Labor supply responses to the 1990s Japanese tax reforms

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A B S T R A C T

The consumption-leisure choice model implies that an exogenous change in tax rates will induce a change in labor supply. This implication is expected to be important to labor supplied by secondary earners under a progressive tax system when spousal income alters effective marginal tax rates. This paper examines labor supply responses to the income tax changes associated with Japanese tax reforms during the 1990s. The results indicate that the hours-of-work elasticity with respect to the net-of-tax rate is 0.8 for married women.

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1. Introduction

Consumer theory implies that an exogenous shift in the budget constraint will induce a change in labor supply. Such a shift can occur by tax changes. Tax reform often alters incentives faced by individuals and thus may alter their work effort. Behavioral responses to tax changes determine not only the relevance of economic theory but also the deadweight loss of taxation and government revenue. Estimating labor supply responses to tax rate changes is indeed one of the central issues in empirical labor economics and public finance.

During Japan's so-called lost decade of the 1990s, the government implemented various income tax cuts as a policy to stimulate the economy and as a by-product of political compromise to introduce and subsequently to increase the consumption tax in Japan. As in many countries, Japan maintains a progressive tax system, under which marginal tax rates go up in a stepwise fashion as income increases. On the one hand, the cross-sectional variation in tax rates itself is not considered exogenous because tax rates can vary according to hours of work. On the other hand, when tax reform is implemented, a change in the tax schedule can generate a plausibly exogenous cross-sectional variation in tax rates over time. A series of Japanese tax reforms during the 1990s provides a good opportunity to identify the labor supply responses to tax rate changes.

Married women are most likely to be affected by Japanese tax reforms among all demographic groups for several reasons. First, the literature suggests that male labor supply responses are zero or small whereas female labor supply responses are measurable and possibly large (Pencavel, 1987; Killingsworth and Heckman, 1987; Blundell and MaCurdy, 1999). Second, female labor supply is low in their late 20s and early 30s, and many married women work part time in their late 30s and 40s in Japan, whereas prime-age male labor supply is highly stable over the life cycle. Finally, there is the "spouse allowance" system in Japan, which makes secondary earners in households more susceptible to the effect of income tax. Under this system, households with low-income secondary earners are eligible for greater tax deductions; thus, there has been serious concern that married women work less and adjust their income so that the spouse allowance will not decrease.

This paper provides the first estimate of labor supply responses in Japan to the changes in tax rates associated with a series of tax reforms using the Japanese Panel Survey of Consumers (JPSC). The spouse allowance system also provides a useful source of variation in tax rates. A life-cycle model of labor supply is used to analyze the impact of tax reforms. After deriving an intertemporal labor supply function, a simple solution is developed to solve the selection problem in employment for the panel data model with endogenous regressors. An important advantage of the approach here is that it can flexibly allow for the unobserved heterogeneity that may be correlated with the regressors.

The next section presents an intertemporal optimization problem and derives an estimable form of the intertemporal labor supply function. Section 3 discusses the econometric problems that can arise in estimating the labor supply model. Section 4 describes the key
features of the Japanese tax system and the 1990s tax reforms. Section 5 describes the panel data used in the analysis. Section 6 presents the empirical results. The final section provides a conclusion.

2. Theoretical framework

2.1. The model

Quasi-experimental studies typically use a static consumption-leisure choice model as theoretical framework to analyze the impact of tax reforms on labor supply (Eissa and Liebman, 1996; Moffitt and Wilhelm, 2000; Meyer and Rosenbaum, 2001; Eissa and Hoynes, 2004).1 Eissa and Hoynes (2004) describe explicitly a unitary household model in which the primary and secondary earners sequentially decide hours of work. This study considers a dynamic model of consumption and labor supply with uncertainty, although the assumption that married women are secondary earners who make their labor supply decisions conditional on their husband’s income is maintained here, too, in order to exploit the variation in tax rates from the spouse allowance system in the empirical analysis. Recently, Blundell et al. (2007a) have developed the collective model of household labor supply in which male labor supply is discrete and female labor supply is continuous and possibly censored. The extension of the collective labor supply model to an intertemporal framework is, however, left for future work. Moreover, the assumption of sequential decision making made here seems a fair approximation of the actual decision process because more than 95% of observations in the JPSC sample are couples in which the husband works full time and the husband’s earnings are greater than or equal to the wife’s earnings.

