About the Elasticity of Taxable Income

Although the response of labor supply and saving to changes in the after-tax wage rate has been the key behavioral outcomes of interest over the past three decades of research on earned income taxation, related topics include composition of income (taxable versus non-taxable, cash versus in-kind), timing of income receipt, composition of portfolios, types of deductions, and the extent of tax avoidance and possibly evasive behavior. Since 1995 there has been much research on the so-called elasticity of taxable income in an effort to quantify the total income response to changes in marginal tax rates (Feldstein 1995; Slemrod 1998; Auten and

Carroll 1999; Moffitt and Wilhelm 2000; Gruber and Saez 2002; Saez 2003; Giertz 2004; Kopczuk 2005).

Organizing Model. The taxable income literature reformulates the canonical static labor supply model in the absence of saving. Instead of hours of work, some measure of income (taxable income, I_t, or gross income, $w_t h_t + N$) is used as the dependent variable. Instead of the after-tax wage ω_t, the focal regressor is the after-tax share, or so-called net-of-tax price $(1-\tau_t)$. The papers in the taxable income literature use panel data to sweep out time-invariant unobserved heterogeneity in income and after-tax shares by first differencing. The first-differenced model of interest is

$$\Delta \ln y_t = \Delta\varphi_t + \theta\Delta \ln(1-\tau_t) + \Delta d_t \gamma + \Delta\varepsilon_t, \qquad (5)$$

where y_t is either taxable or gross income (I_t or $w_t h_t + N_t$), φ_t is a vector of time dummies to control for common macroeconomic shocks, d_t is a vector of observed socioeconomic characteristics, and ε_t is a random error term. Because income and after-tax shares are in logarithms, $\hat{\theta}$ is the estimated elasticity of taxable (or gross) income.

Data and Econometric Specification Issues. Debate in the taxable elasticity literature centers on two measurement questions. (1) What is the proper metric of income? (2) What variables should be included in d_t?

Although income can be defined either gross or net of deductions and exemptions it is usually expressed in constant tax-law terms. Total gross income usually includes wage and salary income, rent, interest, and dividend income, alimony, unemployment insurance, farm income, business income or loss, pension and annuity income, and Schedule E income, but excludes Social Security benefits and capital gains and losses because of their differential tax treatment from ordinary income. Taxable income then nets out deductions and exemptions from gross income. Auten and Carroll (1999) argue that differentiating gross from net income is important because the two measures answer different questions. Gross income yields a total response to tax changes and thus is useful for understanding the implications of tax policy on the before-tax distribution of income, or potential tax base. Taxable income is more relevant if the focus is on the overall behavioral response of taxpayers to tax changes because it includes adjustments and deductions to income, or the actual tax base. Taxable income is relevant for deadweight loss calculations and for optimal tax exercises when one wants to identify the most likely revenue-maximizing tax rate.

The literature has also differed concerning variables to include and how to enter them into the model via control characteristics, d_t. Because they have only two periods of data Auten and Carroll (1999) replace Δd_t with d_0, which is a vector of time-invariant regressors from the initial period. Moffitt and Wilhelm (2000) further suggest that a key variable to include in d_0 is initial income, y_0. The logic is that if a taxpayer has transitorily high or low income in the initial period, which may revert back to normal in the period after the tax change, then failure to control so-called regression to the mean via initial income leads to bias in the estimated tax price elasticity.

Another variable for possible inclusion in a taxable income regression is virtual non-labor income. Virtual non-labor income is the adjustment to non-labor income (N_t) necessary to compensate the worker to act as if he or she faced the same marginal tax rate for all taxable income. Virtual income is $\tilde{N}_t = N_t + \tau_t w_t h_t - T(\bullet)$. Although $\tilde{N}_t$ is a standard regressor in labor supply, Gruber and Saez (2002) were the first to introduce virtual income into the taxable income elasticity literature to separate out income from substitution effects. Their motivation is Feldstein

(1995), who argued that because TRA86 was broadly revenue neutral then the taxable elasticity he estimated was a compensated elasticity that readily mapped into deadweight loss calculations. Because TRA86 was not revenue neutral for all income classes, Gruber and Saez (2002) correctly note that Feldstein's interpretation that he estimated a compensated elasticity is incorrect.

Evidence on the Elasticity of Taxable Income. How the researcher defines income and decides what variables to include in Δd_t has a profound effect on the estimated after-tax share elasticity. Estimates range from 0 to 3 overall. Feldstein's (1995) empirical results are from a difference-in-differences regression where the groups are high, medium, and low marginal tax rate payers based on their pre-TRA86 tax status. With the exception of a fixed effect and separation based on pre-reform marginal tax rate there are no additional control covariates in Feldstein's (1995) model. When he defines income as adjusted gross income by netting out deductions such as IRA contributions Feldstein's estimates are 0.75–1.3; when he defines income as taxable income Feldstein's estimates are 1.1–3.0.

Auten and Carroll (1999) exploited the variation in tax rates from TRA86 just as Feldstein, but instead of using the NBER tax panel for 1985 and 1988 they used the Treasury tax panel for 1985 and 1989. Auten and Carroll also controlled for initial income and additional covariates. Rather than a difference-in-difference estimator, Auten and Carroll used a weighted instrumental variables estimator to control for the possible endogeneity of actual tax price changes with changes in gross income. Their instrument inflates the initial 1985 income to 1989 levels and then constructs a simulated 1989 marginal tax rate based on 1989 tax rules. The instrument Auten and Carroll use is the simulated 1989 after-tax share less the actual 1985 after-tax share. They estimate gross income after-tax share elasticities of 0.45–1.13, with a preferred estimate of 0.57, and a similar taxable income elasticity of 0.55.

As did Feldstein, Gruber and Saez (2002) use the NBER tax panel, but their data span multiple tax reforms during 1979–1990. As did Auten and Carroll, Gruber and Saez control for regression to the mean effects and use an IV estimator with a similarly defined instrument. Gruber and Saez add virtual income as a regressor. Their preferred point estimates are a tax price elasticity for taxable income of 0.4 and a tax price elasticity for gross income of 0.12. Gruber and Saez find that most of the response is driven by taxpayers with gross incomes over $100,000. The gross income elasticity is zero or negative for taxpayers with incomes under $100,000 and ranges from 0.17 to 0.27 for taxpayers with incomes above $100,000. The corresponding estimates for the taxable income elasticity range from zero to about 0.28 for the under $100,000 gross income group and from 0.48 to 0.57 for the over $100,000 gross income group. The differences in taxable income versus gross income tax-price elasticities come from two effects. One effect is mechanical; the gross income definition implies a larger base and thus a smaller potential for response. The other effect is behavioral. Taxable income contains exemptions and deductions which can respond to tax changes. Gruber and Saez (2002) attempt to isolate the two effects and infer that about 40 percent of the difference between the gross income elasticity and taxable income elasticity is due to the mechanical effect and the remaining 60 percent is due to behavioral effects.

