PRELIMINARY

Taxation and Family Labor Supply

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Abstract

I examine the impact of taxation on family labor supply and test economic models of the family by analyzing responses to the Tax Reform of 1991 in Sweden, known as the "tax reform of the century" because of its large magnitude. Using detailed administrative panel data on approximately 11% of the married Swedish population, I find that husbands and wives react substantially to their own marginal tax rates and to their spouses' rates. The estimates imply that husbands' leisure and wives' leisure are complements in the full sample. I test and reject a set of models in which the family maximizes a single utility function. The standard econometric labor supply specification, in which one spouse reacts to the other spouse's income as if it were unearned income, yields biased coefficient estimates. Uncompensated labor supply elasticities are over-estimated by a factor of more than three, and income effects are of the wrong sign. Overall, the results suggest that there is interplay between spouses' labor supply decisions, and that taking account of this joint aspect of their decision-making leads to new conclusions about labor supply responses to taxation.

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I. Introduction

By exploring the effect of taxation on husbands' and wives' joint labor supply decisions, we can test economic models of the family and better understand how to tax families optimally. Standard empirical analyses of the effect of tax rates on labor supply relate a spouse's labor supply decision to his or her own tax rate (e.g. Blundell, Duncan, and Meghir 1998). It has been typical to assume that an individual's labor supply responds to the income of his or her spouse as it would respond to unearned income, following a long tradition beginning with Mincer (1962). In this paper, I relax these restrictions by examining how independent variation in each spouse's tax rate impacts husbands' and wives' joint labor supply decisions.

The Swedish Tax Reform of 1991 (TR91) represents a particularly promising setting for studying these issues. Often called the "Tax Reform of the Century" in Sweden, TR91 decreased the top marginal income tax rate from 76% to 51%, with substantial but smaller decreases in other tax brackets. This represents an opportunity to examine labor supply responses to large exogenous changes in incentives.[2] In the U.S., married couples are almost always taxed jointly on the sum of their incomes, implying that husbands and wives face the same marginal tax rate. Sweden has individual taxation, meaning that an individual's marginal tax rate on earned income depends only on his or her own income. When the Swedish tax schedule changes, husbands and wives face different changes in their marginal tax rates, and the relative size of these changes differs across households, allowing me to identify cross responses.[3]

I use the Longitudinal Individual Data for Sweden (LINDA), a panel of detailed administrative data that follow the labor force activity, government program participation, demographic characteristics, and other relevant features of nearly 1 million individuals (including their families) from 1968 to the present.[4] This allows me to estimate parameters precisely and analyze the impacts of a variety of covariates. Unlike the IRS-Michigan-NBER Tax Panel on the U.S., which measures married couples' taxable income only at the family level, the LINDA data contain information on the income of each spouse.

With a specification allowing for cross responses, I estimate a rich set of parameters, including own and cross income and substitution effects for both husbands and wives. Standard econometric models, in which labor supply is assumed to respond to spousal

[2] Ljunge and Ragan (2005), Hansson (2007), and Selén (2002) also examine the Swedish Tax Reform of 1991. These authors focus on the response of individuals' earned income to taxation, assuming that one spouse reacts to the other's income as if it were unearned income.

[3] I use "own response," "own elasticity," or "own effect" to refer to the reaction to one's own wage, tax rate, or income, and "cross response," "cross elasticity," or "cross effect" to refer to the reaction to the wage, tax rate, or income of one's spouse.

[4] The data contain fewer observations during time periods earlier than the period that I consider, which is in the late 1980s and early 1990s.

income as it responds to unearned income, cannot reflect the possibility that the leisure of one's spouse could be a complement to or a substitute for one's own. A long history of work on the responsiveness of husbands' and wives' labor supply to each other's wages and incomes is primarily based on cross-sectional or aggregate variation (e.g. Ashenfelter and Heckman 1974; Blau and Kahn 2007). A related literature (Feldstein 1995; Gruber and Saez 2002), which examines the response of families' taxable income to the marginal tax rates they face, leaves open the question of how husbands' and wives' decisions separately contribute to families' aggregate responses.[5]

The results reveal that husbands and wives react to each other's marginal tax rates and unearned incomes, as well as to their own. My central estimates show compensated elasticities of individuals' earned income with respect to their own net-of-tax share of .25 and .49 for husbands and wives, respectively. (The net-of-tax share is defined as one minus the marginal tax rate.) It is noteworthy that the female labor supply elasticity is higher than the elasticity for men, even in a country known for its relative gender equality and high female labor force participation rate. Compensated cross elasticities are .048 and .051, respectively. Thus, I find complementarity of spousal leisure in the population as a whole, although there is heterogeneity among demographic groups.[6] The point estimates indicate substitutability of spousal leisure in families with young children and complementarity in families without young children. Elasticities of earned income with respect to own unearned income are large (-.074 and -.056 for husbands and wives, respectively) and precisely estimated. I estimate substantial elasticities of own earned income with respect to spouses' unearned income of -.0041 for husbands and -.018 for wives. When the dependent variable is a measure of taxable labor income, calculated by subtracting tax deductions from labor income, the elasticities are similar. Responses for both husbands and wives are substantial both on the margin of whether to work or not, and on the margin of how much labor they supply conditional on working. These estimates include a number of parameters of interest in contexts other than family labor supply, including income effects and compensated labor supply elasticities.

Since I estimate own and cross uncompensated and compensated effects, I am able to perform two separate tests of the unitary model of family labor supply. The unitary model is defined by the feature that the family can be characterized as maximizing a

[5] Gruber and Saez (2002) include single taxpayers in their regressions as well as households. Hausman and Ruud (1984) and Aronsson and Wikström (1994) examine how husbands' and wives' hours worked respond to taxation.

[6] I use "leisure" as shorthand to refer both to home production and enjoyment of leisure activities. My use of the word "leisure" thus corresponds to what previous literature has called "non-market time." I avoid using the phrase "non-market time" because my measure of labor supply is earnings, not hours worked, so I do not directly observe individuals' time allocations. As discussed below, I examine earnings because it represents a broader measure of labor supply than hours worked, reflecting both hours worked and effort per hour worked. Hunt (1998), Gustman and Steinmeier (2000), Maestas (2001), and Hamermesh (2002) also find evidence consistent with complementarity of spousal leisure.

single utility function. I reject a unitary model based on violations of the "income pooling condition," which states that a married individual's consumption of leisure should react equally to an increase in that individual's unearned income as it reacts to an increase in the unearned income of his or her spouse.[7] The unitary model also predicts that the Slutsky matrix should be symmetric: the compensated response of the husband's leisure to the net-of-tax wage of the wife is predicted to be equal to the compensated response of the wife's leisure to the net-of-tax wage of the husband. For the entire population, I cannot reject Slutsky symmetry at conventional significance levels, though I do reject it for certain population groups.

To determine how much standard econometric models may be biased, I re-estimate my regressions under the customary specification, assuming that one spouse's labor supply reacts to the other spouse's income as it reacts to unearned income. This yields an estimate of the income effect that is large and of the wrong sign. When a husband's marginal tax rate falls, he works more, and complementarity implies that his wife works more, as well. This induces a spurious positive correlation between the change in the measure of the husband's unearned income (which includes his wife's income) and the change in the husband's own labor supply. Thus, the estimated coefficient on the husband's unearned income, which represents the income effect on his labor supply, is overly positive.[8] For both husbands and wives, this specification also produces an estimate of the uncompensated labor supply elasticity that is biased upward by a factor of more than three, as well as an over-estimate of the compensated elasticity.

The paper proceeds as follows. I review a unitary model of family labor supply in Section II. Section III presents an empirical specification corresponding to the model. Section IV describes TR91 and other relevant features of the Swedish economy around 1991. Section V discusses the data. Section VI presents the empirical results and relates them to models of the family. Section VII concludes.

II. Empirical Model

A. Basic Framework

In the framework above, the labor supply of a given spouse may depend on his or her own net-of-tax share and unearned income, and on the net-of-tax share and unearned income of his or her spouse. For my empirical model, I relate the logs of the variables, which will yield coefficient estimates interpretable as elasticities. Thus, the log of a

[7] More generally, the income pooling condition states that a married individual's consumption of any good should react equally to an increase in that individual's unearned income as it reacts to an increase in the unearned income of his or her spouse. See Lundberg, Pollak, and Wales (1997) for an alternative test of income pooling in a developed country. Several papers have tested family models in developing countries, including Udry (1996) and Duflo (2003).

[8] Analogous reasoning implies that the estimated coefficient on the wife's unearned income should be overly positive.

spouse's earned income, $\ln(E_{it}^{s})$, is specified as a function of the log of that individual's net-of-tax share (i.e. the log of one minus that individual's marginal tax rate), $\ln(1-\tau_{it}^{s})$, the log of the other spouse's net-of-tax share, $\ln(1-\tau_{it}^{-s})$, the log of the individual's own income, $\ln(Y_{it}^{s})$, and the log of the other spouse's income, $\ln(Y_{it}^{-s})$. Here the superscript $s \in \{h, w\}$ represents the individual in question, whereas $-s$ denotes that individual's spouse, and h and w refer to the husband and wife, respectively. i indexes couples, and t represents the time period.

To remove individual-level fixed effects that may be correlated with the tax and income variables of interest, the model will be estimated in first differences, as in Gruber and Saez (2002):

$$\begin{aligned}\Delta \ln(E_{it}^{h}) &= \beta_0^h + \beta_1^h \Delta \ln(1-\tau_{it}^{h}) + \beta_2^h \Delta \ln(1-\tau_{it}^{w}) + \beta_3^h \Delta \ln(Y_{it}^{h}) + \beta_4^h \Delta \ln(Y_{it}^{w}) \\ &\quad + X_{iT}^{h}\beta_h^h + X_{iT}^{w}\beta_w^h + \vartheta_t^h + \varepsilon_{it}^h \qquad (1)\end{aligned}$$

$$\begin{aligned}\Delta \ln(E_{it}^{w}) &= \beta_0^w + \beta_1^w \Delta \ln(1-\tau_{it}^{w}) + \beta_2^w \Delta \ln(1-\tau_{it}^{h}) + \beta_3^w \Delta \ln(Y_{it}^{w}) + \beta_4^w \Delta \ln(Y_{it}^{h}) \\ &\quad + X_{iT}^{w}\beta_w^w + X_{iT}^{h}\beta_h^w + \vartheta_t^w + \varepsilon_{it}^w \qquad (2)\end{aligned}$$

where $\Delta \ln(Z_t)$ represents the change from $t-1$ to t in the log of Z. (I use "base year" to indicate $t-1$, the initial year in each pair of years over which the first difference is taken, and "final year" to refer to t, the last year in each pair of years over which the first difference is taken.) The subscript t still appears in the empirical model since multiple first differences will be used. Time dummies ϑ_t^s control for economy-wide earned income growth specific to each period over which the first difference is taken. ε_{it}^h and ε_{it}^w are error terms. X_{iT}^h and X_{iT}^w represent other variables—age, age squared, education, region, number of children, industry, occupation, and sometimes interactions of the covariates—that control for other factors that could influence changes in earned income. The control variables bear the subscript T, which refers to an initial period prior to the earliest observation of t.

The dependent variable, the change in the log of real earned income, is chosen under the rationale that earned income represents a broader measure of labor supply than hours worked does (Feldstein 1995, 1999).[9] For example, effort per hour worked should influence earned income by increasing the marginal product and thus the wage. Measures of hours worked are also subject to substantial measurement error (e.g. Baum-Snow and Neal 2006). While earned income will also reflect changes in the form of compensation–for example, taxation might affect the mix of compensation between fringe benefits and wage compensation–it is not clear whether earned income or hours worked is a "better" measure of labor supply overall, since earned income has two major advantages over hours worked. Feldstein examines the elasticity of taxable income with respect to the net-of-tax share, but I focus primarily on the narrower

[9] Eissa (1995) examines the response of married women's hours worked to the Tax Reform Act of 1986.

measure of earned income. The response of earned income is easier to examine because in the data, the definitions of several types of capital income changed from before the Tax Reform of 1991 to after. Earned income is also interesting because it may capture true effort responses; it may be easier to change taxable income via avoidance activities that do not reflect true labor effort. In some regressions, I also examine how a measure of taxable labor income, formed by subtracting a set of deductions from earned income, responds to the net-of-tax share.[10] It is worth noting that in this context, the relevant independent variable is the net-of-tax share, rather than the net-of-tax wage. Individuals are trading off leisure against consumption in this framework, where higher earned income represents less leisure. In this framework, the relative price of these two commodities is indeed proportional to the net-of-tax rate, rather than the net-of-tax wage. Moreover, it is worth noting that if labor supply is much more inelastic than labor demand, as is commonly presumed, then the incidence of taxation will be borne entirely by workers, and percentage changes in the net-of-tax rate will be identical to percentage changes in the net-of-tax wage.