The conceptual framework adopted here is the intertemporal model of labor supply à la Heckman and MacCurdy (1980) and MacCurdy (1981, 1985). The model involves uncertainty because most tax reforms are best described as once-and-for-all unanticipated shifts in net-of-tax wages in the present and the future, as noted by Blundell and MaCurdy (1985). Denote by $E_t$ the expectation operator conditional on an information set in period $t$. Assuming that preferences are additively separable over time and between consumption and leisure, the intertemporal optimization problem faced by married women is to maximize the expected value of the discounted sum of total utility:

$$E_0 \sum_{t=0}^{\infty} (1 + \rho)^{-t} [u^c(c_t, s_{1t}) + u^b(h_t, s_{2t})]$$  \hspace{1cm} (1)

subject to the budget constraint:

$$a_{t+1} = (1 + r_t + 1) a_t + (1 - r_t) w_t h_t - c_t - p_t q_t,$$  \hspace{1cm} (2)

where $\rho$ represents the rate of time preference, $c$ is the consumption, $h$ is the number of hours worked, $s_1$ and $s_2$ are preference shifters, $a$ is the asset, $r$ is the net-of-tax real rate of return on assets, $w$ is the hourly wage rate, $\tau$ is the effective marginal tax rate, $p$ is an indicator that equals one if the number of hours worked is positive and equals zero otherwise, and $q$ is fixed costs of work.

A dynamic programming formulation of this problem provides a convenient framework for characterizing optimal consumption and hours decisions. Define $V(a_t, s_t)$ as the optimum value of the consumption-leisure choice problem given information up to period $t$. The function value satisfies the Bellman equation:

$$V(a_t, s_t) = \max \left\{ u^c(c_t, s_{1t}) + u^b(h_t, s_{2t}) + \frac{1}{1 + \rho} E_t V(a_{t+1}, s_{1t+1}) \right\},$$  \hspace{1cm} (3)

where $s$ includes all relevant state variables.

The optimal solution can then be characterized by first-order conditions for consumption and hours, together with an intertemporal condition for the marginal utility of wealth in period $t$:

$$u^c_c(c_t, s_{1t}) = \lambda_t,$$  \hspace{1cm} (4a)

$$u^b(h_t, s_{2t}) \geq -\lambda_t a_t,$$  \hspace{1cm} (4b)

$$\lambda_t = \frac{1 + r_t + 1}{1 + \rho} E_t \lambda_{t+1} + 1,$$  \hspace{1cm} (4c)

where $\omega$ is the after-tax wage rate, and $\lambda$ is the Lagrange multiplier associated with the budget constraint. The derivation uses the result that the Lagrange multiplier equals the marginal utility of wealth by the Envelope theorem. Eqs. (4a) and (4b) can be solved for consumption and hours in terms of $\alpha$, $\lambda$, $s_1$ and $s_2$ in the current period. The marginal utility of wealth ($\lambda$) serves as the sufficient statistic that captures all information from other periods that is needed to solve the current-period maximization problem. The implied solution for hours is referred to as the Frisch (or $\lambda$-constant) labor supply function.

To derive an estimable form of the labor supply function, consider the most popular parametric form in the analysis of intertemporal labor supply. While the instantaneous utility of consumption can remain unspecified, the utility of leisure is specified as an isoelastic function that exhibits constant relative risk aversion (CRRA) as follows:

$$u^b(h_t, s_{2t}) = -\exp \left( -\frac{f + \delta k_t + v_t}{\alpha} \right) \cdot \frac{1}{1 + \frac{1}{\alpha} h_t^{1/\alpha}},$$  \hspace{1cm} (5)

where $f$ is the time-constant unobserved taste heterogeneity, $k$ is the number of young children, and $v$ is an idiosyncratic preference shock. 2 Although the implied solution conveniently helps the interpretation of the model, the isoelastic function excludes a corner solution. Given the fact that some married women are not employed, to allow for a corner solution, consider an exponential function that exhibits constant absolute risk aversion (CARA) as follows:

$$u^b(h_t, s_{2t}) = -\exp \left( -\frac{f + \delta k_t + v_t}{\alpha} \right) \alpha \exp \left( h_t^{1/\alpha} \right),$$  \hspace{1cm} (6)

In the presence of uncertainty, the marginal utility of wealth can be written as:

$$\ln \lambda_t = E_{t-1} \ln \lambda_{t-1} + \epsilon_t,$$  \hspace{1cm} (7)

where $\epsilon$ is the forecast error. The Euler Eq. (4c) can then be rearranged as:

$$\ln \lambda_t = \phi_t + \ln \lambda_{t-1} + \epsilon_t,$$  \hspace{1cm} (8)

where $\phi_t = \ln 1 + \rho - \ln (E_{t-1} \exp (\epsilon_t)).$ The $\phi$ term can be captured by a common macroeconomic effect if $\epsilon$ is identically distributed across individuals. Substituting backward in Eq. (10) yields

$$\ln \lambda_t = \sum_{i=1}^{t} \phi_i + \ln \lambda_0 + \sum_{i=1}^{t} \epsilon_i.$$  \hspace{1cm} (9)