Kopczuk (2005) emphasizes that changes in deductions and exemptions may have an independent effect on gross income that had not been adequately addressed in the literature. He notes that changes in the implicit price of deductions can affect behavioral elasticities. Drawing on earlier labor supply research by Triest (1992), Kopczuk (2005) modifies the standard specification by adding an interaction term to Δd_t that permits separating the effects of reforms to the tax base from the effects of reforms to tax rates. The additional variable is $\theta_1 \Delta\psi_t \ln(1-\tau_t)$, where ψ_t is the share of total gross income that is spent on non-taxable commodities. When gross income is the dependent variable in (5), $\hat{\theta}$ is the gross income tax elasticity if $\psi_t = 0$. That is, when $\psi_t = 0$ then $\hat{\theta}$ is the response of gross income induced by substitution away from reported income and toward leisure, fringe benefits, and other forms of income when the taxpayer has no access to deductions. If $\psi_t \neq 0$, but is time invariant, then the gross income elasticity is $\hat{\theta} + \hat{\theta}_1\psi$. A straightforward test of the constancy of the tax elasticity is whether $\hat{\theta}_1 = 0$. Kopczuk notes the test is two-tailed because the coefficient on the interaction can be positive or negative depending on whether deductible goods are substitutes or complements with gross income.

Kopczuk (2005) uses the University of Michigan tax panel and marginal tax rates from the NBER *TAXSIM* module, along with an instrumental variables estimator similar to the earlier taxable income elasticity literature. He finds that the estimated direct elasticity $\hat{\theta}$ is close to zero, which is consistent with the small intensive-margin wage elasticity of labor supply also found by Saez (2003). However, the coefficient on the interaction term $\hat{\theta}_1$ is a sizable 0.7 and statistically significant. Kupczuk's results imply that all the taxable income response is driven by taxpayers with access to deductions and exemptions.

It is important to note that the taxable income elasticity literature to date has based its estimates on potentially endogenous samples. Researchers have tended to discard taxpayers with very low base-year gross incomes (less than $10,000 in Gruber and Saez (2002)) or low base-year marginal tax rates (less that 22 percent in Feldstein (1995) and Auten and Carroll (1999)).

The argument for choosing tax rate or income based samples is to remove the undue influence of regression to the mean by taxpayers at the low end of the distribution. Selecting a sample based on tax or income status, which may be an endogenous response to current year tax policy can produce biased estimates of the behavioral responses of interest. The relevance of sample selection issues was made in the context of labor supply by Blundell, Duncan, and Meghir (1998). They showed that grouping taxpayers based on possibly endogenous tax status yielded different wage and nonlabor income elasticities of labor supply compared to estimates grouped on the basis of attributes likely to be exogenous to current tax policy, such as education attainment and birth cohort. More research on the robustness of the taxable income elasticities to alternative grouping assumptions could be informative to policy considerations.

Taxable Income versus Labor Supply Effects. An important general point raised by Slemrod (1998, 2001) and reiterated by Kopczuk (2005) is that the elasticity of taxable income is not a structural parameter that is simply a function of preferences and technology. Rather, the elasticity of taxable income is a behavioral response that is a function of the tax base and therefore changes when the tax base changes. Slemrod and Kupczuk's point parallels the Lucas Critique for econometric policy evaluation. Exercises such as in Feldstein (1995), where he applied the taxable income elasticities calculated from TRA86 to the 1993 Clinton tax reform, should be viewed warily because the underlying elasticities likely changed with changes in the tax base. Slemrod's critique applies to the difference-in-differences literature in general in that estimates from difference-in-differences models are generally not informative for out-of-sample predictions. The Slemrod criticism does not apply to structural models of labor supply that estimate underlying preference parameters, which should permit statistically informative out-of-sample forecasts (Hausman 1981; Triest 1990; Ziliak and Kniesner 1999, 2005).

Comparing the taxable income elasticities to the structural labor supply elasticities also generally means comparing estimates at the intensive margin. The taxable income elasticity literature has (1) ignored non-workers' labor force participation responses to changes in the after-tax share and (2) ignored non-random sample selection bias potentially in the estimates of the taxable income elasticity based only on workers' responses at the intensive margin. Although they did not focus on the taxable income elasticity per se, Meyer and Rosenbaum (2001) present related results. They present some quasi-structural estimates of the elasticity of employment with respect to the after tax-share for single mothers of about 1.0.

Gruber and Saez (2002) sought to isolate substitution and income effects much like ones found in the structural labor supply literature. They found an income elasticity of about −0.135 for taxable income compared to a substitution elasticity of 0.430. Together the results imply a positive uncompensated wage elasticity. This means that estimated income effects are relatively small in the research of Gruber and Saez (2002). Relatively small income effects is consistent with Ziliak and Kniesner (1999) and earlier papers in much of the literature, but is not in line with what we report in Table 1 here from Ziliak and Kniesner (2005). Not yet known is whether the difference is an artifact of our functional form versus that used in Gruber and Saez (2002) or of our data versus their data. Finally, the difference between the relative income and substitution effects emerging from the structural labor supply versus taxable income elasticity literatures could also stem from the fact that our estimates are from after-tax wage elasticities and theirs are from after-tax shares, which Slemrod (2001) emphasizes may not be the same if there is endogenous tax avoiding or evading behavior.

Summary. The elasticity of taxable income is important to understanding the roles of tax policy in income inequality as well as for policies related to the capacity of governments to raise revenue in both the short and long runs. The relatively recent empirical literature can be characterized as producing estimates of the elasticity of gross income that lie in the range 0–0.2, and estimates of the elasticity of taxable income that lie in a slightly wider range, 0–0.4. What we would like to know more about and could with greater econometric evaluation of model specifications and robustness are the endogenous response at the extensive labor supply margin, the link between taxation schedule and marital status, or the economic implications for the poor of changes in the net tax price. It is unlikely that we will soon have the data and econometric wherewithal to establish the quantitative links between potential or actual tax base and subtleties of the tax system in the United States such as the role of the AMT, treatment of capital gains, or so-called tax gross-ups among rich tax payers.