Since the log of zero is undefined, I add 1 to earnings before logging it, so that the dependent variable is defined even if an individual does not participate in the labor market. The dependent variable for spouse s in couple i is therefore $\ln[(1 + E_{it}^s)/(1 + E_{it-1}^s)]$, and the notation in (9) and (10) can be considered shorthand for this expression. The results are generally insensitive to other choices, such as adding .1 or 10 to earnings before taking the log. In order to address the concern that logging the dependent variable could have an affect on the results particularly at low incomes, in one specification, I exclude from the regressions those who exited the labor force. Moreover, I probe the robustness of the results to logging the independent variables (the net-of-tax share and income) by instead entering these variables linearly in another specification. Because the prediction of Slutsky symmetry only holds when both spouses participate in the labor market, I exclude couples from my main regressions in those pairs of years in which at least one member of the couple does not participate in the labor market in the base year. The measure of income used as an independent variable is "virtual income," which represents the intersection of the individual's extended budget segment in consumption-effort space with the Y-axis.[11] The construction of virtual income is discussed at greater length in Appendix II.[12]

[10] Feldstein (1999) develops a measure of the deadweight loss of taxation in terms of the elasticity of taxable labor income with respect to the net-of-tax share, but the empirical literature (e.g. Feldstein 1995; Gruber and Saez 2002) has focused on the elasticity of taxable income (including capital income) with respect to the net-of-tax share. By investigating the elasticity of taxable labor income, I estimate a parameter that more closely corresponds to Feldstein's (1999) model.

[11] Burtless and Hausman (1978) explain virtual income and why it is the appropriate income measure for estimating income effects in the presence of a nonlinear budget set. Recall that in the model in Section II, taxes on earned income were assumed to be linear and proportional. Virtual income essentially corrects the empirical specification for the potential lack of equality between average and marginal tax rates.

[12] Blomquist and Selin (2007) argue that Gruber and Saez (2002) should have specified income

β_1^h represents husbands' uncompensated elasticity of earned income with respect to their own net-of-tax share, and β_3^h represents husbands' elasticity of earned income with respect to their own unearned income. β_2^h represents husbands' uncompensated elasticity of earned income with respect to their wives' net-of-tax share, and β_4^h represents husbands' elasticity of earned income with respect to their wives' unearned income. (The analogous coefficients in the model for wives bear the analogous interpretations.)

I also develop a framework for analyzing individuals' responses along the margin of whether to work or not, rather than the margin of how much to work (conditional on working). The decision of whether or not to work should be influenced by the average tax rate that one faces as a result of working, as opposed to not working. For simplicity, I run a linear probability model; similar results are obtained under a probit or logit. In a first set of regressions, in which the sample is those initially participating in the labor force, I regress a dummy for exiting the labor force on the individual's own change in the log average after-tax share (the percentage of the average dollar that one keeps when working as opposed to not working), on the spouse's change in the log average after-tax share, and on the controls described above. The coefficients on one's own and one's spouse's change in the log average after-tax share then represent uncompensated elasticities on the extensive margin.

In a second set of regressions, in which the sample is those initially not participating in the labor force, I regress a dummy for entering the labor force on the change in the individual's own imputed log after-tax share and the spouse's imputed log after-tax share. The imputation of the after-tax share is performed by regressing taxable income on demographic characteristics (age, education, and sex) in the sample of married individuals who participate in the labor force (with a separate regression in each year), and then using the predicted values from this regression to calculate the average after-tax share that the individual would face if he or she possessed the predicted taxable income.[13] The coefficients on one's own and one's spouse's log imputed average after-tax share then represent uncompensated elasticities on the extensive margin.

In the main regressions, I consider two sets of one-year differences, which are pooled in the regressions: one from 1989-1990, and the other from 1990-1991. These are the

effects differently—the correct specification places virtual income on the right-hand side—and that we therefore lack well-specified estimates of income effects on broader measures of labor supply. Since previous work has examined the response of households' taxable income to taxation, it is also notable that any specification that relates household taxable income to a household income effect (as in Gruber and Saez 2002) imposes a restriction. The effect of the husband's unearned income on the taxable income of the family is assumed to be equal to the effect of the wife's unearned income on the taxable income of the family. Their specification, which relates the family's taxable income to the family's marginal tax rate, also does not properly account for the incentives of a non-participant spouse, for whom the relevant tax rate is the average tax rate associated with entering the labor force, rather than the family's marginal tax rate.

[13] Imputing income or wages for those not participating in the labor force is common in analyses of labor force participation (e.g. Blau and Kahn 2007).

years of the tax reform. This strategy will identify a short-term effect of the changes in the tax schedule.[14] The main source of exogenous variation is that in TR91, marginal tax rates were reduced much more for those at the top of the income distribution than for those at the bottom. This generates very large exogenous variation across households and time in the net-of-tax shares of husbands relative to their wives. For example, suppose that in Couple 1, the wife is in the lowest tax bracket, and the husband is in the highest tax bracket (both before and after the reform). In Couple 2, both the husband and wife are in the highest tax bracket (both before and after the reform). Those in the highest tax bracket receive a large cut in their marginal tax rate, whereas those in the lowest bracket receive a small cut. Therefore, due to the tax reform, the net-of-tax share of the husband relative to that of the wife increases in Couple 1 but stays constant in Couple 2. Thus, I can relate the changes over time in the relative earnings of the husbands and wives in the two couples, to the changes over time and couples in their relative net-of-tax shares (and to the changes in virtual incomes associated with these tax changes and any simultaneous changes in capital taxation).[15]

B. Instruments

The actual marginal tax rate that an individual faces is potentially endogenous. An individual's marginal tax rate is calculated on the basis of that individual's income. If an individual's income responds to the tax schedule, this would create reverse causality. For example, if an individual responds to an increase in his or her own marginal tax rate by decreasing his or her earned income, and marginal tax rates are progressive, then an OLS estimate of the effect of the net-of-tax share on earned income will be biased downward. Thus, it is typical to instrument for the net-of-tax share with a so-called "simulated instrument." This instrument is constructed by calculating the change in the net-of-tax share that would have occured if the individual had maintained the behavior he or she exhibited in the initial period (Gruber and Saez 2002). The intuitive notion that underlies this procedure is that the change in the tax schedule is exogenous to individuals' initial behavior, so the value of this instrument will not be affected by the endogenous response to the new tax schedule.

In particular, the instrument is constructed by projecting final year taxable income to be base year taxable income for spouse s in couple i, Z^s_{it-1}, multiplied by the growth of mean taxable income per taxpayer in the sample, $(1+g)$. Letting $\hat{Z}^s_{it}$ be projected taxable income, I set $\hat{Z}^s_{it} = (1+g)Z^s_{it-1}$. Suppose that the net-of-tax share (as a function of taxable income) before the tax change is given by $T_{t-1}()$ and the net-of-tax share after the tax change is given by $T_t()$. I use $T_t(\hat{Z}^s_{it}) - T_{t-1}(Z^s_{it-1})$ to instrument for $T_t(Z^s_{it}) - T_{t-1}(Z^s_{it-1})$. In the regressions relating to the extensive margin, the average after-tax share is instrumented analogously.

[14] Gruber and Saez (2002) find relatively similar elasticities at 1-year, 2-year, and 3-year intervals.

[15] My regressions in fact allow for more flexibility than a specification that literally related the relative earnings of the spouses to their relative net-of-tax shares, because I run separate regressions for husbands and wives and enter each spouse's net-of-tax share separately in each regression.

Because virtual income for spouse s in couple i in year t, $Y_{it}^{s,v}()$, varies according to which budget segment the individual locates on, it is a function of actual taxable income.[16] Thus, virtual income is also potentially endogenous. I construct a simulated instrument for the actual change in virtual income, by predicting the change in virtual income that would have occurred, if the individual had projected taxable income $\hat{Z}_{it}^{s}$ in the final period. In other words, I use $Y_{it}^{s,v}(\hat{Z}_{it}^{s}) - Y_{it-1}^{s,v}(Z_{it-1}^{s})$ as an instrument for $Y_{it}^{s,v}(Z_{it}^{s}) - Y_{it-1}^{s,v}(Z_{it-1}^{s})$.[17]

C. Controlling for the Evolution of the Income Distribution

In their regressions relating taxable income to the net-of-tax share and an income effect, Gruber and Saez (2002) control for a ten-piece spline in the log of base year real income. This serves the dual role of controlling for changes in the income distribution that are unrelated to taxation and controlling for mean reversion or other features of the autocorrelation process of the dependent variable. Since the size of the tax change is correlated with income, it may be difficult empirically to tease apart variation in base-year income from variation in the change in marginal tax rates. Indeed, Gruber and Saez (2002) write that using rich controls for base-year income "may destroy identification. This problem is especially acute when the size of the tax rate change is directly correlated with the income level as in the TRA of 1986...In practice, rich controls for base year income make it very difficult to separately identify income and substitution effects with only one tax change. But since we are using many tax reforms, the two effects can be separately identified, as we show below" (pp. 11-12). Because I examine only one tax reform, over-controlling for base year income is a major cause for concern. Given the correlation between base year income and the change in the marginal tax rate, the regression results may be highly sensitive to mis-specification, for example of the functional form with which base year income enters.

To address this issue, I calibrate the evolution of the income distribution using a period in which no major tax change occurs, and I assume that absent the tax change, the income distribution would have evolved similarly during the period of the change. I then relate the remaining variation in earned income to exogenous variation in the

[16] $Y_{it}^{s,v}()$ is subscripted by i because it also depends on capital income and government transfers, which vary by individual.

[17] Since each spouse's tax rate on capital income was potentially different prior to the reform (because each spouse's capital income was taxed separately), this created an incentive for couples to avoid taxes by allocating capital income to the lower-taxed spouse. However, this does not affect my estimates because I instrument for the actual change in virtual income using the change that would have been expected on the basis of the different components of pre-reform virtual income. The estimation procedure therefore effectively throws away any variation coming from individuals' endogenous responses to the new tax schedule, and therefore throws away any variation relating to re-allocation of capital income. It is also worth noting that, as I discuss later, capital income has been taxed at a flat rate of 30% since the 1991 reform, thus eliminating any incentive for couples to re-allocate their assets to the lower-taxed spouse.

marginal tax rate, controlling for a rich set of covariates that can capture effects unique to the period of the tax change.

I begin this procedure by performing the following regressions during a period in which the change in the tax schedule is negligible:[18]

$$\begin{aligned}\Delta \ln(E^h_{it}) &= \xi^h_0 + f[\ln(E^h_{it-1})]\xi^h_{E,h} + f[\ln(E^w_{it-1})]\xi^h_{E,w} + f[\ln(Z^h_{it-1})]\xi^h_{Z,h} \\ &\quad + f[\ln(Z^w_{it-1})]\xi^h_{Z,w} + X^h_{iT}\xi^h_h + X^w_{iT}\xi^h_w + \upsilon^h_{it} \qquad (3)\end{aligned}$$

$$\begin{aligned}\Delta \ln(E^w_{it}) &= \xi^w_0 + f[\ln(E^w_{it-1})]\xi^w_{E,w} + f[\ln(E^h_{it-1})]\xi^w_{E,h} + f[\ln(Z^w_{it-1})]\xi^w_{Z,w} \\ &\quad + f[\ln(Z^h_{it-1})]\xi^w_{Z,h} + X^w_{iT}\xi^w_w + X^h_{iT}\xi^w_h + \upsilon^w_{it} \qquad (4)\end{aligned}$$

Here f is a ten-piece spline in lagged log real income. I use ten-piece splines in one's own lagged log real earned income, one's spouse's lagged log real earned income, one's own lagged log real taxable income, and one's spouse's lagged log real taxable income. I include a ten-piece spline in lagged log real taxable income because in the main regressions of interest, changes in log real earned income will be related to changes in marginal tax rates. Marginal tax rates are computed based on taxable income, so controlling for lagged log real taxable income addresses possible mean reversion relating to taxable income. The results are insensitive to other specifications, such as those with greater or fewer knots of the spline, or those with polynomials rather than splines. The knots of the spline are placed at deciles of the income distribution. $\xi^h_{E,h}$, $\xi^h_{E,w}$, $\xi^h_{Z,h}$, $\xi^h_{Z,w}$, $\xi^w_{E,w}$, $\xi^w_{E,h}$, $\xi^w_{Z,w}$, and $\xi^w_{Z,h}$ represent vectors of coefficients on these splines. The control variables X^h_{iT} and X^w_{iT} may be omitted or included in this regression; I include them, though the results of all of the regressions are insensitive to this choice. The analogous regressions are performed for the husband.