That is, the $\lambda$ term can be captured by a time effect that is common across individuals and a fixed effect that can vary across individuals. The forecast error can be decomposed as:

$$\epsilon_t = \gamma \Delta \ln \omega_{t-1} + \xi_t,$$  \hspace{1cm} (10)

1 See also Moffitt and Kehrer (1981) and Pencavel (1987) for experimental studies on the US negative income tax programs in the late 1960s and 1970s.

2 Age and its square can also be included as taste shifters, but the estimating equation derived below remains essentially unchanged.

3 Eq. (7) can be written as $\lambda_t = \exp (E_{t-1} \ln \lambda_{t-1}) \exp (\epsilon_t)$. Taking expectations yields $E_{t-1} \ln \lambda_t = \exp (E_{t-1} \ln \lambda_{t-1}) \exp (E_{t-1} \epsilon_t)$, or equivalently, $\exp (E_{t-1} \ln \lambda_{t-1}) = \frac{E_{t-1} \ln \lambda_t}{\exp (E_{t-1} \epsilon_t)}$. Thus, $\lambda_t = \frac{E_{t-1} \ln \lambda_{t-1}}{\exp (E_{t-1} \epsilon_t)}$. The Euler Eq. (4c) in period $t-1$ can be rewritten as $E_{t-1} \ln \lambda_{t-1} = 1 + \frac{1}{\alpha} \ln \lambda_t + \frac{1}{\alpha} \ln \lambda_{t+1}$. Hence, $\lambda_t = 1 + \frac{1}{\alpha} \ln \lambda_{t+1} - \frac{1}{\alpha} \ln \lambda_{t-1}$.
Taking the derivative of the utility function with respect to $\sigma \phi$:

$$\frac{\partial u}{\partial \sigma} = \frac{\partial u}{\partial \sigma} + \frac{\partial u}{\partial \phi} \cdot \frac{\partial \phi}{\partial \sigma}$$

Substituting the forecast error Eq. (12) and the wage Eq. (11) into the productivity, and $\xi$ is a idiosyncratic productivity shock. The life-cycle wage profile is typically increasing and concave. In that case, $\theta > 0$ and $\phi > 0$.

Assuming the interior solution in the case of CRRA preferences, the conditions (5) and (11) lead to the Frisch labor supply function:

$$\ln h_t = (f + \sigma \ln h_0) + \sigma \ln \omega + \delta \xi_t + \sigma \sum_{s=1}^{t-1} \epsilon_s + \nu_t + \sigma \sum_{s=1}^{t-1} \epsilon_s$$

This equation implies that, first, hours of work are longer at the points of the life cycle when wages are high. Second, hours of work can vary with taste shifters such as the number of children. Finally, the participation condition implies that higher of-net-of-tax rate ($\sigma + \mu$) is the policy-relevant elasticity that accounts for labor supply responses to parametric shifts in the lifetime wage profile. Again, cross-sectional variation in tax rates over time is required to identify the labor supply elasticity.

Under the CARA preferences, the Frisch labor supply function can be derived as:

$$\Delta h_t = \left\{ \begin{array}{ll} (\alpha + \mu) \Delta \ln (1-\tau_t) + \Delta x_t \pi + \Delta \epsilon_t & \text{if she works} \\ 0 & \text{otherwise} \end{array} \right.$$

where $\mu = \sigma \gamma, \Delta \pi \phi = (\alpha + \mu)(\theta - \theta/2) + \delta \Delta k_t + (\alpha + \mu)\delta t + \sigma \theta_t$, and $\Delta h_t = \Delta \nu_t + (\alpha + \mu) \Delta \zeta_t + \sigma \epsilon_t$. The policy-relevant elasticity can be calculated by $(\alpha + \mu) \bar{h}$, where $\bar{h}$ is the sample mean of hours worked among the employed.