6. What We Know About the Welfare Effects of Taxation

Inferring how consumer well being changes in response to taxes has motivated economic analyses of tax reform and labor supply since at least the seminal research of Harberger (1964). Calculations of the efficiency cost of taxation focus either on the total deadweight loss (Harberger 1964; Hausman 1981; Auerbach 1985; Triest 1990; Ziliak and Kniesner 1999) or on the marginal welfare cost of taxation (Wildasin 1984; Browning 1987; Snow and Warren 1996). One measure of total welfare change is a hypothetical payment to the government by the typical worker under the pre tax-reform wage that would leave welfare unchanged under the post tax-reform income (Kay 1980). The hypothetical payment, or equivalent variation measure, compares an initial distorted equilibrium with a final distorted equilibrium. The equivalent variation measure fixes utility at its post-reform level and lets wage differences imply a change in worker well being across tax regimes. Another common total deadweight loss measure is of the change in consumers' surplus, called welfare variation, where the wage vector is held at the pre tax-reform level and utility differs when taxes change (King 1983). The welfare variation measure of moving from one distorted equilibrium to another is the change in consumer utility less the actual revenue extracted. Both the equivalent variation and the welfare variation measures of changes in total welfare give similar ordinal rankings under revenue neutral tax changes.

Organizing Model. Recent theoretical research considering the efficiency cost of a tax system has focused on the marginal welfare cost of government revenue (*MWC*), which is how much economic welfare changes in response to a change in tax rates and revenue. Within-period utility estimates map straightforwardly into the *MWC*, so that the results in Ziliak and Kniesner (2005) are informative to discussions of tax reform. Because the calculations are static they provide a partial picture of the potential behavioral response to a tax change. Other obvious behavioral aspects of interest are inter-temporal changes, which may include both anticipated components and the unanticipated components occurring in the case of uncertain tax policy. Still, results from the two-stage budgeting formulation we summarize here from Ziliak and Kniesner (2005) use within-period preferences from a life-cycle framework so that the corresponding *MWC* calculations we discuss here, are so-called life-cycle consistent estimates.

The bulk of the econometric estimates of the welfare cost of taxation stemming from models of labor supply and taxes have emphasized tax reforms that are revenue neutral (Hausman 1981, Triest 1994, Ziliak and Kniesner 1999, 2005). Econometric research has largely presented so-called differential tax calculations where there is no balanced-budget spending or revenue effects so that the *MWC* reflects pure distortions of labor supply (Ballard 1990; Browning 1987). Alternatively, much of the theoretical research on the marginal cost of public funds has focused on balanced-budget tax policy where a marginal dollar of public spending is financed by an additional dollar of tax revenue (Snow and Warren 1996).

An empirically transparent calculation is the marginal welfare cost of government revenue in the event of revenue-neutral reforms (Browning 1987, equation (10)). Browning defines the marginal welfare cost as $MWC = \left[\frac{\tau + 0.5d\tau}{1-\tau}\right]\eta_w^c \frac{d\tau}{d\overline{t}}$, with τ the marginal tax rate, $d\tau$ the change in the marginal tax rate, η_w^c the compensated wage elasticity of labor supply, $\overline{t}$ the average tax rate, and $\frac{d\tau}{d\overline{t}}$ the change in the progressivity of the tax code in response to the tax reform. The *MWC* formula highlights that only substitution effects and no income effects matter for revenue-neutral welfare calculations.

Welfare Effect Estimates. For each calculation we set $\tau = 0.323$, which is the sample average marginal tax rate for men, $d\tau = 0.01$, which is a one percentage point change in the marginal tax rate, and $\frac{d\tau}{d\overline{t}}$ equal to 1.32, for progressive tax reforms (the ratio of the sample average marginal tax rate to the sample average tax rate) or equal to 1.0 for proportional tax reforms. We consider three specifications for the marginal welfare cost of taxation. In specification (1) we set $\eta_w^c = 0.328$ based on the direct translog *MRS* elasticities with non-durable consumption; in specification (2) we set $\eta_w^c = 0.092$ for the direct translog *MRS* elasticities with food consumption; in specification (3) we set $\eta_w^c = 0.652$ for the quadratic direct *MRS* elasticities with non-durable consumption. There are six calculations in Table 2, then, when we use the three different compensated wage elasticities for the progressive versus proportional changes in the tax code.

In the base case model with non-separable preferences in Table 2 the marginal welfare cost of an additional dollar of taxation ranges from 16 to 21 percent depending on whether the reform is a proportional or a progressive change in the tax structure. The deadweight welfare losses are sizable and suggest possibilities for welfare-improving revenue neutral tax reforms in the United States. Specification (2) makes clear that how we measure consumption has a large impact on our estimates of welfare loss. With food as our measure the *MWC* of taxation is a modest 4.5 to 6 percent. Specification (3) pushes the estimated *MWC* in the opposite direction. Imposing additivity between consumption and leisure yielded a larger estimate of the compensated wage elasticity, which translates into a doubling of the marginal welfare cost of taxation relative to the base case model that relaxes separability. Models with additive preferences between consumption and labor supply likely yield upper-bound estimates of the deadweight loss of taxation.

Summary. There can be improved labor-market efficiency from revenue-neutral tax reforms. Our base-case estimates with non-durable consumption suggest that the marginal welfare cost of taxation is 16–21 percent depending on whether the reform results in a proportional or progressive change in the tax structure. By way of comparison, in Ziliak and Kniesner (1999) we impose separability between consumption and leisure but admit nonseparability in the intertemporal budget constraint stemming from the joint nonlinear taxation of labor and capital income, and estimate that the typical U.S. prime-age married male worker would pay up to 23 percent of his adjusted gross income to eliminate the current progressive income tax (a total welfare loss calculation), and would pay a more modest two percent of adjusted gross income to face an across-the-board cut in income tax rates.

As an additional reference point we note that Hausman's (1981) widely cited estimates of the willingness to pay for removing income taxes are much lower than ours ($1/11^{th}$). However, our research in Ziliak and Kniesner (2005) highlighted that the functional form of preferences -- specifically linearity in the labor-supply response to a wage change or additivity between consumption and leisure -- has a significant impact on estimated wage elasticities of labor supply. Separability between consumption and leisure choices, whether in a linear or a non-linear labor supply model, leads to an upward bias (as much as double) in compensated wage elasticities used in evaluating labor-market and tax policies.