These regressions yield an estimated set of coefficients $\hat{\xi}^h_{E,h}$, $\hat{\xi}^h_{E,w}$, $\hat{\xi}^h_{Z,h}$, $\hat{\xi}^h_{Z,w}$, $\hat{\xi}^w_{E,w}$, $\hat{\xi}^w_{E,h}$, $\hat{\xi}^w_{Z,w}$, and $\hat{\xi}^w_{Z,h}$, which collectively calibrate how income evolves in the absence of a tax change. In the later period that spans the tax change, I use these estimated coefficients to partial out the predicted effect of base year income, thus creating residual changes in the log of real earned income, $\tilde{\Delta}\ln(E^h_{it})$ and $\tilde{\Delta}\ln(E^w_{it})$, for the husband and the wife, respectively:

$$\begin{aligned}\tilde{\Delta} \ln(E^h_{it}) &= \Delta \ln(E^h_{it}) - f[\ln(E^h_{it-1})]\hat{\xi}^h_{E,h} - f[\ln(E^w_{it-1})]\hat{\xi}^h_{E,w} \\ &\quad - f[\ln(Z^h_{it-1})]\hat{\xi}^h_{Z,h} - f[\ln(Z^w_{it-1})]\hat{\xi}^h_{Z,w} \qquad (5)\end{aligned}$$

$$\begin{aligned}\tilde{\Delta} \ln(E^w_{it}) &= \Delta \ln(E^w_{it}) - f[\ln(E^w_{it-1})]\hat{\xi}^w_{E,w} - f[\ln(E^h_{it-1})]\hat{\xi}^w_{E,h} \\ &\quad - f[\ln(Z^w_{it-1})]\hat{\xi}^w_{Z,w} - f[\ln(Z^h_{it-1})]\hat{\xi}^w_{Z,h} \qquad (6)\end{aligned}$$

[18] I only examine one such first difference, so time dummies do not appear in these regressions.

These residuals represent the remaining variation in the change in earned income, with the predicted effect of lagged income removed. I now modify equations (9) and (10), relating the residuals to the independent variables:

$$\begin{aligned}\tilde{\Delta}\ln(E^h_{it}) &= \beta^h_0 + \beta^h_1\Delta\ln(1-\tau^h_{it}) + \beta^h_2\Delta\ln(1-\tau^w_{it}) \\ &\quad +\beta^h_3\Delta\ln(Y^h_{it}) + \beta^h_4\Delta\ln(Y^w_{it}) + X^h_{iT}\beta^h_h + X^w_{iT}\beta^h_w + \vartheta^h_t + \varepsilon^h_{it} \qquad (7)\end{aligned}$$

$$\begin{aligned}\tilde{\Delta}\ln(E^w_{it}) &= \beta^w_0 + \beta^w_1\Delta\ln(1-\tau^w_{it}) + \beta^w_2\Delta\ln(1-\tau^h_{it}) \\ &\quad +\beta^w_3\Delta\ln(Y^w_{it}) + \beta^w_4\Delta\ln(Y^h_{it}) + X^w_{iT}\beta^w_w + X^h_{iT}\beta^w_h + \vartheta^w_t + \varepsilon^w_{it} \qquad (8)\end{aligned}$$

I instrument for tax rates and virtual incomes using the simulated instruments described earlier. Because the estimates of $\hat{\xi}^h_{E,h}$, $\hat{\xi}^h_{E,w}$, $\hat{\xi}^h_{Z,h}$, $\hat{\xi}^h_{Z,w}$, $\hat{\xi}^w_{E,w}$, $\hat{\xi}^w_{E,h}$, $\hat{\xi}^w_{Z,w}$, and $\hat{\xi}^w_{Z,h}$ are uncertain—regressions (11) and (12) yield point estimates of these parameters, but these point estimates have standard error bands—it is necessary to bootstrap the standard errors for regressions (15) and (16). I run 10,000 iterations of the bootstrap with 1,000 individuals each (sampled with replacement); for husbands, regressions (11) and (15) are run on these individuals, and for wives, regressions (12) and (16) are run.[19]

The procedure described in this section is conceptually similar to a "triple difference" strategy, in which the differences across couples over time are contrasted between a period of no policy change and a period of a policy change. The assumption is that the influence of all of the factors that are unique to the period spanning the tax change can be removed with the controls. I control extensively for occupation, industry, region, education, and several other demographic variables. The evidence is consistent with the contention that this procedure removes the true effect of lagged income and business cycle effects, since adding more extensive controls makes little difference to the estimated coefficients of interest.[20]

D. Implications of the Unitary Model for the Parameter Estimates

Since the empirical model is specified in terms of elasticities, I transform the coefficient estimates to relate them to the predictions of the model. For individuals at the sample means of income, income pooling implies:

$$\beta^h_3\bar{Y}^w = \beta^h_4\bar{Y}^h \qquad (9)$$

[19] In the absence of the calibration procedure—if I were to run regressions (9) and (10), rather than regressions (15) and (16)—I would cluster the standard errors by individual to correct for the fact that each person is re-sampled over the two one-year differences considered. When I simply run regressions (15) and (16) and cluster the standard errors by individual, without performing the bootstrapping, I estimate slightly smaller standard errors.

[20] My procedure also bears a conceptual resemblance to the empirical strategy of Lindsey (1987). Lindsey predicts how much taxable income should exist in each part of the income distribution, absent the tax change. The difference between the actual amount of taxable income in each part of the distribution and the predicted amount is then attributed to the effect of taxation. My procedure performs a similar comparison, but differs from the Lindsey strategy by employing panel data, rather than repeated cross sections.

and

$$\beta_3^w \bar{Y}^h = \beta_4^w \bar{Y}^w \tag{10}$$

where bars above the income variables represent their sample mean values.[21]

To test Slutsky symmetry, begin by recalling the Slutsky relation in the context of earned income:

$$\frac{\partial E^h}{\partial(1-\tau^w)}|_u = \frac{\partial E^h}{\partial(1-\tau^w)} - E^w \frac{\partial E^h}{\partial Y^w} \tag{11}$$

$$\frac{\partial E^w}{\partial(1-\tau^h)}|_u = \frac{\partial E^w}{\partial(1-\tau^h)} - E^h \frac{\partial E^w}{\partial Y^h} \tag{12}$$

After performing transformations to express the elasticity estimates as marginal effects, the following equality is implied by Slutsky symmetry, evaluated at the sample means of the variables:

$$\beta_2^h \frac{\bar{E}^h}{1-\bar{\tau}^w} - \bar{E}^w \beta_4^h \frac{\bar{E}^h}{\bar{Y}^w} = \beta_2^w \frac{\bar{E}^w}{1-\bar{\tau}^h} - \bar{E}^h \beta_4^w \frac{\bar{E}^w}{\bar{Y}^h} \tag{13}$$

III. The Tax Reform of 1991

The Tax Reform of 1991 changed tax rates dramatically.[22] The net-of-tax share increased by 24.6% on average. By contrast, the U.S. Tax Reform Act of 1986 increased the net-of-tax share by only 4.8% on average (Ljunge and Ragan 2005). TR91 revised several other aspects of the tax system, including the VAT and corporate taxes. The period considered in this paper includes two tax reductions, from 1989-1990 and 1990-1991, the latter of which was far larger.

Table 1 shows the tax schedule for the national Swedish government, called the "state tax schedule," in 1989 and 1991. Marginal tax rates fell substantially for those at the top of the income distribution but fell little for those at the bottom. Before TR91, the state tax schedule was comprised of two different schedules, the basic schedule and the additional schedule. Basic taxable income differed from additional taxable income because a number of deductions could be taken on the basic schedule that could not be taken on the additional schedule. The total state marginal tax rate was calculated by

[21] In my tests, I use the sample mean values from 1989, before the tax change. I also test these predictions for individuals at other points in the income distribution. In addition, I perform these tests, and the test of Slutsky symmetry, using the results of an empirical specification in which the net-of-tax-shares and virtual incomes of the husband and wife enter linearly, so that it is not necessary to transform the coefficient estimates from elasticities into effects.

[22] A detailed description and analysis of TR91 can be found in Agell, Englund, and Södersten (1998). This section and the next also often draw on the description of TR91 in Ljunge and Ragan (2005). Many of the important features of the reform had been anticipated since 1987, when a commission began to plan the reform (Agell, Englund and Södersten 1998).

summing the basic marginal tax rate and the additional marginal tax rate. Starting in 1991, the distinction between basic and additional taxable income was eliminated, and income was taxed according to a single state tax schedule.

Prior to 1991, Sweden had a global tax system, under which earned income and capital income were taxed at the same marginal tax rate, calculated on the basis of an individual's earned income, taxable government transfers, capital income, and deductions. Starting in 1991, Sweden changed to a dual tax system, under which the marginal tax rate on earned income is computed only based on earned income (and taxable government transfers and deductions), and capital income is taxed at the flat rate of 30%. These changes in the taxation of unearned income provide sizeable exogenous variation in after-tax unearned income, thus aiding in the identification of income effects.

The reform also broadened the tax base, to make up for the revenue lost due to the tax cuts. For example, before 1991, nominal interest expenses were fully deductible against typically high marginal income tax rates, whereas after the reform, they were deductible against the lower capital income tax rate of 30%. Due to such broadening of the base, deductions and exclusions fell as a share of total income. The reform was designed to be almost revenue-neutral. The Swedish Ministry of Finance (1991) projected that 89.1 billion Swedish Kronor (SEK) would be lost due to the tax cuts, and that SEK 8.2 billion would be lost due to increased spending planned for 1991. However, the projections indicated that SEK 95.1 billion would be recouped through the combination of base broadening (SEK 79.6 billion), dynamic gains from increased economic activity in response to the tax cuts (SEK 5.0 billion), and increases in other revenues such as corporate tax revenues (SEK 10.4 billion).

The total marginal tax rate is calculated as the sum of the local, municipal and state tax rates. The mean value of the sum of local and municipal rates is 31% (both before and after the reform), with a minimum of 27% and a maximum of 33% over all the years examined. It is possible to construct an alternative measure of the marginal tax rate that includes the phase-outs and phase-ins of the basic deduction and of various transfers (such as a housing-related transfer). Ultimately, how much individuals respond to such incentives is an empirical question. The results are similar when other measures of the marginal tax rate are employed.

Some features of the Swedish macroeconomic environment are shown in Figure 1. The dashed line represents real percentage GDP growth per capita. Sweden entered a recession in late 1990, with real per capita GDP growth rates of 1.0%, -1.1%, -1.2%, and -2.0% in 1990, 1991, 1992, and 1993, respectively. The solid line shows the unemployment rate, which increased substantially during the recession. It is possible to argue that this macroeconomic turmoil could help me to uncover family labor supply responses. During a period of economic calm, couples may re-optimize their decisions infrequently, but in a period of turmoil, we may be able to observe these changes more readily and relate them to exogenous changes in tax policy. On the other hand, one could argue that in a weak labor market, families may not have labor supply choices available to them that they otherwise would have made. The overall impact on the parameter estimates is *a priori* unclear. To control for the influence of these macroeconomic factors, I control for a rich set of covariates, including dummies for 2-digit industry codes, 2-digit occupation codes, and other covariates interacted with year. Income effects could also have come not only from changes in capital income measured in the data, but also by the changes in wealth induced by the macroeconomic environment or by the capitalization of changes in the tax rules into asset prices. A particular source of concern is that housing prices in Sweden fell substantially around the time of the reform. When I include a measure of the imputed income from housing wealth in my measure of virtual income, I estimate similar income effects.

To understand the context in which the tax reform occurred, it is also worth noting similarities and differences between Sweden and the United States. Many relevant features of the countries are similar.[23] For example, completed fertility of the 1961 birth cohort is 2.03 in Sweden and 1.96 in the U.S. The percentage of the population currently divorced in 2003 was 11.3% in Sweden and 10.2% in the U.S. Female labor force participation is higher in Sweden, but not much higher: 75.6% of Swedish women aged 15-64 participated in the labor market in 2002, as opposed to 70.1% of those in the U.S. Male labor force participation among those 15-64 was only slightly higher in the U.S. in 2002 (83.0%) than in Sweden (79.4%). Real income is somewhat higher in the the U.S. In 2007 dollars (PPP), Swedish GDP per capita in 1990 was $27,240, whereas U.S. GDP per capita was $33,812. Finally, a relatively large fraction of couples in Sweden cohabitate rather than formally marrying, yet the percentage married is still relatively similar (45.2% in Sweden in 2003, as opposed to 59.6% in the U.S). The sample of married Swedes is thus selected in certain ways, but it is *a priori* unclear whether and how this should affect the parameter estimates.

IV. The LINDA Data

I use the Longitudinal Individual Dataset for Sweden (LINDA), described in detail in Edin and Fredriksson (2000). Based on the administrative records of the Swedish government, these data follow individuals and their families longitudinally. I examine yearly data from 1988 to 1991, inclusive. The data contain approximately 3.35% of the Swedish population, in addition to family members of these individuals. A random sample of 20% of the immigrants to Sweden and their families is also included. The full data consist of approximately 950,000 sampled individuals per year, comprising approximately 11% of the Swedish population. After weighting by sample weights to correct

[23]The statistics in this paragraph are drawn from Blau, Ferber, and Winkler (2005), and Stevenson and Wolfers (2007).

for the over-sampling of immigrants, the full sample is cross-sectionally representative of the married Swedish population in any given year.