### 3. Econometric issues

#### 3.1. Instrumental variable method

Solving the lifetime utility maximization problem among the participants results in the first-difference version of the Frisch labor supply function Eq. (16), where the dependent variable is change in hours of work and the explanatory variables include change in the log of net-of-tax rate, age, year dummies, and change in the number of children.6 Age can be replaced with change in age squared. The error term consists of idiosyncratic shocks in preferences, productivity, and forecast error and thus may be heteroscedastic and serially correlated. Moreover, the error term may be correlated with cross-sectional variation in the actual tax rates over time. Because the changes in tax rates are associated with previous earnings, some of the variation can reflect labor supply responses to tax reforms.5 The first-difference estimator, which is also known as the difference-in-differences estimator, will not be consistent. In the presence of mean reversion, the change in hours of work should be larger for workers who

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4 Consider a static optimization problem in which an individual maximizes a CRRA utility function: $u(c, h, s_1, s_2) = g(h) - \frac{c^{\lambda}}{\lambda} + \frac{s_1^{\rho}}{\lambda} + \frac{s_2^{\rho}}{\lambda}$ for $\rho > 0$ and $\lambda > 0$, where $g(\cdot)$ is an unknown function, subject to the budget constraint: $c = c(h) + y$. Taking the derivative of the utility function with respect to $h$ after substituting the budget constraint leads to the first-order condition: $g(h) = c(h) + y$. This optimality condition implies that the Marshallian elasticity is $e_m = \frac{\partial u}{\partial c} \frac{\partial c}{\partial h} = \frac{c(1 - (\alpha \sigma + \gamma) + \gamma)}{(1 - (\alpha \sigma + \gamma) + \gamma)}$ and that the income elasticity is $e_i = \frac{\partial u}{\partial y} \frac{\partial y}{\partial h} = \frac{\partial y}{\partial h} \frac{\partial y}{\partial h}$. By the Slutsky equation, the Hicksian elasticity is $e_h = \frac{\partial e_i}{\partial \theta} = \frac{\partial e_i}{\partial \phi}$.

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7 This problem is similar to the one that arises in experimental studies of negative income tax programs (Keeley and Robins, 1980; Moffitt and Kehrer, 1981).
experienced a negative temporary shock in the previous year. The estimated labor supply elasticity will then be biased downward. To circumvent this problem, the approach proposed by Auten and Carroll (1999) and Gruber and Saez (2002) is used here.

To control for mean reversion, the lagged hours of work is first incorporated as an additional regressor into the hours-of-work Eq. (14):

$$\Delta h_{it} = \beta \Delta \ln (1 – \tau_{it}) + \Delta x_{it} \pi + g(h_{it-1}) + \Delta e_{3it}$$

where $x$ is the vector of observed attributes that includes the number of children under the age of seven before compulsory education, the number of children aged seven to 15 during compulsory education, age-squared, and year dummies, $e_i$ is the error term, $p$ is an indicator that equals one if the individual is employed and equals zero if she is a full-time housewife, $i$ is an index for individuals, and $t$ is an index for year hereafter.

The labor supply responses to tax rates are denoted by $\beta$. To mitigate the bias arising from mean reversion, the effect of lagged hours of work is nonparametrically specified. In practice, the unknown function $g(.)$ is approximated by fifth-order polynomials. After making the exclusion restrictions tenable, the instrumental variable approach is applied to Eq. (17). The instrument used here is constructed in a way that rules out the variation in tax rates arising from behavioral responses.

$$Z_{it} = (1 – \hat{\tau}_i) – (1 – \tau_{it-1}) = \tau_{t-1} – \hat{\tau}_0,$$

where $\hat{\tau}$ represents the net-of-tax rate calculated from the previous taxable income at year $t$ – 1 under the current tax system at year $t$. In other words, $\hat{\tau}$ is the effective tax rate if the tax schedule alone changes. Thus, the instrument ($Z_{it}$) indicates how the net-of-tax rate would change in response to tax reforms without behavioral responses. The reduced-form equation for the change in the log of net-of-tax rate can be described by:

$$\Delta \ln (1 – \tau_{it}) = \kappa_1 Z_{it} + \Delta x_{it} \kappa_2 + g(h_{it-1}) + \Delta e_{2it},$$

where $\Delta e_{2it}$ is the error term.

3.2. Sample-selection correction method

A potential problem with the approach above is the composition change of labor market participants. The estimated labor supply responses may suffer from a selection bias if the composition effects are not fully captured by an individual fixed effect, a time effect, and other observed attributes. To correct for the potential selection bias, a simple panel-data model with an endogenous regressor is developed here, building upon the sample-selection correction model proposed by Olsen (1980).