In a recent working paper Feldstein (2006) presented calculations of the marginal welfare cost of taxation with respect to tax revenue that range from 68–76 percent, which are considerably higher than what we have emphasized here. Feldstein's estimates are derived from the elasticity of taxable income literature where he relies on a compensated tax price elasticity of 0.4 (the preferred estimate from Gruber and Saez (2002)) and an income elasticity of 0.15. As described previously we would expect his estimates to exceed the estimates reported in Ziliak and Kniesner (2005) because of the additional behavioral margins that adjust in response to marginal tax rate changes. However, Feldstein's (2006) estimates rely on separability of preferences between consumption and leisure (although some forms of deductible consumption are included in his estimates), and as demonstrated in Table 2 the *MWC* is upwardly biased under the assumption of separability.

Research developing models that combine nonseparable preferences with nonseparable budgets would seem a logical next step in considering more fully the efficiency cost aspects of taxes and pinning down more completely the welfare implications of tax policy.

Table 2.
Estimates of the Marginal Welfare Cost of Taxation (Percent)

	(1)	(2)	(3)
Progressive Tax:	20.9	5.9	41.7
$\frac{d\tau}{d\bar{t}} = 1.32$	(4.1)	(0.73)	(28.3)
Proportional Tax:	15.9	4.5	31.6
$\frac{d\tau}{d\bar{t}} = 1$	(3.1)	(0.56)	(21.4)

NOTE: All estimates are based on equation (10) in Browning (1987) where the marginal welfare cost of taxation is $MWC = \left[\frac{\tau + 0.5d\tau}{1-\tau}\right]\eta_w^c \frac{d\tau}{d\bar{t}}$, with τ as the marginal tax rate, $d\tau$ the change in the marginal tax rate, η_w^c the compensated wage elasticity of labor supply, $\bar{t}$ the average tax rate, and $\frac{d\tau}{d\bar{t}}$ the change in the progressivity of the tax code in response to the tax reform. For each calculation we set $\tau = 0.323$, $d\tau = 0.01$, and $\frac{d\tau}{d\bar{t}}$ equal to 1.32 for progressive tax reforms (the ratio of the sample average marginal tax rate to the sample average tax rate) or equal to 1.0 for proportional tax reforms. In specification (1) we set $\eta_w^c = 0.328$ based on the direct translog *MRS* elasticities with nondurable consumption in Table 2 of Ziliak and Kniesner (2005), in specification (2) we set $\eta_w^c = 0.092$ for the direct translog *MRS* elasticities with food consumption in Table 3 of Ziliak and Kniesner (2005), and in specification (3) we set $\eta_w^c = 0.652$ for the quadratic direct *MRS* elasticities with nondurable consumption in Table 3 of Ziliak and Kniesner (2005). The standard errors are based on 1000 bootstrap replications of the *MRS* and Euler equations.

7. What We Know About the Optimal Income Tax

It is not unreasonable to contend that the ultimate objective of research on taxation is to use the estimates in solving for the economically optimal tax structure. The classic issue is that minimizing the excess burden of the tax is constrained by the desire to use tax rates for greater equality of economic well being. The two goals conflict because economic efficiency is greater with a flatter tax structure while greater equality of outcomes goes with a more progressive tax structure. The tradeoff of efficiency against equity becomes more complicated when there are consumption and or leisure externalities to consider in the optimal tax computation (Abel 2005, Grodner and Kniesner 2006a, Kooreman and Schoonbeek 2004).

Organizing Model: An Optimal Tax Considering Efficiency and Equity. A particularly clear development of the numerical links among labor supply wage elasticities, the statistical distribution properties of the tax base, the social planner's objective function, and an optimal income tax appears in Saez (2001, 2002). Saez (2001) uses realistic values for labor supply elasticities with both utilitarian and Rawlsian social welfare weights and finds a general scheme for income tax rates that fall then rise due to phase out of income guarantees as part of equity considerations, which makes for a lower average tax rate and more efficient tax system than one with a single proportional rate that could be 60 percent or more at an optimum.

In the case where both labor supply margins come into play and equity and efficiency trade off, Saez (2002) shows that the optimal tax bracket scheme has the property that $\frac{T_i - T_{i-1}}{c_i - c_{i-1}} = \frac{1}{\zeta_i h_i}\sum_{j=i}^{I} h_j[1 - g_j - \eta_j \frac{T_j - T_0}{c_j - c_0}]$, where subscripts index successively higher incomes and taxes, T is total tax, c is taxable income, h measures labor supply, g is a marginal social welfare weight, ζ is the labor force participation elasticity, and η is the hours-worked elasticity. Saez's

(2002) formula also clarifies the roles of the labor supply elasticity at the participation versus hours-worked margins to solutions to the basic optimal tax problem. There is general agreement that the labor supply response at the extensive margin exceeds the response at the intensive margin and that, at least for single women, the labor supply elasticity at the extensive margin exceeds 1.0 (Ziliak 2005). The optimal tax and transfer policy in the context of Saez's (2002) model is the following. For low-income populations the optimal tax policy is akin to an EITC program providing a modest guarantee to non-workers, with tax rates that are negative over a range of low earnings, and tax rates that become positive and high as workers move up the earnings distribution.

Insurance Considerations for an Optimal Tax. Economists have now begun to examine a third dimension of the tax system that need be considered under an optimal tax calculation, the implicit insurance or income and consumption smoothing properties of an income based tax that supplements the smoothing permitted via private credit and insurance markets. It is important to recognize that even a proportional tax smoothes disposable income by making the variability of net income less than the variability of gross income (Varian 1980). For example, if there is a proportional tax rate, τ, so that disposable income is $y^d = (1 - \tau)y$, then $\sigma^2_{y^d} = (1-\tau)^2\sigma^2_y < \sigma^2_y$ because $(1-\tau)^2 < 1.0$. Because of the additional negative covariance term between y and $(1-\tau)$ a progressive income tax rate such that $\partial\tau / \partial y > 0$ makes the relative variability of disposable income less than under a proportional tax.