Gender, age, region of residence, occupation, industry, number of children, educational attainment, and other covariates are included in the data. In the regressions, the values of all of these control variables are taken from 1988. These covariates are not available in the U.S. administrative data on tax returns, including the IRS-Michigan-NBER tax panel. My measure of earned income includes only wages paid from employers to employees (and excludes goverment transfers). I construct taxable labor income by subtracting certain deductions from earned income. During the period under consideration, the data do not contain a measure of hours worked. Further details about the data are contained in Appendix II.

I include in my main sample married individuals who are between 18 and 65 years old (inclusive), whose earned income in the base period is greater than zero, who are not self-employed, who do not hold shares in a closely held corporation, and whose spouses share all of these characteristics. I examine those 65 and under to exclude the retirement decision from my analysis. I exclude those in a household in which at least one spouse is self-employed (or in which at least one spouse holds shares in a closely held corporation) because the relative earnings of husbands and wives in these households may not correspond to the relative amounts of labor they supply, due to tax avoidance activities. 178,366 individuals fit these criteria, consisting of 89,183 husbands and the same number of wives.

Summary statistics are shown in Table 2. The mean income in the sample is SEK 174,932 for husbands, as opposed to SEK 103,459 for wives.[24] Mean taxable labor income is also higher for husbands (SEK 155,283) than for wives (SEK 93,831). Husbands are 44.01 years old on average, whereas wives' average age is 41.29. Husbands are older on average because men tend to marry somewhat younger women, and the sample is limited to couples with both spouses under 66. The mean number of children under 18 is 1.40, which is the same for both spouses because it is limited to children for whom both spouses are the parents.[25] Since men tend to have higher earnings and marginal tax rates are progressive, the mean net-of-tax share of husbands (.45) is somewhat lower than that of wives (.57). Since virtual income increases as the marginal tax rate increases (*ceteris paribus*), and since men have larger capital income than women, it makes sense that husbands have substantially higher virtual income on average (SEK 75,477 for husbands, as opposed to SEK 13,863 for wives).

Couples display positive assortative mating. In 1989, their earned incomes have a modest positive correlation of .22, and the correlation of their net-of-tax shares is .36. Pooling the changes from 1989 to 1990 and from 1990 to 1991, the correlation

[24] In 2007 U.S. dollars, these amounts are equivalent to $46,634 in mean earnings for husbands and $27,580 for wives.

[25] The mean number of children under 8 is .60.

between the changes in their earned incomes is .13, the correlation between the changes in their simulated net-of-tax shares is .27, and the correlation between the changes in their actual net-of-tax shares is .26. Appendix Table A1 shows the number of couples who experienced each type of tax change. A cell displays the number of couples in which the husband and wife received a given combination of simulated percent changes in their net-of-tax shares. For a given simulated change in one spouse's net-of-tax share, there is substantial heterogeneity in the other spouse's simulated change.

V. Empirical Results

A. Preliminary Evidence

Figure 2 shows that during the period of the tax reform, larger gains in earned income occurred in the parts of the income distribution that also experienced larger tax cuts, relative to the period without the tax reform. I use the evolution of the income distribution from 1988 to 1989 to calibrate how the income distribution develops, as described in Section III.C.[26] Thus, my regressions effectively contrast the change in the income distribution from 1988 to 1989, to the changes from 1989 to 1990 and from 1990 to 1991, and relate these relative changes to those in marginal tax rates, controlling for other factors. Figure 2 graphically depicts these relationships.

On the x-axis of Figure 2 is real earned income in the base year (in SEK divided by 10,000). The squares represent the mean simulated change in the the log of the net-of-tax share from 1990 to 1991 in each 1990 income group within a 10,000-Kronor range, minus the mean simulated change in the log of the net-of-tax share from 1988 to 1989 in each 1988 income group.[27] The circles show the mean gain in the log of real earned income in each 1990 earned income group from 1990 to 1991, minus the mean gain in the log of real earned income in each 1988 earned income group from 1988 to 1989. Figure 2a shows the graph for husbands, and Figure 2b shows the graph for wives.[28] It is evident that there are much larger gains in log real earned income from 1990 to 1991 at the top of the income distribution, relative to the bottom of the income distribution, than from 1988 to 1989. For both husbands and wives, the line showing the gain in log real earned income and the line showing the simulated increase in the

[26] I use the 1988-9 progression of the income distribution, rather than the progression over later years, since individuals may still have been reacting to the tax changes in the years following the reform.

[27] The simulated change in the net-of-tax share is not monotonically increasing in base year real earned income because the brackets before and after the tax change do not occur at exactly the same points in the income distribution, because the tax base changed from 1990 to 1991, and because the marginal tax rate is based on taxable income (rather than earned income).

[28] There are few women in the high income ranges—between SEK 180,000 and SEK 250,000, there are only 306 women on average in each 10,000-Kronor range—so it is unsurprising to find substantial volatility in mean earnings growth in this range.

log net-of-tax share tend to grow quickly with base year real earned income until about SEK 200,000, after which both lines level off.

In other pairs of recession years (1991-2 and 1992-3), there is no similar pattern of relatively large income gains at the top of the distribution compared to the bottom; rather, the change in inequality in these years is similar to that from 1988 to 1989. It should be unsurprising, therefore, that when I use the evolution of the income distribution from 1991 to 1992 or from 1992 to 1993 to calibrate the coefficients on lagged income, similar results are obtained. This is true even despite the fact that the recession deepened substantially in 1992 and 1993. 1992 and 1993 saw even more negative real GDP growth rates (-1.2% and -2.0%, respectively) than in 1991 (-1.1%), and larger percentage point increases in unemployment occurred from 1991 to 1992 (2.5 percentage points) and from 1992 to 1993 (3.8 percentage points) than from 1990 to 1991 (1.3 percentage points). In this context, it is worth noting that inequality is only weakly countercyclical in Sweden. Absent the tax reform, the estimates of Björklund (1991) imply that the deterioration in macroeconomic conditions from 1990 to 1991 would have lead to a much smaller increase in inequality than the increase that was actually observed from 1990 to 1991. The available evidence also shows that inequality does not usually increase more in the first year of a recession than in subsequent recession years (which is apparent in the work of Kopczuk, Saez, and Song 2007 on the U.S.). Moreover, the pattern of large relative income gains at the top of the income distribution from 1990 to 1991 survives when partialing out the effects of characteristics such as industry, occupation, education, age, and interactions of these variables. This suggests that the large relative decreases in marginal tax rates at the top of the income distribution help to drive the large increase in inequality in 1991 relative to the surrounding years.

B. Preliminary Regressions

I anchor the evolution of the income distribution by regressing the change in the log of real earned income from 1988 to 1989 on a ten-piece spline in own and spousal 1988 log real earned income and 1988 log real taxable income, as well as control variables. Most coefficients on the splines are significantly different from zero, indicating that lagged income controls are important. The coefficients on the different pieces of the spline are significantly different from each other, indicating that rich controls for lagged income are warranted. In the main regressions, I instrument for four independent variables. The first-stage regressions are extremely significant, with first-stage F-statistics ranging from just over 6,000 to nearly 10,000. The R-squared ranges from .47 to .56. When a given variable is the depedent variable, its predicted value enters highly significantly, with a coefficient between .8 and .9. Other variables usually have small coefficients, with one exception. When the dependent variable is an individual's change in the log of real virtual income, the change in the log of that individual's own predicted net-of-tax share has a sizeable effect. This is unsurprising, given the strong correlation between virtual income and the marginal tax rate.

C. Basic Results

Table 3 shows the basic regression results. In columns 1 and 2, I perform regressions (15) and (16) for the husband and wife. The controls include age, age squared, number of children below 18, as well as dummies for nine possible levels of education, 24 Swedish regions, and year. I estimate fairly low own uncompensated elasticities: .17 for husbands and .25 for wives. The estimates are precise, with standard errors of .021 and .026, respectively. While Gruber and Saez (2002) find no significant income effects, I find large and precisely-estimated own income elasticities of -.074 for husbands and -.056 for wives. The negative sign is consistent with the presumption that leisure is a normal good. In keeping with the typical finding that women's labor supply is more elastic than men's, wives' own uncompensated elasticity is significantly higher than husbands' ($p<.01$).

Given these parameter estimates, it is possible to calculate compensated own and cross elasticities, using the Slutsky equation and the transformation from elasticities into effects at the sample means. These are shown in the bottom section of the table. The compensated own elasticity is .25 for husbands and .49 for wives (significantly different from each other, and from zero, at the 1% significance level). Wives' elasticity is slightly higher than the Gruber and Saez (2002) estimate of the household compensated elasticity, whereas husbands' elasticity is somewhat lower. Ljunge and Ragan (2005), who consider both single and married taxpayers, estimate a higher compensated elasticity for men (.37) and a similar compensated elasticity for women (.52).

Compensated cross elasticities, .048 and .051 for husbands and wives, respectively, are also substantial. Both are significantly different from zero ($p<.05$). As one would expect, these are smaller than the compensated elasticities with respect to one's own net-of-tax share. Interestingly, husbands and wives have similar uncompensated cross elasticities and similar compensated cross elasticities. The uncompensated cross elasticities are not significantly different from zero at conventional levels. Cross income elasticities, -.0041 for husbands and -.018 for wives, are also substantial and significantly different from zero ($p<.01$).

It is theoretically ambiguous whether the leisure of husbands and wives should be complementary or substitutable. The results show complementarity: as the net-of-tax share of one's spouse rises, one's own earnings rise. A number of factors could lead to complementarity. It makes sense that if one's spouse takes more leisure time, it would be more enjoyable (provide higher marginal utility) to take more leisure time oneself. Complementarity is also consistent with several forms of social interactions. If spouses want to be like one another, this would lead to complementarity. Similarly, if spouses learn from one another about "how to work hard," or, conversely, "how to enjoy leisure," this would also lead to complementarity.[29]

[29] It is important to be clear about the interpretation of this result. Recall that I have used "leisure"

It is instructive to consider how husbands and wives would respond if their marginal tax rates both rose by one percentage point, taking into account own and cross responses. This is relevant to the U.S. context, where a husband's and a wife's marginal tax rate move in tandem because they are taxed jointly on the sum of their incomes. Applying the uncompensated elasticity estimates to husbands and wives with the sample mean values of the net-of-tax share, I find that a one percentage point increase in the marginal tax rate would cause husbands to decrease their earnings by .43 percent and wives to decrease their earnings by .49 percent. A fully compensated one percentage point increase in the marginal tax rate would cause husbands to decrease their earnings by .64 percent and wives to decrease their earnings by 1.18 percent.

Columns 3 and 4 add further controls for the 2-digit occupation and the 2-digit industry of both the husband and wife, and interactions of all of the control variables with the year dummies. This controls still further for business cycle factors unique to each year of the tax change. These regressions show broadly similar estimates, with slightly smaller elasticities. The results are also similar when I add more interactions of these variables to the regression, such as interactions of occupation and industry with education, age, or region.

In Columns 5 and 6, taxable labor income is the dependent variable. The compensated own elasticity of taxable labor income with respect to the net-of-tax share is .22 for husbands and .35 for wives, and the compensated cross elasticities are .061 and .051, respectively. Interestingly, the elasticity estimates are similar to those in the regressions in which earned income is the dependent variable. This may relate to the fact that in Sweden, the deductions available both before and after the reform may not have been particularly elastic. For example, one of the major deductions was for costs associated with commuting to work, and these choices are relatively inelastic with respect to price in the short run (e.g. Goodwin, Dargay, and Hanly 2004).

Appendix Table A2 shows the results of other specifications. Among other things, these specifications help to address the concern that functional form restrictions (such as logging the independent or dependent variable) help to drive the results. In Columns 1 and 2, I take the sample from Table 3, but in order to focus more directly on the intensive margin, I exclude those individuals in couples in which at least one member does not participate in the labor market in the final period.[30] Since this involves selecting the sample on the basis of an outcome variable, the results should be interpreted with caution. Because I exclude labor market non-participants, I can allow the dependent variable to be the residuals of $\ln(E_t^s/E_{t-1}^s)$ (rather than the residuals of $\ln[(1+E_t^s)/(1+$

as shorthand for both consumption of leisure and effort in non-market work. "Complementarity," as I use the term, should be taken only to indicate that when one spouse's net-of-tax share rises, the other works more. The proper interpretation of this response—whether it represents decreased leisure, decreased home production, or the influence of some other factor—should be addressed in future work.

[30]The results are similar when I take the sample from Table 3 and instead exclude those individuals who do not participate in the labor market in the final period.

$E^s_{t-1})$], as in Table 3). When either dependent variable is used, the results are nearly identical, suggesting that adding 1 to earnings before logging it does not substantively affect the results. Interestingly, the estimated coefficients are usually about half as large as the estimated coefficients in the comparable specification in Columns 1 and 2 of Table 3. However, the ratios to one another of the estimated coefficients in Columuns 1 and 2 of Appendix Table A5 are similar to the ratios to one another of the estimated coefficients in Columuns 1 and 2 of Table 3. In Columns 3 and 4 of Appendix Table A5, I run the same specification as in Columns 1 and 2 of Table 3, but the independent variables enter in levels, rather than in logs. I again reject income pooling (p<.01 for both spouses) but cannot reject Slutsky symmetry at conventional levels.