We assume that the participation condition (15) can be approximated by an index function in a linear form:

$$p_{it} = Z_{2it} \kappa_3 + x_{it} \kappa_4 + a_i + e_{3it},$$

where $Z_{2}$ is fixed costs that vary by regional labor market conditions, $a_i$ is an individual fixed effect, and $e_{3it}$ is the error term. The regional labor market conditions are specified as the interaction terms between 47 prefectural dummies and nine year dummies. This specification is motivated by the fact that fixed costs, such as commuting costs, child care costs, and job search costs, vary across regions over time. The idea to use the regional labor market conditions as excluded instruments is similar to the one proposed by Blundell et al. (1987). By virtue of linear specification, the time-invariant unobserved heterogeneity can be eliminated after the first-difference transformation:

$$\Delta p_{it} = Z_{2it} \kappa_3 + \Delta x_{it} \kappa_4 + \Delta e_{3it},$$

For identification and estimation, the following set of assumptions is imposed on the model presented above: (a) $(p,x,z)_{it}$ is always observed, whereas $(h,\tau,z)_{t}$ is observed when $p = 1$. (b) $E[\Delta e_{2it}|\Delta Z] = E[\Delta e_{2it}|\Delta Z_0] = 0$, where $\Delta Z = (z_{it}, \tau_{it}, x_{it}, g(h_{it-1}))$ and $\Delta Z_0 = (z_{t}, \tau_{t}, x_{t})$; (c) $\kappa_3 \neq 0$; (d) $E[\Delta e_{2it}|\Delta e_{2t}, g(Z)] = E[\Delta e_{2it}|\Delta e_{2t}] = \psi e_{2it}$; (e) $e_{2it}$ has a uniform distribution; (f) $E[\Delta e_{2it}|\Delta Z_0] = 0$; (g) $\kappa_3 \neq 0$; (h) $E[\Delta e_{2it}|\Delta Z] = E[\Delta e_{2it}|\Delta Z_{it}]$, where $\Delta Z_{it} = (z_{it}, \tau_{it}, x_{it}, g(h_{it-1}))$.

Assumption (a) states the observational rule. Assumption (b) is necessary to estimate consistently the selection equation (20). Assumption (c) is the rank condition for excluded instruments. The exclusion restriction is crucial for identification, as the sample-selection correction term is a linear function. In other words, the sample-selection correction term is linearly dependent on the other explanatory variables in the absence of an excluded instrument in the selection equation; thus, the parameter $\psi$ is not identifiable. Assumption (g) requires the excluded instrument, which is the predicted change in net-of-tax rates assuming that income remains the same as in the base year, to be correlated with the log of net-of-tax rate.

Under assumptions (d), (e), and (f), it follows that $E[\Delta e_{2it}|\Delta Z_{it}]$, $p_{it} = p_{it-1} = 1 = \psi \Delta e_{3it}$. Under the additional assumption (h), the hours-of-work equation can be rewritten as:

$$E[\Delta h_{it}|\Delta Z_{it}, p_{it} = p_{it-1} = 1] = E[\Delta \ln (1 – \tau_{it})|\Delta Z_{it}, p_{it} = p_{it-1} = 1] + \Delta x_{it} \pi + g(h_{it-1}) + \psi \Delta e_{3it},$$

where the last term serves as the sample-selection correction term. In practice, the residual term is interacted with the year dummies to allow for the differential effect of sample selection over time. If the estimated coefficients on the selection correction terms differ statistically significantly from zero, the estimation suffers from selection bias in the absence of sample-selection correction terms.

The estimation procedure requires only a linear regression as follows. First, the residual $Z_{it}$ is constructed after a set of parameters ($\kappa_3, \kappa_4$) is consistently estimated via OLS regression of (21). Then, the instrumental variable method is applied to estimate Eq. (22), where the residual constructed in the first step is included as the selection correction term, and a set of parameters ($\beta, \pi, \psi$) is consistently estimated. Alternatively, instead of the instrumental variable method, OLS can be applied to the first-difference equation (17) after the selection correction terms and the residual constructed from the OLS regression of (19) in the presence of the sample-selection correction terms are incorporated as additional regressors. The standard errors are computed using a block bootstrap technique in which the sampling unit is an individual to allow for heteroscedasticity and serial correlation.

Importantly, the sample-selection correction model developed here can allow for an arbitrary correlation between regressors and unobserved heterogeneity. As proposed by Semykina and Wooldridge (2005), it is also possible to estimate the selection equation using a probit model under the normality assumption. However, this specification requires the assumption that unobserved heterogeneity can be expressed as a linear projection of observed characteristics. Moreover, our method does not suffer from the incidental parameter problem, unlike the Tobit model analyzed in Heckman and MacCurdy (1980). Another advantage is computational simplicity.