In Kniesner and Ziliak (2002b) we show that the U.S. tax system reduces the variability of consumption by about 10 percent compared to what it would be in the absence of income taxes. In Kniesner and Ziliak (2002a) we examine the consumption smoothing issue further by solving explicitly for the welfare benefits to the consumer from the tax-based income insurance that smoothes consumption. We solve explicitly for the proportional increase in consumption needed to make the consumer indifferent to the consumption smoothing benefits of a flatter tax, including a proportional or a lump sum tax. Households confronting the highly graduated pre-ERTA U.S. tax structure would have to be paid up to 2.5 percent of their per capita consumption to switch to a revenue neutral lump sum tax because of its lack of implicit consumption insurance. Our results in Kniesner and Ziliak (2002a,b) imply that the amount of consumption insurance implicitly in the income-based Federal tax system is currently \$100–\$200 billion, which is similar to the amount U.S. consumers spend on private health or auto insurance.

Anderson and Dognowski (2004) show that even if the individual were somehow able to smooth consumption completely in private credit markets the individual would still want to smooth leisure. The optimal tax on labor earnings would then be progressive so as to reduce net wage fluctuations. For a logarithmic utility function in consumption and leisure the optimal tax rate that smoothes leisure satisfies the requirement that $\frac{1}{(1-\tau_2)w_2}\frac{\tau_2}{(1-\tau_2)}=\frac{1}{(1-\tau_1)w_1}\frac{\tau_1}{(1-\tau_1)}$ where the wage rate is unexpectedly higher in state 2. The implication is a procyclical optimal tax rate, although not to the point where the net wage is state independent (Anderson and Dognowski 2004).

Summary. Absent long-run considerations relating to the saving and growth issues that concern many in government, an optimal income tax must consider three dimensions: efficiency, equity, and insurance. A flatter tax creates less deadweight loss but also less after-tax equality of consumption plus more variable consumption and leisure. It is a challenge, perhaps an impossible one, to solve for the structure of income taxes that would maximize a welfare function for society that considered efficiency, equity, and insurance aspects of current income-based taxation.

8. What We Know, Could Know, and Probably Never Know

As Auerbach (2006) notes in an accompanying paper, the future of tax reform efforts will depend on our empirical knowledge of how taxes affect behavior. There are several aspects of the effects of income taxes on individuals that seem settled, but many more areas are in need of additional research. We now summarize what we know reasonably well.

We know that most of the traditional estimates of the intratemporal uncompensated wage elasticities of labor supply of men and women are positive, but small, with a range 0–0.2. Given the accompanying small negative income effect the attendant traditional compensated wage elasticities of labor supply are also small. The implication from the mode estimates is that the reduction in the deadweight loss of income taxation is likely to be modest in any given period for most tax proposals. More ambitious reforms could create sizable sizeable welfare gains from a lifetime perspective or when labor supply interactions come into play. Econometrically richer models have enlarged the elasticity estimates somewhat by considering social interactions and less statistically restrictive representations of the budget constraint or the labor supply function, raising the compensated wage elasticity of labor supply for men to between 0.3 and 0.4.

We also know that the wage response of labor supply at the participation margin exceeds the wage response at the hours-worked margin. The magnitudes at both margins are important for the design of optimal tax and transfer programs (Saez 2002). Although the evidence to date suggests that the extensive margin elasticity exceeds 1.0, most of the work applies to women and thus more research is needed on both margins for men.

The preponderance of evidence to date suggests that the elasticity of taxable income is larger than the uncompensated wage elasticity of labor supply for workers and lies in the range 0–0.4, with more evidence in favor of 0.4. The implication is that taxpayers, notably high-income taxpayers, shift income from non-deductible to deductible income and consumption activities in response to tax reforms.

What we know less well is how taxation affects life-cycle labor supply, consumption, and saving decisions. The evidence to date is theory-consistent in that intertemporal substitution elasticities exceed their within-period counterparts, with a range of 0.2–0.5 for labor supply of men, and 0–0.5 for consumption (depending on whether one uses aggregate consumption data (0) or micro household panel data (0.5)). Perhaps most important, our survey suggests that individual total saving behavior responds to tax policy with an after-tax wage elasticity of as much as 1.0, but much remains unknown and some important behaviors may never be knowable given the difficulty in measuring saving accurately.

Finally, we probably know the least about what some would say is the ultimate objective of research on the personal income tax, the structure of optimal income tax rates. Research has clarified greatly the roles of the sensitivities of consumption and labor supply to tax related parameters. Particularly valuable has been work on the roles of the labor supply elasticities at the extensive versus intensive margins in light of the accompanying welfare program transfers and tax credits for the low-income population. The greater participation elasticity of labor supply implies that a traditional welfare program is suboptimal compared to an EITC program. Not to be forgotten is that any income based tax smoothes disposable income and provides implicit insurance against unwanted fluctuations in consumption and leisure. Recent research suggests that income based taxes reduce unplanned consumption variability by over 10 percent and that the implicit consumption insurance that income-based taxes provide is of similar aggregate value as health and automobile insurance in the United States. When considering an optimal tax structure comprehensively one must consider three dimensions: efficiency, equity, and insurance.

Although graduated tax rates reduce efficiency, graduated tax rates enhance equity and insurance. It is likely an impossible challenge to derive an optimal tax structure in light of all three margins of policy interest simultaneously.

References

Abel, Andrew B. 2005. “Optimal Taxation when Consumers Have Endogenous Benchmark Levels of Consumption.” *Review of Economic Studies* 72(1): 21–42.

Alesina, Alberto, Edward Glaeser, and Bruce Sacerdote. 2005. “Work and Leisure in the U.S. and Europe: Why So Different.” National Bureau of Economic Research Working Paper 11278.

Altig, David, Alan J. Auerbach, Laurence J. Kotlikoff, Kent A. Smetters, and Jan Walliser. 2001. “Simulating Fundamental Tax Reform in the United States.” *American Economic Review* 91(3): 574–595.

Anderson, Torben M. and Robert R. Dogonowski. 2004. “What Should Optimal Income Taxes Smooth?” *Journal of Public Economic Theory* 6(3): 491–507.

Auerbach, Alan J. 1985. “The Theory of Excess Burden and Optimal Taxation.” In Alan Auerbach and Martin Feldstein, eds., *Handbook of Public Economics* Volume 1, Amsterdam: Elsevier Science, North-Holland, 61–127.

Auerbach Alan J. 2006. “Tax Reform in the 21st Century: The Known, The Unknown, and the Unknowable.” Presented at the Conference: *Is it Time for Fundamental Tax Reform?: The Known, the Unknown, and the Unknowable* at the James A. Baker III Institute of Public Policy, Rice University, April 27–28, 2006.