My results can be compared with the predictions of the unitary model of family labor supply. The unitary model of family decision-making is defined by the feature that the family's behavior can be characterized as maximizing a single utility function. This yields two central predictions that have received most of the attention in previous literature.[31] First, income pooling: the husband's (wife's) labor supply should react equally to a change in his (her) own uneared income as to a change in his wife's (her husband's) unearned income. This condition holds because the family does not distinguish between the unearned income of the husband and the unearned income of the wife in making its labor supply and consumption decisions; rather, the household acts as a single agent that pools its unearned income and reacts to it the same whether its source is the husband or wife. Second, Slutsky symmetry: The compensated response of the husband's leisure to the wife's net-of-tax wage should be equal to the compensated response of the wife's leisure to the husband's net-of-tax wage. Standard consumer demand theory implies this condition. The family has a single utility function , so the Slutsky matrix for the consumption of goods, including the leisure of the husband and wife, must be symmetric about the diagonal.[32]

[31] Blundell and MaCurdy (1999) present a unitary model in which families trade off consumption and the hours worked of both the husband and wife. This model includes the two predictions discussed presently and several other less often tested conditions. Appendix I presents a unitary model of family labor supply in which families choose consumption and the earned income of each spouse.

[32] Browning, Chiappori and Lechene (2004) have pointed out that income pooling can fail to hold even in a unitary model, for the following reason. In a "collective" model of family labor supply (Chiappori 1992), the family splits the resources available to it in a Pareto optimal way. Under a collective model, the family maximizes a weighted sum of the utilities of the husband and wife, where the weight can depend on prices, the household's total expenditure on all goods, and on so-called "distribution factors"—variables that do not enter individuals' preferences, such as the distribution of income within the family. Suppose that the weight depends on the distribution of unearned income across spouses but does not depend on prices or total expenditure. Then Slutsky symmetry will still hold (since the weight does not depend on prices), and moreover the household can be represented as maximizing a single utility function (that depends parametrically on the distribution factors). However, because the weight depends on the distribution of unearned income, income pooling could be violated. For example, if the weight on a given spouse's utility is strictly increasing in that spouse's unearned income, then that spouse will be able to appropriate more of a windfall of unearned income to him or her than of an equal windfall of unearned income to the other spouse. Thus, in order to reject all possible unitary models, we must reject Slutsky symmetry.

The log-log specification yields coefficients that can be interpreted as elasiticies, whereas the predictions of the unitary model are in terms of linear effects. It is therefore most direct to compare the linear model in Appendix Table A5 with the unitary model. The own income effect for husbands is significantly different from the cross income effect for husbands ($p<.001$), and the own income effect for wives is significantly different from the cross income effect for wives ($p<.001$). These inequalities represent a violation of the income pooling prediction of the unitary model presented above, under which own and cross income effects should be equal. I cannot reject the unitary model's prediction of Slutsky symmetry—the equality in equation (22)—at conventional significance levels ($p=.19$). However, I discuss later that Slutsky symmetry is violated in a number of demographic groups. Income pooling is also violated, and Slutsky symmetry holds, when I consider the log-log specification in Table 3 and evaluate the implied effects at the sample means of the independent and dependent variables in question.

One concern is that families who received tax cuts of different magnitudes are systematically different from one another. Typically, the more a husband's income exceeds his wife's, the larger his tax cut will be relative to hers. If shocks (unrelated to taxation) to couples were correlated with how much husbands earned relative to their wives, then the coefficient estimates could be biased. To address this concern, I examine couples in which the usual positive correlation between spouses' relative incomes and their relative simulated changes in tax rates is reversed. Specifically, I examine couples in which the spouse that had the larger income prior to the tax cut received the smaller simulated tax cut. This occurred in 28% of the sample. There were two primary reasons it occurred. First, as shown in Table 1, there are certain income ranges in which those with higher incomes received smaller tax cuts. Second, the tax base shifted in TR91, implying that the size of one's tax cut depended not only on the size of one's income, but also on the composition of that income; those making income from sources that received lighter tax treatment in TR91 tended to get larger tax cuts. The results for the 28% of couples are very similar to those for the couples in which the higher-earning spouse received the larger tax cut. When I run the specification corresponding to Columns 1 and 2 of Table 3 on only the 28% subsample, my estimates are .14, .024, -.057, -.0038, .23, .019, -.054, and -.013 for the uncompensated own elasticity for husbands, the uncompensated cross elasticity for husbands, the own income effect for husbands, the cross income effect for husbands, the uncompensated own elasticity for wives, the uncompensated cross elasticity for wives, the own income effect for wives, and the cross income effect for wives, respectively. When I run the same regressions on the remaining 72% of couples, the point estimates are only slightly larger and all statistically indistinguishable from those in the 28% subsample: .18, .035, -.084, -.0046, .27, .026, -.066, and -.025, respectively.

D. Heterogeneous Effects

Table 4 disaggregates by whether the couple has young children (under the age of 8). The points estimates indicate complementarity of spousal leisure among those without young children and substitutability among those with young children. The sample sizes are smaller in each disaggregated group than in the population as a whole, so it is unsurprising to find point estimates of cross elasticities that are sometimes insignificantly different from 0. Nonetheless, the uncompensated and compensated cross effects for both husbands and wives are significantly smaller in families with young children than in those without young children ($p<.05$ in all cases). This pattern is consistent with a framework in which spouses' time is substitutable in home production (in particular, for child care) and complementary in consuming leisure.

In comparing the regressions for different population groups, one must bear in mind that the means of the covariates are not constant across the groups. For example, the group with young children is on average younger than the rest of the population. To hold these covariates constant in comparing the results across groups, it is possible to run another set of regressions. In this set of regressions, the tax variables of interest–the change in one's own net-of-tax rate, the change in one's spouse's net-of-tax rate, the change in one's own virtual income, and the change in one's spouse's virtual income–are interacted with each of the covariates of interest (dummies for being in each of the education, age, and children categories considered in Table 4). In principle, it would be possible to interact the four tax variables of interest with an even wider range of covariates. In practice, this yields a regression with a large number of excluded instruments–20 excluded instruments in the regression involving the dummies just listed. It is unsurprising that with so many instruments, the coefficient estimates are usually insignificant: when the excluded category is those 18-35 with no young children and post-secondary schooling, 16 out of 20 coefficients are insignificantly different from zero. However, it is important to note that the coefficient on the interaction of the dummy indicating the presence of young children with the change in the spouse's net-of-tax rate is -.07, with a standard error of .03. In other words, there is significantly more substitutability of spousal leisure in families with young children than in families without young children, even when one controls for other covariates.

E. Extensive Margin

In Table 5, I examine how taxation affects spouses' decisions regarding whether or not to work. In Columns 1 and 2, in which the sample is individuals participating in the labor market in the base period, I regress a dummy that equals 1 when one exits the labor market (and 0 otherwise) on the (instrumented) change in one's own log average after-tax share and the (instrumented) change in the log average after-tax share of one's spouse. The residuals are calculated using the 1992-3 evolution of the income distribution, since layoffs are likely to occur in very different parts of the income distribution during a recession than during a boom. (Recall that the recession was ongoing in 1992-3.) Consistent with the presumption that one is less likely to exit the labor force when one keeps more of one's income, the coefficient on one's own average after-tax share is negative and highly significant (-.068 for husbands and -.091 for wives).

This implies an elasticity of participation with respect to the average after-tax share of .084 for husbands and .12 for wives.[33] Consistent with gross complementarity of spousal leisure, the coefficients on the spouse's average after-tax share are also negative and highly significant (-.031 for husbands and -.011 for wives). As one would presume, the cross elasticities are smaller than the own elasticities.

In Columns 3 and 4 of Table 5, in which the sample is individuals not participating in the labor market in the base period, I regress a dummy that equals 1 when one enters the labor market (and 0 otherwise) on the change in one's own log imputed average after-tax share and the change in the log imputed average after-tax share of one's spouse. Consistent with the presumption that one is more likely to enter the labor force when one keeps more of one's income, the coefficient on one's own average after-tax share is positive and significant (.067 for husbands and .059 for wives). Consistent with complementarity of spousal leisure, the coefficient on spouse's average after-tax share is also positive (.029 for husbands and .031 for wives), though both estimates are insignificant. The cross elasticity is smaller than the own elasticity. Taken together, these results show substantial responses on the extensive margin, with own responses substantially larger than cross responses. The responses are approximately the same size for husbands as for wives.

F. Comparison with Standard Labor Supply Specifications

Table 6 shows the results of other labor supply specifications, which yield quite different results than those in Table 3. In Columns 1 and 2 of Table 6, I estimate a standard labor supply model in which married individuals treat their spouses' income as unearned income. This specification imposes a restriction—the coefficient on one's own change in log real virtual income is restricted to be the same as the coefficient on the change in the log real income of one's spouse—and is therefore *a priori* undesirable. Own uncompensated elasticities are .58 and .71 for husbands and wives, respectively. These are much greater than the estimates of .17 and .25 in Columns 1 and 2 of Table 3. The income elasticities, .24 and .19 for husbands and wives, are very large and of the wrong sign.[34] The implied compensated own-elasticities are .46 and .62 for husbands and wives, respectively, which are also higher than the compensated elasticities in Table 3 (.25 and .49, respectively). Very similar biases occur in all of the estimates in Table 6 when the dependent variable is taxable labor income.

If the leisure of husbands and the leisure of wives are complementary, then we would expect the standard specification to yield income elasticities that are more positive than

[33] Eissa (1995) finds a participation elasticity of .4 for married women with high family incomes.

[34] In principle, it is possible that leisure is an inferior good, which would be consistent with the positive coefficient on the change in log real unearned income. However, it appears implausible that leisure would be so strongly inferior, and the coefficient restriction associated with this specification makes it independently undesirable.

the true income elasticities.[35] Suppose, for example, that a wife receives a tax cut, leading her earned income to rise. Under complementarity, the tax cut for this wife also leads her husband to earn more. Thus, a rise in the husband's earned income is correlated with a rise in the wife's earned income. Under the standard specification, the change in the husband's earned income contributes to the change in the measure of the wife's unearned income. Thus, the wife's unearned income (which includes the husband's income in this specification) tends to rise when the wife's earned income rises, which contributes to a positive coefficient on the wife's unearned income. Given that income elasticities are overly positive, it also makes sense that uncompensated elasticities are over-estimated. *Ceteris paribus*, a rise in the net-of-tax share will decrease virtual income, since the intersection of the extended budget segment with the y-axis falls when the net-of-tax share rises. In the specification of Tables 3 and 4, the change in one's own log net-of-tax share is therefore negatively correlated with the change in one's log real virtual income. Yet when spousal income is included along with own virtual income in the measure of unearned income, as in the standard specification, this negative correlation is dulled. Thus, in the specification in Columns 1 and 2 of Table 6, the coefficient on the change in one's own log net-of-tax share picks up some of the variation that is actually attributable to the change in one's log real virtual income.

To explore the factors responsible for these results, Columns 3 and 4 run the traditional specification, but with own (instrumented) virtual income entered separately from (uninstrumented) spousal income. This replicates the specification in Columns 1 and 2, but without the restriction imposed that own virtual income is summed with spousal income in calculating the measure of own unearned income. The coefficient on spousal income is positive and large, whereas the coefficient on own virtual income is negative and large. This is consistent with the assertion that the positive correlation between the change in spousal income and the change in one's own income induces overly positive income effects in Columns 1 and 2. I reject the hypothesis that the coefficient on own virtual income is the same as the coefficient on spousal income ($p<.001$).[36] Uncompensated own elasticities and the coefficients on own log virtual income are similar to those in the specification in Table 3. As argued above, it appears that the own uncompensated elasticity is over-estimated in Columns 1 and 2 because when spousal income is included along with own virtual income in the measure of unearned income, the own uncompensated elasticity term picks up variation actually attributable to own virtual income.

Columns 5 and 6 estimate the results without terms for income effects. While such a specification is sometimes taken to estimate the uncompensated elasticity of labor

[35] In the presence of substitutable spousal leisure, the estimated income elasticities should be overly negative.

[36] I also reject the hypothesis that these coefficients are equal when I run a specification in which each of these variables enters the regression linearly (rather than the logarithmic specification in Table 6).

supply, it is worth nothing that these elasticity estimates are substantially different from the estimates of the uncompensated elasticities from Table 3.[37] I have also examined a specification (omitted from the tables) in which terms for income effects are omitted, and only terms for spouses' own change in the log net-of-tax share are included. Interestingly, these estimates are extremely similar to those in Columns 5 and 6.