The distributional assumption for the error term appears to be strong, and it may be considered a disadvantage. In general, the drawback of the linear probability model is that the predicted response probability does not necessarily fall within the range

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8 The derivation does not rely on the assumption that the error terms are jointly normally distributed.

9 Card (1990) employs essentially the same approach.
between zero and one. However, the estimator is consistent as long as the mean independence assumption, i.e., assumption (b), holds, and the prediction approximately overlaps between the linear probability model and the probit/logit model around the middle of the distribution. Moreover, Newey (1999) shows that the linear sample-selection correction model proposed by Olsen (1980) may provide a consistent estimator under certain conditions placed on regressors, despite its misspecification of the distribution. In other words, the uniform distribution assumption, i.e., assumption (e), is not necessary for consistency, and it can be replaced by the set of conditions presented in Newey (1999). However, this result does not extend to the non-linear sample-selection correction model, where the selection equation is specified as a probit or logit model. Therefore, which parametric assumption is stronger is not definitive.

4. Institutional background

4.1. Tax basis, deductions, and progressivity

As in many countries, income tax is imposed on individual taxable income, and the labor income tax is progressive in Japan. There are several tax brackets, and marginal tax rates increase by roughly 10% in each bracket. The number of tax brackets was five until 1998 and decreased to four in 1999. The maximum marginal tax rate then decreased from 50% to 37%. Labor income is taxed separately from capital income which is taxed uniformly.

Various tax deductions are permitted in Japan. Some tax deductions such as the allowance for dependents can reduce the taxable income of either the husband or the wife, but not both. Thus, spousal income can affect the marginal tax rate and the amount of tax liability. Moreover, the amount of the spouse allowances varies with spousal income within a certain range of income. The rate of deduction for employment income varies with labor income from 5% to 40% when gross income exceeds 1.65 million yen.

4.2. Spouse allowances

The spouse allowance permits individuals with spouses earning low incomes to deduct an amount of tax liability. More specifically, the sum of the spouse allowance and special spouse allowance, denoted by $SA$, varies according to the secondary earner’s income, denoted by $P$, and is deducted from the primary earner’s tax liability as follows:

$$SA = \begin{cases} S_{A_{max}} & \text{if } P < c_1, \\ S_{A_{max}} - (p - c_1) & \text{if } c_1 \leq P < c_2, \\ 0 & \text{if } c_2 \leq P, \end{cases}$$

(23)

where $S_{A_{max}} = 0.7$, $c_1 = 0.65$, and $c_2 = 1.35$ million yen until 1994, and $c_2 = 1.41$ million yen from 1995. The phase-out region is generated by the decrease in the special spouse allowance. The shape of the spouse allowance schedule looks similar to that of the Earned Income Tax Credit (EITC), as illustrated in Fig. 1. There is, however, no phase-in region in the spouse allowance system. This implies that the spouse allowance system does not create incentives but only disincentives to work.

Consider a household in which primary and secondary earners share a common budget constraint. The spouse allowance system alters the secondary earner’s marginal tax rates as well as the amount of the primary earner’s tax liability in the phase-out region, because the deduction amount for the special spouse allowance decreases proportionally with spousal income, as noted by Akabayashi (2006). Fig. 2 shows that the effective marginal tax rates of the secondary earner fall into four categories after spouse allowances are taken into account. The plateau region corresponds to the first income range, the phase-out region corresponds to the second and third income ranges, and there is no spouse allowance in the fourth income range. Thus, the effective marginal tax rate equals the secondary earner’s own rate in the first and last income ranges. In contrast, in the second and third income ranges, the effective marginal tax rate faced by the secondary earner equals her own marginal tax rate plus the primary earner’s marginal tax rate, because the sum of the spouse allowance and the special spouse allowance decreases at the same rate as income increases. Although the basic allowance and the deduction for employment income lower the individual tax liability to zero in the first and second income ranges, the effective marginal tax rate of the secondary earner is not zero but her husband’s marginal tax rate in the second range. The second and third categories of annual income ranged from 0.7 to 1 million yen and from 1 to 1.35 million yen, respectively, until 1994, and from 0.7 to 1.03 million yen and from 1.03 to 1.41 million yen, respectively, after 1995. The first and last categories are outside these intervals.

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10 The exchange rate of the Japanese yen to the US dollar ranged from 94 to 131 yen between 1993 and 1999.

11 There is basically no variation in effective tax rates for those who have no individual labor income when individual income is taxed separately from spousal income, and when labor income is taxed separately from capital income.