Auerbach, Alan J. and Daniel Feenberg. 2000. “The Significance of Federal Taxes as Automatic Stabilizers.” *Journal of Economic Perspectives* 14: 37–56.

Auerbach, Alan J. and Joel Slemrod. 1997. “The Economic Effects of the Tax Reform Act of 1986.” *Journal of Economic Literature* 35(2): 589–632.

Auten, Gerald, and Robert Carroll. 1999. “The Effect of Income Taxes on Household Income.” *Review of Economics and Statistics* 81(4): 681–693.

Ballard, Charles. 1990. “Marginal Efficiency Cost Calculations: Differential Analysis vs. Balanced-Budget Analysis.” *Journal of Public Economics* 41: 263–276.

Bernheim, B. Douglas. 2002. “Taxation and Saving.” In Alan Auerbach and Martin Feldstein, eds., *Handbook of Public Economics* Volume 3, Amsterdam: Elsevier Science, North-Holland, 1173–1249.

Blomquist, N. Soren. 1985. “Labor Supply in a Two-Period Model: The Effect of a Nonlinear Progressive Income Tax.” *Review of Economic Studies* 52: 515–24.

Blomquist, Soren, Matias Eklöf, and Whitney Newey. 2001. “Tax Reform Evaluation Using Non-Parametric Methods: Sweden 1980–1991.” *Journal of Public Economics* 79: 543–568.

Blomquist, Soren and Whitney Newey. 2002. “Nonparametric Estimation with Nonlinear Budget Sets.” *Econometrica* 70(6): 2455–2480.

Blundell, Richard, and Thomas MaCurdy. 1999. “Labor Supply: A Review of Alternative Approaches.” In *Handbook of Labor Economics*, Volume 3A, Orley Ashenfelter and David Card, editors, Amsterdam: North-Holland, 1559–1695.

Blundell, Richard, Martin Browning, and Costas Meghir. 1994. “Consumer Demand and the Life-Cycle Allocation of Household Expenditures.” *Review of Economic Studies* 61: 57–80.

Blundell, Richard, Alan Duncan, and Costas Meghir. 1998. “Estimating Labor Supply Responses Using Tax Reforms.” *Econometrica* 66(4): 827–861.

Blundell, Richard, Costas Meghir, Elizabeth Symons, and Ian Walker. 1988. “Labour Supply Specification and the Evaluation of Tax Reforms.” *Journal of Public Economics* 36(1): 23–52.

Boskin, Michael. 1978. “Taxation, Saving, and the Rate of Interest.” *Journal of Political Economy* 86(2): S3–S27.

Browning, Edgar. 1987. “On the Marginal Welfare Cost of Taxation.” *American Economic Review* 77(1): 11–23.

Browning, Martin. 2005. “A Working Paper from April 1985: Which Demand Elasticities Do We Know and Which Do We Need to Know for Policy Analysis?” *Research in Economics* 59: 293–320.

Browning, Martin, and Costas Meghir. 1991. “The Effects of Male and Female Labor Supply on Commodity Demands.” *Econometrica* 59(4): 925–951.

Burtless, Gary and Jerry Hausman. 1978. “The Effect of Taxation on Labor Supply: Evaluating the Gary Negative Income Tax Experiment.” *Journal of Political Economy* 86(6): 1103–1130.

Camerer, Colin, Linda Babcock, George Loewenstein, and Richard Thaler. 1997. “Labor Supply of New York City Cabdrivers: One Day at a Time.” *Quarterly Journal of Economics* 112(2): 407–441.

Carroll, Christopher. 1997. “Buffer-Stock Saving and the Life-Cycle/Permanent Income Hypothesis.” *The Quarterly Journal of Economics* 111(1): 1–57.

Carroll, Christopher, and Lawrence Summers. 1991. “Consumption Growth Parallels Income Growth: Some New Evidence.” In *National Saving and Economic Performance*, eds. B. Douglas Bernheim and John Shoven, 305–343. Chicago: University of Chicago Press.

Chiappori, Pierre-Andre. 1992. “Collective Labor Supply and Welfare.” *Journal of Political Economy* 100(3): 437–467.

Davis, Steven J. and Magnus Henrekson. 2004. “Tax Effects on Work Activity, Industry Mix and Shadow Economy Size: Evidence From Rich-Country Comparisons.” National Bureau of Economic Research Working Paper 10509.

Deaton, Angus. 1991. “Saving and Liquidity Constraints.” *Econometrica* 59(5): 1121–1142.

Diamond, John W. and George R. Zodrow. 2006. “Consumption Tax Reform: The Effect of Business Equity and Housing Price Changes on Intergenerational Redistributions.” Presented at the Conference: *Is it Time for Fundamental Tax Reform?: The Known, the Unknown, and the Unknowable* at the James A. Baker III Institute of Public Policy, Rice University, April 27–28, 2006.

Eissa, Nada. 1996. “Labor Supply and the Economic Recovery Tax Act of 1981,” in *Empirical Foundations of Household Taxation*, M. Feldstein and J. Poterba eds., Chicago: University of Chicago Press, 5–38.

Eissa, Nada and Hilary Hoynes. 2005. “Behavioral Responses to Taxes: Lessons from the EITC and Labor Supply.” National Bureau of Economic Research Working Paper 11729.

Farber, Henry. 2005. “Is Tomorrow Another Day? The Labor Supply of New York City Cab Drivers.” *Journal of Political Economy* 113(1): 46–82.

Feldstein, Martin. 1993. “Tax Rates and Human Behavior.” *Wall Street Journal*, May 7, A14.

Feldstein, Martin. 1995. “The Effect of Marginal Tax Rates on Taxable Income: A Panel Study of the 1986 Tax Reform Act.” *Journal of Political Economy* 103(3): 551–572.

Feldstein, Martin. 2006. “The Effect of Taxes on Efficiency and Growth.” National Bureau of Economic Research Working Paper 12201.

Gentry, William, and R. Glenn Hubbard. 2004. “The Effects of Progressive Income Taxation on Job Turnover.” *Journal of Public Economics* 88(11): 2301–2322.

Giertz, Seth H. 2004. “Recent Literature on Taxable-Income Elasticities.” CBO Technical Paper 2004-16.