VI. Conclusions

This paper looks inside the family to uncover rich aspects of spouses' labor supply decisions and argues that this may lead to new conclusions about the effect of taxation on family labor supply. The analysis reveals that individuals respond substantially to their spouses' incentives, with sizeable compensated cross elasticities and cross income effects. I estimate several other parameters of interest, such as own income and substitution effects and labor supply elasticities for a number of demographic groups. The compensated labor supply elasticity of married women is higher than that of married men, even in Sweden, which is often noted for its gender equality and high female labor force participation rate. The customary specification, which treats spousal income as unearned income, produces income effects that are wrong-signed and large, and considerable bias results in the estimates of the uncompensated and compensated own elasticities. Traditional specifications may substantially mis-estimate labor supply parameters.

These results have implications for models of the family and for optimal taxation. The paper uncovers a reaction to spousal incentives, thus rejecting an extremely simple model of the family in which individuals pay no attention to the incentives of their spouses. The point estimates indicate that spousal leisure is substitutable in families with young children but complementary in families without young children. This suggests a model in which spousal time is substitutable in household production—specifically, in caring for young children—whereas spousal time is complementary when consuming leisure. The unitary model of family labor supply is rejected by the income pooling test, with own income effects much larger than cross income effects. Though I cannot reject Slutsky symmetry for the population as a whole, I do reject it for certain population groups. Taken together, these results suggest that family models in which income pooling is violated by a large margin, but Slutsky symmetry almost holds, should be explored further.

The formal implications of these estimates for optimal taxation should be developed. Feldstein (1999) derives a measure of the deadweight cost of taxing labor income under the assumption of a unitary decision-maker. If families do not obey the unitary model,

[37] This would only yield a correctly-specified estimate of the uncompensated elasticity if marginal tax rates were constant throughout the income distribution.

the measure of deadweight loss for families would presumably be different. If spousal leisure is complementary, this suggests that tax rates should be set lower than they would optimally be set if individuals maximized without regard to the behavior of their spouses. Complementarity implies that taxation has a ripple effect through households, since a decrease in the labor supply of one spouse will lead to a decrease in the labor supply of the other. On the other hand, the standard specification over-estimates compensated labor supply elasticities, which (all else equal) suggests that this specification yields an overly large estimate of the welfare cost of taxation and of the marginal welfare cost of increasing marginal tax rates. The standard specification also over-estimates uncompensated elasticites, which suggests that it over-estimates the labor supply response to changing the marginal tax rate and the associated revenue loss. Papers on the optimal taxation of the family (e.g. Kleven, Kreiner, and Saez 2006; Alesina, Ichino, and Karabarbounis 2007) could also be informed by parameter estimates of families' responses to taxation.

This work could be extended in a number of other ways. It would be illuminating to estimate a collective model of family labor supply (e.g. Chiappori 1992). Chiappori shows how estimates of the parameters of a collective model could be used to evaluate the welfare implications of tax reforms. Also, data on hours worked or fringe benefits would allow me to determine to what extent they respond to taxation. Time-use data could help me to determine to what extent leisure or home production are affected.

The ability to examine the effects of separate changes in each spouse's marginal tax rate has allowed me to go beyond the restrictions of the standard labor supply specification. The difference in the resulting estimates is large, and the implications for understanding labor supply could be far-reaching. Several European countries have individual taxation and have made available administrative micro-data on the income of each spouse. This suggests the possibility of future work on taxation and family labor supply in such contexts, which could add to the new picture of family labor supply emerging from this paper.

Appendix I. The Predictions of the Unitary Model in the Context of Earned Income

The model in Section II relates the net-of-tax wages of married couples to their hours worked. A full picture of labor supply encompasses more than just hours worked. In this section, I consider the case of labor effort that is reflected in earnings. Earnings reflect both hours worked and effort per hour worked.

In this framework, pre-tax earned income is taken to reflect overall effort. The Slutsky symmetry condition will still hold in the context of earned income: The first spouse's compensated responcse of earnings to the second spouse's net-of-tax share is equal to the second spouse's compensated response of earnings to the first spouse's net-of-tax share. This can be seen through the following reasoning. In the standard unitary framework, a family maximizes

$$U(C,\, L^h,\, L^w) \tag{14}$$

$$\text{s.t. } C = w^h(1-\tau^h)(T^h - L^h) + w^w(1-\tau^w)(T^w - L^w) + Y \tag{15}$$

or

$$\max U(w^h H^h + w^w H^w + Y, H^h, H^w) \tag{16}$$

over H^h and H^w, where $H^h = T^h - L^h$, $H^w = T^w - L^w$, and $Y = Y^h + Y^w$.

In the context of earned income, this family maximizes

$$U((1-\tau^h)E^h + (1-\tau^w)E^w + Y, E^h, E^w) \tag{17}$$

over E^h and E^w, where E^h and E^w represent the pre-tax earned income of the husband and the wife. (The variable E has been chosen to suggest not only earned income, but also to emphasize that pre-tax earned income is a composite measure of effort.) We can interpret U in this context as defined over consumption ($= (1-\tau^h)E^h + (1-\tau^w)E^w + Y$), and the effort of each spouse E^h and E^w.

It is clear that maximization of (17) over E^h and E^w is entirely analogous to maximization of (16) over H^h and H^w, and that both will yield Slutsky matrices that are symmetric, negative semidefinite, and homogenous of degree zero. This is because the Slutsky matrix is guaranteed to be symmetric as long as the utility function U represents a continuous, locally nonsatiated and strictly convex preference relation defined on any consumption set, and the Hicksian demand function is continuously differentiable (Mas-Collel, Whinston, and Green, Proposition 3.G.2). These assumptions can be made over any consumption set (including a consumption set that includes pre-tax earned income) and should hold at least as plausibly in the context of earned income as in the context of hours worked (when both spouses participate in the labor market, precluding corner solutions).

The utility function $U((1-\tau^h)E^h + (1-\tau^w)E^w + Y^h + Y^w, E^h, E^w)$ treats Y^h and Y^w symmetrically. It is therefore clear that when we solve for $\partial E^h/\partial Y^h$, $\partial E^h/\partial Y^w$, $\partial E^w/\partial Y^h$, and $\partial E^w/\partial Y^w$ using the first order conditions and the implicit function theorem, we must have $\partial E^h/\partial Y^h = \partial E^h/\partial Y^w$ and $\partial E^w/\partial Y^h = \partial E^w/\partial Y^w$.

Appendix II. Additional Data Description

Education dummies are dummies for nine categories measuring highest school attainment. Industry and occupation are defined at the 2-digit level. Occasional missing values of these covariates are represented by dummies indicating missing values. Self-employed individuals include those who have business or farm income in 1988. For the vast majority of households considered in the regressions, both spouses' earnings are positive in both base periods (i.e. both 1989 and 1990). However, a number of households have positive earnings for both household members in the base period in one of these years but not in the other. Observations for these individuals are included in the regressions only when the income of both household members is positive in the base year; otherwise, the dependent variable is a missing value. 178,366 individuals are in households in which both spouses have positive earnings in at least one of the years examined.

In 1991, Sweden switched from a global tax system, under which the marginal tax rate on earned income depends on the sum of earned income, capital income, and taxable government transfers (minus deductions), to a dual tax system, under which the marginal tax rate on earned income is computed only based on earned income (and deductions and taxable government transfers), and capital income is taxed at a flat rate. This implies that the proper way to calculate virtual income is different in 1991 than it was before 1991. Prior to 1991, virtual income is calculated by computing the intersection of the individual's extended budget segment with the y-axis in taxable income-consumption space, and adding the value of untaxed transfers. Predicted virtual income in 1990 is calculated by inflating the value of taxable income in 1990 by the mean per-person growth in taxable income of individuals in the sample, calculating the virtual income associated with this predicted budget segment, and adding this amount to the predicted value of untaxed transfers (calculated by inflating 1989 untaxed transfers by the mean per-person growth in untaxed transfers from 1989 to 1990 of individuals in the sample).

In 1991, virtual income is computed by adding three quantities: the intersection with the y-axis of the individual's extended budget segment in pre-tax taxable labor income-consumption space, the after-tax value of capital income, and the value of untaxed government transfers. (Here taxable labor income is taken to include government transfers.) Because of the change in the tax base, in constructing the instrument for the marginal tax rate for 1991, I project 1991 taxable labor income by multiplying each individual's 1990 taxable labor income by the mean per-individual growth in taxable labor income of individuals in the sample from 1990 to 1991. I calculate predicted virtual income in 1991 by determining what virtual income would have been in 1991 if an individual had the projected taxable labor income in 1991, as well as the projected values of capital income and untaxed transfers (calculated by inflating the values of capital income and untaxed transfers from 1990 by the mean growth from 1990 to

1991 in the per capita values of these variables of individuals in the sample). Like all income variables, virtual income is always represented in real terms.

When it enters as a dependent variable in my regressions, I construct taxable labor income by subtracting deductions from earned income. The deductions in question do not include deductions for interest payments or capital losses. To form a consistent measure of deductions, I exclude those that were available only before or only after 1991. When I subtract deductions from earned income, the result is occasionally negative. (Because the sample excludes labor market non-participants, earned income minus deductions is negative for only .28% of the sample.) Since I examine the change in the log of real taxable labor income, and the log of zero or a negative number is undefined, I set the values of real taxable labor income equal to 1 for these individuals in the years in which it is negative. The results are insensitive to this choice. Before 1991, certain deductions could be claimed only against the basic tax schedule. However, all of the deductions included in my measure of deductions prior to 1991 could be claimed against both the basic schedule and against the additional schedule. Thus, their marginal tax price was equal to the net-of-tax share associated with earned income, so a specification that relates my measure of taxable labor income to this net-of-tax share is appropriate.

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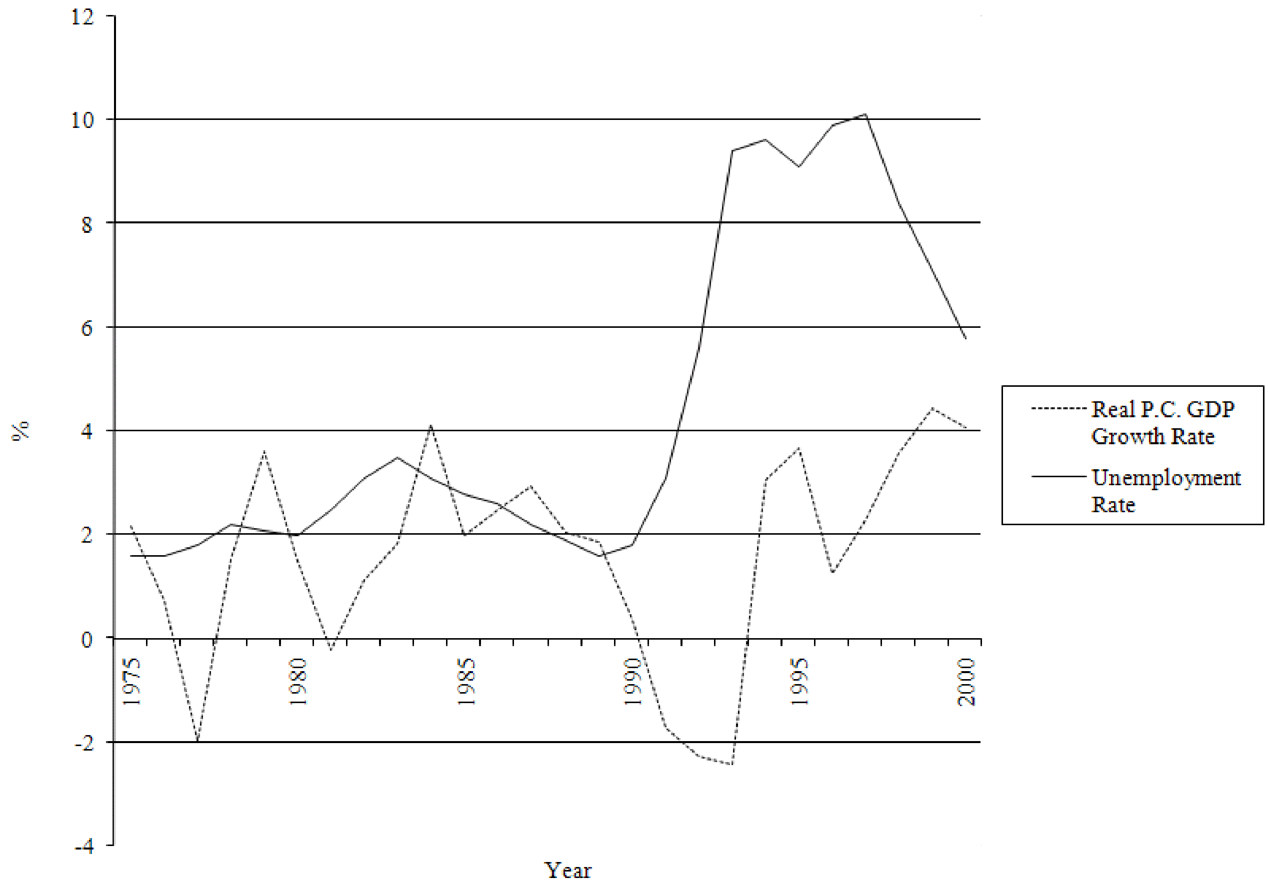
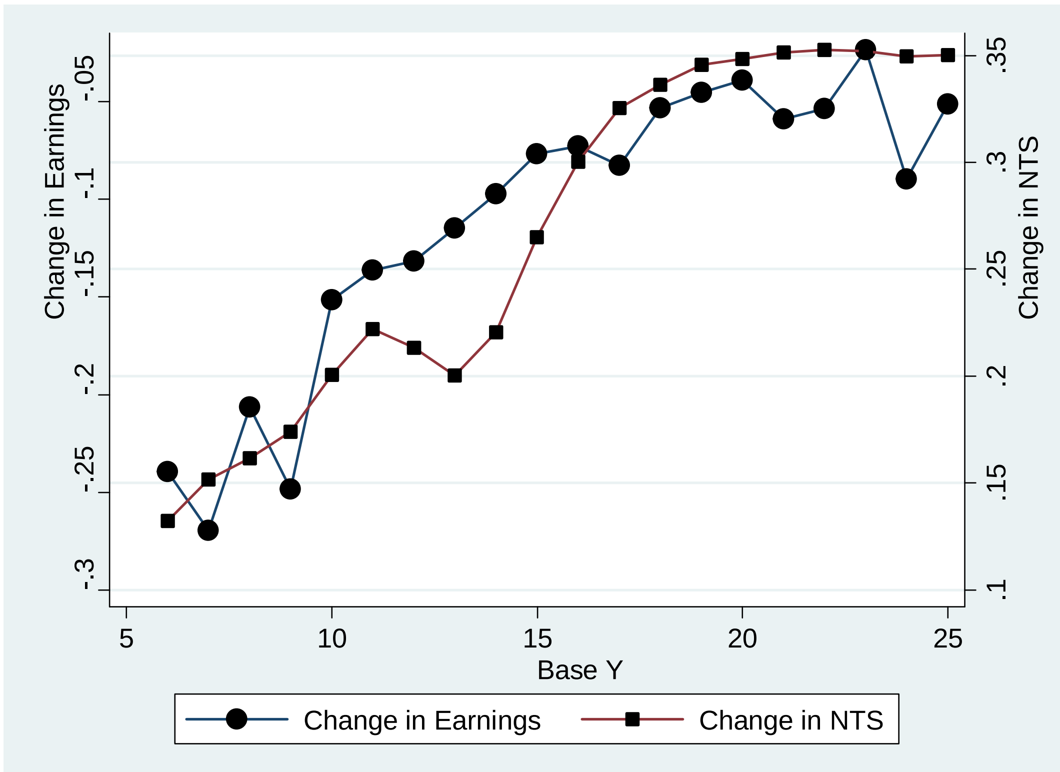
Figure 1. Macroeconomic Variables in Sweden, 1975-2000