12 However, individuals whose annual taxable incomes are greater than or equal to 10 million yen are not eligible for the special spouse allowance.
5.4. The 1990s tax reforms

Five reductions in income tax were implemented during the 1990s, as summarized in Table 1. In fact, a series of Japanese tax reforms in the 1990s significantly altered the marginal tax rate for many people. No tax reform relevant to this study was implemented between 2000 and 2002. The structure of the income tax cuts varied in each case. Of the five tax cuts, two were permanent, two were temporary, and one included both permanent and temporary cuts.

Permanent changes were implemented in three ways. First, the tax brackets were changed in 1994 and reduced in 1999. Second, in 1999 the maximum tax rate was reduced from 50% to 37%. Third, personal tax deductions, such as the basic allowance, the allowance for dependents, the spouse allowance, and the special spouse allowance, were increased by 30 thousand yen in 1995.

Temporary changes were implemented in two ways. First, a 15% or 20% tax refund of the income tax liability, called the special tax cut, was introduced temporarily in 1994, 1995, and 1996. In 1999, a 20% fixed rate tax cut was introduced without a specified time limit. The upper limits of the tax refunds in 1994, 1995, and 1996 were 2 million yen, 50 thousand yen, and 50 thousand yen, respectively. Second, in 1998, the fixed amount of income tax refund was made proportional to the number of dependents. 13

5. Data

Theoretical and econometric issues have been discussed so far on the assumption that panel data are available. The data used in the analysis are from the Japanese Panel Survey of Consumers (JPSC) from 1993 to 2002. A nationwide representative sample of 1500 women aged 24 to 34 has been surveyed each year since 1993, and 500 women aged 24 to 27 have been surveyed each year since 1997. The analysis of hours worked focuses on married women who report after-tax income for at least two sequential years, along with their husbands, to calculate their tax rates. The appendix provides details on calculating income tax. Respondents are excluded from the sample if there are missing values or clearly inconsistent responses regarding employment status, hours of work, and income. Based on these criteria, the sample consists of 3070 observations from an unbalanced panel of 659 married women. Full-time housewives are added when calculating income tax. Respondents are excluded from the sample to 7040 observations from 1177 married women.

Table 2 summarizes the characteristics of the sample used in the analysis. There is considerable cross-sectional diversity in employment status and industry. The analysis here is not limited to tenured or permanent employees. In particular, 53% of the employed are employed as part-time workers, who can change their hours of work more flexibly. The standard deviation among part-time and tempo-

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13 An interesting question may be whether and how labor supply responses differ in response to permanent and temporary tax changes. One way of testing this question may be to examine the responses to only those tax changes associated with permanent tax reforms. However, the distinction between temporary and permanent changes is not obvious in all cases.
6. Empirical results

The results reported in columns 1 and 2 of Table 2 are obtained by applying the instrumental variable method to the first-difference equation (17) using the excluded instrument (22). The results are presented in both the presence and absence of year dummies. In the absence of year dummies, the constant term is included in the covariates. The standard errors and the test statistics reported here are all robust to heteroscedasticity and serial correlation. The parameter estimates obtained here are consistent with the standard results in the literature (Killingsworth and Heckman, 1987). The estimated coefficient on the log of net-of-tax rate suggests a positive and moderately large labor supply response. The effect of income tax on hours of work differs statistically from zero at the 5% significance level in the absence of year dummies and at the 10% significance level in the presence of year dummies. A 10 percent point decrease in the marginal tax rate increases hours of work by 2.8 per week. The elasticity with respect to the net-of-tax rate is 0.81 at the sample mean of hours worked. The number of young children decreases hours of work, although the estimated effect is not statistically significant. These results are robust to outliers in hours of work. The joint significance level of the fifth-order polynomials in lagged hours of work is 0.00.

The results reported in column 3 are obtained by implementing the sample-selection correction method developed in the earlier section. In the estimation of the labor market participation equation (21), the F-statistic is 58.13 with a p-value of 0.00 under the null hypothesis that all of the coefficients on the excluded instruments are zero. This means that year-specific regional labor market conditions provide the sample-selection correction terms with independent variation and that the rank condition for identification holds. Then, in the estimation of the hours-of-work equation (22), the χ² statistic is 7.84 with a p-value of 0.55 under the hypothesis that all of the coefficients for the sample-selection correction terms are zero, indicating no sample-selection bias. The estimated tax effect is indeed identical to that in column 2.14

The correlation between the instrumental variable and the endogenous variable is strong in the first-stage regression of (23). In other words, the changes in effective tax rates are strongly associated with the tax changes arising from tax reforms from columns 4 to 6 of Table 2. The results indicate that tax cuts reduce net-of-tax rates, as expected. Under the hypothesis that the coefficient of the excluded instrument equals zero, the F-statistics are 158 in the absence of year dummies in column 4, 127 in the presence of year dummies in column 5, and 118 in the presence of year dummies and sample-selection correction terms in column 6. The instrument used is strong enough to make an inference for the finite sample.