Goolsbee, Austan. 1997. “What Happens When You Tax the Rich? Evidence from Executive Compensation.” NBER Working Paper 6333.

Grodner, Andrew, and Thomas J. Kniesner. (2006a). “Social Interactions in Labor Supply.” *Journal of the European Economic Association*, 4(6), forthcoming.

Grodner, Andrew, and Thomas J. Kniesner. (2006b). “An Empirical Model of Labor Supply with Social Interactions: Econometric Issues and Tax Policy Implications.” Center for Policy Research, Syracuse University Working Paper 69.

Gruber, Jonathan, and Emmanuel Saez. 2002. "The Elasticity of Taxable Income: Evidence and Implications." *Journal of Public Economics* 84(1): 1–32.

Hall, Robert. 1978. "Stochastic Implications of the Life Cycle-Permanent Income Hypothesis: Theory and Evidence." *Journal of Political Economy* 86(6): 971–987.

Hall, Robert. 1988. "Intertemporal Substitution in Consumption." *Journal of Political Economy* 96(2): 339–357.

Hall, Robert and Mishkin, Fredric. 1982. "The Sensitivity of Consumption to Transitory Income: Estimates from Panel Data on Households." *Econometrica* 50(2): 461–481.

Harberger, Arnold. 1964. "Taxation, Resource Allocation and Welfare," in *The Role of Direct and Indirect Taxes in the Federal Reserve System*, J. Due (ed.), Washington: Brookings Institute.

Hausman, Jerry. 1981a. "Labor Supply." In *How Taxes Affect Economic Behavior*, edited by Henry Aaron and Joseph Pechman. Washington, DC: The Brookings Institution.

Hausman, Jerry. 1981b. "Income and Payroll Tax Policy and Labor Supply," in *The Supply Side Effects of Economic Policy*, L. H. Meyer (ed.), Boston: Kluwer Academic Publishers, 173–202.

Hausman, Jerry and Paul Ruud. 1984. "Family Labor Supply with Taxes." *American Economic Review Papers and Proceedings* 74(2): 242–248.

Heckman, James. 1974a. "Life Cycle Consumption and Labor Supply: An Explanation of the Relationship Between Income and Consumption over the Life Cycle." *American Economic Review* 64(2): 188–194.

Heckman, James. 1974b. "Shadow Prices, Market Wages, and Labor Supply." *Econometrica* 42(4): 679–694.

Heckman, James. 1979. "Sample Selection Bias as Specification Error." *Econometrica* 47(1): 153–161.

Heckman, James. 1993. "What Has Been Learned About Labor Supply in the Past Twenty Years?" *American Economic Review Papers and Proceedings* 83(2): 116–121.

Heckman, James and MaCurdy, Thomas. 1980. "A Life Cycle Model of Female Labour Supply." *Review of Economic Studies* 47: 47–74.

Heckman, James and MaCurdy, Thomas. 1982. "Corrigendum on a Life Cycle Model of Female Labour Supply." *Review of Economic Studies* 49: 659–660.

Heim, Bradley. 2005a. "The Impact of the Earned Income Tax Credit on the Labor Supply of Married Couples: Structural Estimation and Business Cycle Interactions." Mimeo. Duke University.

Heim, Bradley. 2005b. "The Incredible Shrinking Elasticities: Married Female Labor Supply, 1979–2003." Mimeo. Duke University.

Hotz, V. Joseph; Kydland, Finn E.; and Sedlacek, Guilerme L. 1988. "Inter-temporal Preferences and Labor Supply." *Econometrica* 56: 35–60.

Hotz, V. Joseph, and John Karl Scholz. 2003. "The Earned Income Tax Credit." In *Means-Tested Transfers in the U.S.*, Robert Moffitt, editor, Chicago: University of Chicago Press.

Hoynes, Hilary W. 1996. "Welfare Transfers in Two-Parent Families: Labor Supply and Welfare Participation under AFDC-UP." *Econometrica* 64(2): 295–332.

Hurst, Erik, and James P. Ziliak. 2006. ""Do Welfare Asset Limits Affect Household Saving? Evidence from Welfare Reform." *Journal of Human Resources* 41(1): 46–71.

Imai, Susumu and Michael P. Keane. 2004. "Intertemporal Labor Supply and Human Capital Accumulation." *International Economic Review* 45(2): 601–641.

Kay, J. A. 1980. "The Deadweight Loss of a Tax System." *Journal of Public Economics* 13(1): 111–119.

Keane, Michael, and Robert Moffitt. 1998. "A Structural Model of Multiple Welfare Program Participation and Labor Supply." *International Economic Review* 39(3): 553–589.

Killingsworth, Mark. 1983. *Labor Supply*, Cambridge UK: Cambridge University Press.

Kimmel, Jean and Thomas J. Kniesner. 1999. "New Evidence on Labor Supply: Employment versus Hours Elasticities by Sex and Marital Status." *Journal of Monetary Economics* 42(2): 289–301.

King, Mervyn. 1983. "Welfare Analysis of Tax Reforms Using Household Data." *Journal of Public Economics* 21(2): 183–214.

Kniesner, Thomas J. and James P. Ziliak. 2002a. "Tax Reform and Automatic Stabilization." *American Economic Review* 92(3): 590–612.

Kniesner, Thomas J. and James P. Ziliak. 2002b. "Explicit Versus Implicit Income Insurance." *Journal of Risk and Uncertainty* 25(1): 5–20.

Kooreman, Peter L. and L. Schoonbeek. 2004. "Characterizing Pareto Improvements in an Interdependent Demand System." *Journal of Public Economic Theory* 6(3): 427–443.

Kopczuk, Wojciech. 2005. “Tax Bases, Tax Rates, and the Elasticity of Reported Income.” *Journal of Public Economics* 89: 2093–2119.

Kumar, Anil. 2005. “Lifecycle Consistent Estimation of Effect of Taxes on Female Labor Supply in the U.S: Evidence from Panel Data.” Mimeo, Federal Reserve Bank of Dallas.

Low, Hamish and Daniel Maldoom. 2004. “Optimal Taxation, Prudence, and Risk Sharing.” *Journal of Public Economics* 88:443–464.

Lundberg, Shelly, Robert Pollak, and Terrence Wales. 1997. “Do Husbands and Wives Pool Resources?: Evidence from the UK Child Benefit.” *Journal of Human Resources* 32: 463–480.