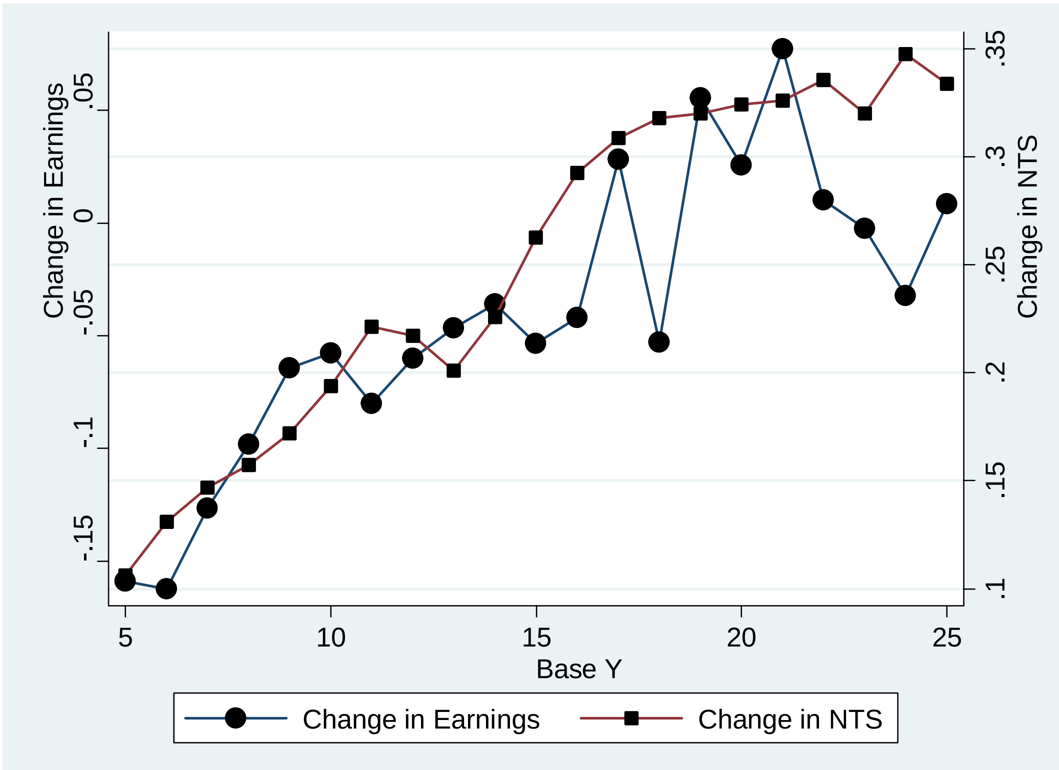
Source: U.S. Bureau of Labor Statistics, Foreign Labor Statistics. The dashed line shows the yearly growth rate of real GDP per capita in Sweden in each year from 1975 to 2000. The solid line shows the unemployment rate in Sweden in each year.

Figure 2a. Changes in Earnings and Changes in Net-of-Tax Shares of Husbands, by Base Year Income Group



Notes: The figure shows that larger gains in real earned income took place in the same parts of the income distribution that experienced larger cuts in marginal tax rates. On the x-axis is real earned income (in Swedish Kronor) in the base year, divided by 10,000. The squares represent the mean simulated change in the log of the net-of-tax share (NTS) from 1990 to 1991 in each base-year income group (within a 10,000-Kronor range), minus the mean simulated change in the log of the net-of-tax share from 1988 to 1989 in each base-year income group. The mean simulated change in the log of the net-of-tax share is not monotonically increasing in base year real earned income because the brackets before and after the tax change do not occur at exactly the same points in the income distribution, because the tax base changed from 1990 to 1991, and because the marginal tax rate is based on taxable income (not earned income). The circles show the mean gain in the log of real earned income from 1990 to 1991 in each base year earned income group, minus the mean gain in the log of real earned income from 1988 to 1989 in each base year earned income group.

Figure 2b. Changes in Earnings and Changes in Net-of-Tax Shares of Wives, by Base Year Income Group



Notes: The figure shows that larger gains in real earned income took place in the same parts of the income distribution that experienced larger cuts in marginal tax rates. On the x-axis is real earned income (in Swedish Kronor (SEK)) in the base year, divided by 10,000. The squares represent the mean simulated change in the log of the net-of-tax share (NTS) from 1990 to 1991 in each base-year income group (within a 10,000-SEK range), minus the mean simulated change in the log of the net-of-tax share from 1988 to 1989 in each base-year income group. The mean simulated change in the log of the net-of-tax share is not monotonically increasing in base year real earned income because the brackets before and after the tax change do not occur at exactly the same points in the income distribution, because the tax base changed from 1990 to 1991, and because the marginal tax rate is based on taxable income (not earned income). The circles show the mean gain in the log of real earned income from 1990 to 1991 in each base year earned income group, minus the mean gain in the log of real earned income from 1988 to 1989 in each base year earned income group. It is unsurprising that in the higher income ranges, wives' mean income gains exhibit substantial volatility, since between SEK 180,000 and SEK 250,000, on average there are only 306 women in each 10,000-Kronor range.

Table 1. Marginal Tax Rates by Income and Year

1989 Schedule			1991 Schedule		
Bracket Start	Bracket End	MTR	Bracket Start	Bracket End	MTR
0	70,000	.36	0	149,284	.31
70,000	140,000	.51	149,284	—	.51
140,000	190,000	.65			
190,000	—	.76			

Source: Statistics Sweden. "MTR" refers to the marginal tax rate. The marginal tax rate is calculated by summing the Swedish state marginal tax rate with the average sum of local and municipal marginal tax rates (31% both before and after the reform). All amounts shown in the table are in real 1989 Swedish Kronor (SEK). In nominal terms, the end of the first bracket in 1991 was SEK 180,300. In 1989, an individual's tax liability was the sum of his or her liabilities on two different tax schedules, the basic tax schedule and the additional tax schedule. "Additional taxable income" refers to the measure of taxable income on the basis of which the liability on the additional tax schedule was calculated; "basic taxable income" refers to the measure of taxable income on the basis of which the liability on the basic tax schedule was calculated. Additional taxable income differed from basic taxable income because one could claim more deductions on the basic schedule than on the additional schedule. The additional schedule applied to individuals whose additional taxable income was above SEK 140,000. The tax schedule shown above for 1989 assumes that basic taxable income is equal to additional taxable income. The tax base also shifted in a number of ways from 1989 to 1991. For example, before 1991, the marginal tax rate on earned income was calculated as a function of both capital and labor income, whereas starting in 1991, capital income became irrelevant to the calculation of the marginal tax rate on earned income. "—" indicates that the bracket continues at all higher levels of income.

Table 2. Summary Statistics

	Husbands		Wives	
	Mean	SD	Mean	SD
Earnings	174,932	84,644	103,459	49,778
Taxable Labor Income	155,283	77,684	93,831	46,267
Age	44.0	9.16	41.29	9.11
Children < 18	1.40	1.18	1.40	1.18
Net-of-Tax Share	.45	.10	.57	.088
Virtual Income	75,477	20,092	13,863	13,561

Source: LINDA data. The sample contains 178,366 individuals, of whom 89,183 are husbands and 89,183 are wives. The sample includes only married Swedes who are not self-employed, do not hold shares in a closely held corporation, are between 18 and 65 years old (inclusive), whose earnings are greater than zero in 1989 or 1990, and whose spouses share these characteristics. The values of the variables are from 1988 and are expressed in 1988 SEK. The net-of-tax share is defined as one minus the marginal tax rate. Taxable labor income is calculated by subtracting certain deductions from earned income, as described in Appendix II.

Table 3. IV Regressions of the Change in Log Real Earnings or Log Real Taxable Labor Income on the Change in both Spouses' Log Net-of-Tax Shares and Log Real Virtual Incomes

	Earned Inc.				Taxable Labor Inc.	
	(1) H	(2) W	(3) H	(4) W	(5) H	(6) W
ΔOwn	.17	.25	.15	.22	.17	.19
NTS	(.021)***	(.026)***	(.021)***	(.025)***	(.022)***	(.026)***
ΔSpouse	.031	.023	.026	.024	.046	.042
NTS	(.028)	(.022)	(.027)	(.020)	(.028)	(.022)***
ΔOwn	-.074	-.056	-.055	-.043	-.052	-.046
Income	(.0055)***	(.0027)***	(.0051)***	(.0022)***	(.0050)***	(.0024)***
ΔSpouse	-.0041	-.018	-.00072	-.013	-.0038	-.016
Income	(.0022)**	(.0044)***	(.0019)	(.0040)***	(.0020)*	(.0024)***
Add'l. Controls?	No	No	Yes	Yes	Yes	Yes
N	89,183	89,183	89,183	89,183	89,183	89,183
Compensated	.25	.49	.21	.38	.22	.37
Own Elasticity	(.020)***	(.024)***	(.020)***	(.023)***	(.029)***	(.038)***
Compensated	.048	.051	.037	.040	.061	.057
Cross Elasticity	(.023)**	(.021)**	(.021)*	(.019)**	(.030)**	(.029)***

Notes: The dependent variable in Columns 1-4 is the residuals of $\ln[(1+E_t)/(1+E_{t-1})]$. E is earned income. The residuals are calculated by partialing out the predicted effect of lagged income, as described in the text. "ΔOwn NTS" is $\ln[(1\text{-MTR}_t)/(1\text{-MTR}_{t-1})]$, where MTR is one's own marginal tax rate. "ΔOwn Income" is $\ln[(1+\text{VI}_t)/(1+\text{VI}_{t-1})]$, where VI is one's own virtual income. "ΔSpouse NTS" and "ΔSpouse Income" are the analogs. The sample includes married Swedes who are not self-employed, do not hold shares in a closely held corporation, are between 18 and 65 years old (inclusive), whose earnings are positive in 1989 or 1990, and whose spouses share these characteristics. The years examined are 1989-90 and 1990-91. All regressions control for year dummies and the 1988 values of age, age squared, number of children, and dummies for education level and region. "Add'l. Controls" means that 2-digit industry and occupation dummies for both spouses and interactions of all of the controls with year dummies are included. "H" and "W" denote regressions for husbands and wives, respectively. "N" is the total number of individuals in the regressions. In Columns 5 and 6, the dependent variable is the residuals of taxable labor income. Bootstrapped standard errors are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 4. Heterogeneous Treatment Effects by Presence of Young Children: IV Regressions of Husbands' and Wives' Change in Log Real Earnings on the Instrumented Changes in both Spouses' Log Net-of-Tax Shares and both Spouses' Log Real Virtual Incomes