Finally, given the result that no sample-selection bias can be found, the instrumental variable method is also applied to the first-difference equation in double-log form using the same instrument in Table 4. The estimated parameters obtained in Table 4 are similar to those in Table 3. Overall, the labor supply elasticities range between 0.81 and 0.83 in the presence of year dummies.

The labor supply responses of married men and unmarried women may also be relevant in determining the effects of tax policy. To examine their behavioral responses, the same analysis is conducted separately for married men and unmarried women. This exercise reveals small and highly statistically insignificant elasticities with respect to the net-of-tax rate for both married men and unmarried women. Thus, the labor supply responses of married men and unmarried women to the 1990s tax reforms appear to be negligible.

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Table 3  
First-difference instrumental variable estimates for hours of work.

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Hours of work</th>
<th>Log of net-of-tax rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Log of net-of-tax rate</td>
<td>25.9 (12.4)</td>
<td>28.2 (14.6)</td>
</tr>
<tr>
<td>Tax reforms</td>
<td>0.75 (0.06)</td>
<td>0.72 (0.06)</td>
</tr>
<tr>
<td># children aged 0–6</td>
<td>–0.34 (0.64)</td>
<td>–0.23 (0.65)</td>
</tr>
<tr>
<td># children aged 7–15</td>
<td>–0.04 (0.60)</td>
<td>–0.04 (0.62)</td>
</tr>
</tbody>
</table>

Notes: Standard errors in parentheses are clustered at the individual level. Standard errors in square brackets are estimated by block bootstrap.

Table 4  
First-difference instrumental variable estimates for the log of hours of work.

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Log of hours of work</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
</tr>
<tr>
<td>Log of net-of-tax rate</td>
<td>0.77 (0.37)</td>
</tr>
<tr>
<td># children aged 0–6</td>
<td>–0.02 (0.02)</td>
</tr>
<tr>
<td># children aged 7–15</td>
<td>–0.01 (0.02)</td>
</tr>
</tbody>
</table>

Notes: Standard errors in parentheses are clustered at the individual level. Other covariates in the first-difference equation include the constant term, the change in age-squared, and the fifth-order polynomials in lagged hours of work.

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14 These results hold even after prefectoral dummies are added only in z₂ or in both x and z₂.
Acknowledgements

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Appendix. Calculation of income tax

The marginal tax rates and the amount of tax liability have non-linear relationships with taxable income and the number of dependents. The withholding tax table for monthly salary payments reports the amount of labor income tax liability that corresponds to taxable labor income and the number of dependents. The JPCS collects data on the monthly after-tax incomes of respondents and their husbands, and on the number of children that they have.

Using the tax table and the data set, income tax is calculated as follows. First, the marginal tax rates are calculated from the tax table, after both permanent and temporary tax cuts are taken into account. Second, the after-tax income, which corresponds to the amount of tax liability, is calculated as taxable income less the amount of tax liability from the tax table. Third, the number of dependents for each individual is calculated from the data set. Children and a spouse earning lower than a certain threshold are considered dependents. It is assumed that couples will deduct the dependent allowance from the taxable income of the higher-earning spouse to gain a tax advantage. Fourth, data on the marginal tax rates and the amount of tax liability from the tax table are matched to the JPSC data on after-tax income and the number of dependents. Finally, the spousal tax liability is deducted if the before-tax income falls into the second or third income ranges.

The sample distribution of marginal tax rates is summarized as follows. Among the 3070 observations of employed women, the effective marginal tax rate is zero for 17.3%, greater than zero but less than 0.1 for 68.8%, greater than or equal to 0.1 but less than 0.2 for 13.8%, and greater than or equal to 0.2 for 0.001%. In fact, the various tax deductions lower the marginal tax rate.

The author recognizes the limitations of calculating income tax from the withholding tax table for monthly salary payment. This table does not account for several tax deductions, such as deductions for life insurance premiums, casualty insurance premiums, and buying a home, which can be claimed as a year-end tax adjustment. However, more accurate approximation is beyond the scope of this paper. The measurement-error problem can be alleviated by the instrumental variable method.

References