McCaffery, Edward J. 2006. “Behavioral Economics and Fundamental Tax Reform.” Presented at the Conference: *Is it Time for Fundamental Tax Reform?: The Known, the Unknown, and the Unknowable* at the James A. Baker III Institute of Public Policy, Rice University, April 27–28, 2006.

MaCurdy, Thomas. 1981. “An Empirical Model of Labor Supply in a Life-Cycle Setting.” *Journal of Political Economy* 89: 1059–1085.

MaCurdy, Thomas. 1983. “A Simple Scheme for Estimating an Inter-temporal Model of Labor Supply and Consumption in the Presence of Taxes and Uncertainty.” *International Economic Review* 24: 265–289.

MaCurdy, Thomas, David Green, and Harry Paarsch. 1990. “Assessing Empirical Approaches for Analyzing Taxes and Labor Supply.” *Journal of Human Resources* 25(3): 415-489.

Mankiw, N. Gregory and Matthew Weinzierl. 2006. “Dynamic Scoring: a Back-of-the-Envelope Guide.” *Journal of Public Economics* forthcoming.

Meyer, Bruce and Dan Rosenbaum. 2001. “Welfare, the Earned Income Tax Credit, and the Labor Supply of Single Mothers.” *Quarterly Journal of Economics* 116(3): 1063-1114.

Moffitt, Robert, and Mark Wilhelm. 2000. “Taxation and the Labor Supply Decisions of the Affluent.” In Joel Slemrod, ed., *Does Atlas Shrug? The Economic Consequences of Taxing the Rich*. New York: Russell Sage Foundation.

Mroz, Thomas. 1987. “The Sensitivity of an Empirical Model of Married Women's Hours of Work to Economic and Statistical Assumptions.” *Econometrica* 55(4): 765–799.

Oettinger, Gerald S. 1999. “An Empirical Analysis of the Daily Labor Supply of Stadium Vendors.” *Journal of Political Economy* 107(2): 360–392.

Pencavel, John. 1986. “Labor Supply of Men.” In *Handbook of Labor Economics,* vol. 1, no. 5, eds. Orley Ashenfelter and Richard Layard, 3–102. Amsterdam: North Holland.

Prescott, Edward C. 2004. "Why Do Americans Work So Much More Than Europeans?" *Federal Reserve Bank of Minneapolis Quarterly Review*, 28(1): 2–13..

Runkle, David E. 1991. "Liquidity Constraints and The Permanent-Income Hypothesis: Evidence from Panel Data." *Journal of Monetary Economics* 27(1): 73–98.

Saez, Emmanuel. 2001. "Using Elasticities to Derive Optimal Income Tax Rates." *Review of Economic Studies* 68: 205–229.

Saez, Emmanuel. 2002. "Optimal Income Transfer Programs: Intensive Versus Extensive Labor Supply Responses." *Quarterly Journal of Economics* 117: 1039–1073.

Saez, Emmanuel. 2003. "The Effect of Marginal Tax Rates on Income: A Panel Study of 'Bracket Creep'." *Journal of Public Economics* 87: 1231–1258.

Saez, Emmanuel. 2006. "Discussion of 'Tax-Induced Individual Behavioral Responses.'" Presented at the Conference: *Is it Time for Fundamental Tax Reform?: The Known, the Unknown, and the Unknowable* at the James A. Baker III Institute of Public Policy, Rice University, April 27–28, 2006.

Scholz, John Karl, Ananth Seshadri, and Surachai Khitatrakun. 2006. "Are Americans Saving "Optimally" for Retirement?" *Journal of Political Economy*, 114(4): 607–643.

Shaw, Kathryn. 1989. "Life-Cycle Labor Supply with Human Capital Accumulation." *International Economic Review* 30(2): 431–456.

Sickles, Robin. 2006. "Discussion of 'Tax-Induced Individual Behavioral Responses.'" Presented at the Conference: *Is it Time for Fundamental Tax Reform?: The Known, the Unknown, and the Unknowable* at the James A. Baker III Institute of Public Policy, Rice University, April 27–28, 2006.

Sieg, Holger. 2000. "Estimating a Dynamic Model of Household Choices in the Presence of Income Taxation." *International Economic Review* 41(3): 637–668.

Slemrod, Joel. 1998. "Methodological Issues in Measuring and Interpreting Taxable Income Elasticities." *National Tax Journal* 51(4): 773–788.

Slemrod, Joel. 2001. "A General Model of the Behavioral Response to Taxation." *International Tax and Public Finance* 8(2): 119–128.

Snow, Arthur, and Ronald Warren. 1996. "The Marginal Welfare Cost of Public Funds: Theory and Estimates." *Journal of Public Economics* 61: 289–305.

Strawczynski, Michel. 1998. "Social Insurance and the Optimum Piecewise Linear Income Tax." *Journal of Public Economics* 69(3): 371–388.

Triest, Robert K. 1990. “The Effect of Income Taxation on Labor Supply in the United States.” *Journal of Human Resources* 25(3): 491–516.

Triest, Robert K. (1992). “The Effect of Income Taxation on Labor Supply when Deductions are Endogenous.” *Review of Economics and Statistics* 25(1): 91–99.

Triest, Robert. 1994. “The Efficiency Cost of Increased Progressivity.” In *Tax Progressivity and Income Inequality*, ed. J. Slemrod, 137–170. Cambridge: Cambridge University Press.

van Soest, Arthur. 1995. “Structural Models of Family Labor Supply: A Discrete Choice Approach.” *Journal of Human Resources* 30(1): 63–88.

Varian, Hal. 1980. “Redistributive Taxation as Social Insurance.” *Journal of Public Economics* 14(1): 49–68.

Wildasin, David. 1984. “On Public Good Provision with Distortionary Taxation.” *Economic Inquiry* 22(2): 227–243.

Zeldes, Stephen P. 1989. “Consumption and Liquidity Constraints: An Empirical Investigation.” *Journal of Political Economy* 97(2): 305–346.

Ziliak, James P. 2005. “Taxes, Transfers, and the Labor Supply of Single Mothers.” Mimeo, University of Kentucky.

Ziliak, James P. and Thomas J. Kniesner. 1999. “Estimating Life-Cycle Labor-Supply Tax Effects.” *Journal of Political Economy* 107(2): 326–359.

Ziliak, James P., and Thomas J. Kniesner. 2005. “The Effect of Income Taxation on Consumption and Labor Supply.” *Journal of Labor Economics*, 23(4): 769–796.