	Young Children		No Young Children	
	(1) H	(2) W	(3) H	(4) W
ΔOwn	.081	.30	.23	.21
NTS	(.026)***	(.039)***	(.031)***	(.034)***
ΔSpouse	-.038	-.021	.028	.040
NTS	(.016)**	(.023)	(.023)	(.028)
ΔOwn	-.091	-.055	-.058	-.057
Income	(.0070)***	(.0033)***	(.0074)***	(.0035)***
ΔSpouse	-.0061	-.018	-.0025	-.019
Income	(.0025)**	(.0061)***	(.0032)	(.0059)***
N	34,158	34,158	55,025	55,025

Notes: Columns 1 and 2 show regression results for families with at least one young child (defined as a child under 8 years old), whereas Columns 3 and 4 show regression results for those without a young child. The dependent variable is the residuals of $\ln[(1+E_t)/(1+E_{t-1})]$, where E denotes earnings and the subscript denotes the year. The residuals are calculated by partialing out the predicted effect of lagged income on the true value of $\ln[(1+E_t)/(1+E_{t-1})]$, using the 1988-9 evolution of the income distribution to determine the coefficients, as described in the text. "ΔOwn NTS" is $\ln[(1\text{-MTR}_t)/(1\text{-MTR}_{t-1})]$, where MTR refers to one's own marginal tax rate and the subscript refers to the year; "ΔSpouse NTS" is the analog. "ΔOwn Income" refers to $\ln[(1+VI_t)/(1+VI_{t-1})]$, where VI is virtual income and the subscript refers to the year; "ΔSpouse Income" is the analog. The sample includes only married Swedes who are not self-employed, do not hold shares in a closely held corporation, are between 18 and 65 years old (inclusive), whose earnings are greater than zero in 1989 or 1990, and whose spouses share these characteristics. The years included in the regressions are 1989-1990 and 1990-1991, when the tax changes occurred. These years are pooled in the regressions. All regressions control for year dummies and the 1988 values of age, age squared, number of children, dummies for nine education levels, and dummies for 24 regions. "H" refers to regressions for husbands, and "W" refers to regressions for wives. "N" refers to the total number of individuals included in the regressions, the vast majority of whom appear in both 1989-1990 and 1990-1991. Standard errors are in parentheses and have been bootstrapped as described in the text. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 5. Extensive Margin: Regressions of Dummies for Entering or Exiting the Labor Force on the Changes in both Spouses' Log Average After-Tax Shares

	Exit		Enter	
	(1) H	(2) W	(3) H	(4) W
ΔOwn	-.068	-.091	.067	.059
ATS	(.0028)***	(.0056)***	(.019)***	(.028)**
ΔSpouse	-.031	-.011	.029	.031
ATS	(.0037)***	(.0023)***	(.048)	(.026)
N	89,183	89,183	5,710	7,172

Notes: The table shows the results of a linear probability model for exiting or entering the labor force. In Columns 1 and 2, the dependent variable is the residuals of a dummy that equals 1 if an individual exits the labor force over the years in question. The sample is restricted to those couples in which both spouses initially participate in the labor market. The residuals are calculated by partialing out the predicted effect of lagged income on the true value of $\ln[(1+E_t)/(1+E_{t-1})]$, using the 1992-3 evolution of the income distribution to determine the coefficients, as described in the text. "ΔOwn ATS" is $\ln[(1\text{-}ATS_t)/(1\text{-}ATS_{t-1})]$, where ATS refers to one's own average after-tax share and the subscript refers to the year; "ΔSpouse ATS" is the analog. As described in the text, these are instrumented using simulated instruments.

In Columns 3 and 4, the dependent variable is a dummy that equals 1 if an individual enters the labor force over the years in question. The sample is restricted to those who initially do not participate in the labor market. For those who initially do not participate in the labor market, the average after-tax share has been imputed by regressing taxable income on age, age squared, sex, and education in each year separately, and calculating the average after-tax share that an individual would face in each year if they possessed this imputed taxable income.

In all regressions, the sample includes only married Swedes who are not self-employed, do not hold shares in a closely held corporation, are between 18 and 65 years old (inclusive), and whose spouses share these characteristics. The years included in the regressions are 1989-1990 and 1990-1991, when the tax changes occurred. These years are pooled in the regressions. All regressions control for year dummies and the 1988 values of age, age squared, number of children, dummies for nine education levels, and dummies for 24 regions. "H" refers to regressions for husbands, and "W" refers to regressions for wives. "N" refers to the total number of individuals included in the regressions. Standard errors, bootstrapped as described in the text, are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 6. Comparison with Other Specifications: IV Regressions of Husbands' and Wives' Change in Log Real Earnings on the Instrumented Change in Own Log Net-of-Tax Share and the Instrumented Change in a measure of Log Real Unearned Income or the Instrumented Change in Spouse's Log Net-of-Tax Share

	(1) H	(2) W	(3) H	(4) W	(5) H	(6) W
ΔOwn NTS	.57	.78	.17	.24	.42	.71
	(.021)***	(.026)***	(.021)***	(.026)***	(.020)***	(.026)***
ΔVirtual Inc.	.24	.19				
+ΔSpouse Inc.	(.012)***	(.010)***				
ΔSpouse NTS					.075	.082
					(.027)***	(.020)***
ΔVirtual Inc.			-.073	-.057		
			(.0051)***	(.0023)***		
ΔSpouse Inc.			.11	.12		
			(.0055)***	(.0056)***		
N	89,183	89,183	89,183	89,183	89,183	89,183

Notes: The dependent variable is the residuals of $\ln[(1+E_t)/(1+E_{t-1})]$, where E denotes earnings and the subscript denotes the year. The residuals are calculated by partialing out the predicted effect of lagged income on the true value of $\ln[(1+E_t)/(1+E_{t-1})]$, using the 1988-9 evolution of the income distribution to determine the coefficients, as described in the text. "ΔOwn NTS" is $\ln[(1\text{-}MTR_t)/(1\text{-}MTR_{t-1})]$, where MTR refers to one's own marginal tax rate and the subscript refers to the year; "ΔSpouse NTS" is the analog. "ΔVirtual Inc.+ΔSpouse Inc." refers to $\ln[(1+(VI+SI)_t)/(1+(VI+SI)_{t-1})]$, where VI is the individual's own virtual income and the subscript refers to the year, and SI is actual spousal income in the year in question. "ΔVirtual Inc." refers to $\ln[(1+VI_t)/(1+VI_{t-1})]$, and "ΔSpouse Inc." is defined similarly. The sample includes only married Swedes who are not self-employed, do not hold shares in a closely held corporation, are between 18 and 65 years old (inclusive), whose earnings are greater than zero in 1989 or 1990, and whose spouses share these characteristics. The years included in the regressions are 1989-1990 and 1990-1991, when the tax changes occurred. These years are pooled in the regressions. All regressions control for year dummies and the 1988 values of age, age squared, number of children, dummies for nine education levels, and dummies for 24 regions. "H" refers to regressions for husbands, and "W" refers to regressions for wives. "N" refers to the total number of individuals included in the regressions, the vast majority of whom appear in both 1989-1990 and 1990-1991. Standard errors are in parentheses and have been bootstrapped as described in the text. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Appendix Table A1. Number of Spouses with each Possible Combination of Simulated Percent Changes in Net-of-Tax Shares

		Changes for Wives											
		-23	-6	-2	8	26	29	33	38	77	81	82	156
	-23	0	2	1	71	1	8	34	0	0	0	0	0
	-6	0	89	0	906	0	199	1,470	0	0	28	9	3
	-2	1	2	10	245	1	13	164	0	0	3	3	2
	8	5	58	18	4,582	1	256	2,182	3	1	56	10	12
Changes	26	0	0	4	61	2	7	33	0	0	4	1	1
for	29	1	5	17	9,553	0	3,107	17,221	0	0	428	193	28
Husbands	33	2	249	2	9,066	1	1,508	13,592	1	0	213	84	23
	38	0	0	0	13	1	0	8	2	0	0	0	0
	77	0	1	0	4	0	0	0	0	0	0	0	0
	81	0	502	7	5,500	3	2,873	10,064	1	1	1,047	359	115
	82	0	2	0	205	0	33	332	0	0	18	57	4
	156	0	20	0	36	0	8	45	0	0	6	15	32

Notes: The number in each cell represents the number of couples in the sample in which the husband and wife had a given combination of simulated percent changes in their net-of-tax shares from 1989 to 1991. The heading of each column shows the simulated percent change in wives' net-of-tax share; the heading of each row shows the simulated percent change in husbands' net-of-tax share. The simulated percent change in the net-of-tax share is calculated as the percent change in the net-of-tax share that an individual would have experienced from 1989 to 1991 if his or her income had grown at the economy-wide growth rate of per-person income. The table shows 87,649 observations, which is 1,534 observations smaller than the sample size in the regressions in Table 3 (89,183). This is because some additional individuals enter the sample in 1990, because both of the members of their household have positive earnings in 1990, but not in 1989. There are 12 possible percentage changes in the net-of-tax share because in 1989, the total marginal tax rate was the sum of the marginal tax rate on the basic schedule and the marginal tax rate on the additional schedule, and two individuals with the same marginal tax rate on one of these schedules could have a different marginal tax rates on the other schedule. For simplicity, I have assumed that everyone faces the same total local and municipal tax rate of 31% (which is the mean sum of these tax rates both before and after the reform).

Appendix Table A2. Alternative Specifications: IV Regressions of the Change in Log Real Earnings on the Instrumented Change in both Spouses' Net-of-Tax Shares and the Instrumented Change in both Spouses' Real Virtual Incomes

	Always Participate		Linear Specification	
	(1) H	(2) W	(3) H	(4) W
ΔOwn	.10	.13	.36	.49
NTS	(.011)***	(.014)***	(.054)***	(.068)***
ΔSpouse	.016	.018	.048	.053
NTS	(.015)	(.012)	(.031)	(.036)
ΔOwn	-.041	-.029	-.78	-3.10
Income	(.0030)***	(.0014)***	(.049)***	(.16)***
ΔSpouse	.00030	-.0097	-.26	-.17
Income	(.0011)	(.0024)***	(.12)**	(.053)***
N	86,276	86,276	89,183	89,183

Notes: In Columns 1 and 2, I include only observations on individuals in couples in which both members have positive earnings in both the base year and the final year. Since couples are selected on the basis of an outcome variable, the results should be interpreted with caution. The dependent variable is the residuals of $\ln(E_t/E_{t-1})$, where E is earned income. The residuals are calculated by partialing out the predicted effect of lagged income from $\ln(E_t/E_{t-1})$, as described in the text. "ΔOwn NTS" is $\ln[(1\text{-MTR}_t)/(1\text{-MTR}_{t-1})]$, where MTR is one's own marginal tax rate, and "ΔOwn Income" refers to $\ln[(1+\text{VI}_t)/(1+\text{VI}_{t-1})]$, where VI is one's own virtual income. "ΔSpouse NTS" and "ΔSpouse Income" are the analogs. I now turn from Columns 1 and 2 to Columns 3 and 4. In Columns 3 and 4, the sample is the same as the sample in Table 3 (i.e. it includes those in couples in which both members have positive earnings in the base year). The independent variables are in levels. "ΔOwn NTS" refers to $(1\text{-MTR}_t)/(1\text{-MTR}_{t-1})$, where MTR is one's own marginal tax rate, and "ΔOwn Income" refers to $(1+\text{VI}_t)/(1+\text{VI}_{t-1})$, where VI is one's own virtual income. The results are similar when "ΔOwn Income" is defined as $\text{VI}_t/\text{VI}_{t-1}$. "ΔSpouse NTS" and "ΔSpouse Income" are the analogs. The coefficients and standard errors on ΔOwn Income and ΔSpouse Income have been multiplied by 1,000,000. In all columns, the sample includes only married Swedes who are not self-employed, do not hold shares in a closely held corporation, are between 18 and 65 years old (inclusive), and whose spouses share these characteristics. The years examined are 1989-90 and 1990-91. All regressions control for year dummies and the 1988 values of age, age squared, number of children, dummies for nine education levels, and dummies for 24 regions. "H" refers to regressions for husbands, and "W" to those for wives. "N" is the total number of individuals included in the regressions. Standard errors are in parentheses and have been bootstrapped as described in the text. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.