Child benefit, tax allowances, and behavioral responses: The case of Japanese reform, 2010–2011[☆]

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April 2016

The reform of Japan's child benefit system in 2010 was followed by the abolition of the tax allowance for dependents in 2011. This study uses micro-level data from the Employment Status Survey and an estimation of a discrete-choice model of labor supply to examine the effects of these reforms on the labor supply, after-tax incomes, and utility of households. The results show that the reforms decreased the labor supply of parents and that the funds necessary to implement them were underestimated by 22% when this behavioral change was disregarded.

JEL: J20, H24

Key Words: Child benefit; tax reform; discrete-choice model; household labor supply; Japan

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[☆] Micro-level data from the Employment Status Survey of 2002 were provided by the Research Centre for Information and Statistics of Social Science at Hitotsubashi University's Institute of Economic Research. I am grateful to the anonymous referees, Takuro Miyamoto, Masayoshi Hayashi, and Atsuhiro Yamada for their helpful comments and suggestions. I acknowledge the financial support from KAKENHI (Grant-in-Aid for Young Scientists B-25780190) and the Seimei Foundation. The usual disclaimers apply.

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1. Introduction

Many industrial countries have introduced packages of cash benefits, tax allowances, subsidies, and services in kind to assist children and their parents (Bradshaw and Finch, 2002). Although Japan is no exception, the Japanese government spent only 1.11% of GDP on family benefits in cash, services, and tax breaks in 2001 (OECD Family Database). The Democratic Party of Japan (DPJ), which assumed office in 2009, replaced the existing child benefit, known as "*jido teate*," with a new version called "*kodomo teate*" in 2010.[1] This reform abolished the income test and raised the limitation on the eligible age and the associated benefits, as reflected in the budget increase from 996 billion yen in FY 2009 to 2,285 billion yen in FY 2010. Meanwhile, the tax allowance for young dependents was abolished in 2011. This package of reforms increased public spending on family benefits in cash, services, and tax breaks in 2011 to 1.74% of GDP, which was still lower than the OECD average (2.25%).

These reforms changed the distribution of tax payments as well as household behaviors. Because the tax allowance for dependents represented a deduction from taxable income, a reduced allowance resulted in a relatively high tax payment for the rich compared with the poor under progressive taxation. On the other hand, the amount of child benefit is fixed. Therefore, this package of reforms should be pro-poor. Since the reforms alter the budget set of households, their behavior could be affected, which in turn changes the tax payments. This study uses a discrete-choice model of labor supply to quantify the effects of these reforms on household behavior, the distribution of tax payments, and income and welfare.

Since child benefit is a lump-sum payment and does not require parents to be employed, it can have a negative effect on labor supply and a positive effect on leisure consumption because of

[1] Both *jido* and *kodomo* mean "children" in Japanese.

the income effects generated by an increase in after-tax income, at least in the short run.[2] In fact, by simulating the effects of increased child benefit in Sweden, Brink et al. (2007) found that the effects included a decrease in labor supply. Gonzales (2013) and Tamm (2010) found, in Spanish and German cases, respectively, that the impact of universal child benefit on labor supply is negative.[3] The child tax credit has been shown to exert a similar effect in Canada (Milligan and Stabile, 2007).[4]

In this study, I examine the combined effects of Japan's 2010 child benefit reform and 2011 tax allowance abolition on the labor supply, after-tax incomes, and utility of households, based on a micro-simulation comparing before and after the reform. For this purpose, I estimate the parameters of the utility function based on a labor supply model that discretizes the hours worked, pioneered by van Soest (1995). I also compute the wage elasticity of labor supply.[5] I further calculate the government's requirement of public funds for a scenario involving the

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[2] Although we focus on labor supply behavior, child benefit can affect household spending patterns (Blow et al., 2012).

[3] Gonzales (2013) found that eligible mothers are less likely to be working one year after delivery. Her results showed a positive effect on fertility and a negative effect on abortion and formal childcare.

[4] Many studies have examined the effects of child-related benefits and/or tax breaks that are designed to encourage parents to participate in the labor force, such as the Earned Income Tax Credit (EITC) in the United States, the Working Tax Credit (WTC) in the United Kingdom, the National Child Benefit in Canada, and the French Family Tax Splitting. See, e.g., Blank (2002), Blundell (2000), Immervoll et al. (2007), and Milligan and Stabile (2007). The effects of subsidies available for childcare, which lead to a decrease in the cost of childcare, on the labor supply of mothers are also examined (e.g., Anderson and Levine, 1999; Baker et al., 2008; Berger and Black, 1992; Havnes and Mogstad, 2011).

[5] For studies of labor supply elasticity, see Blundell and MaCurdy (1999) and Evers et al. (2008). For an investigation in the Japanese context, see Bessho and Hayashi (2011).

behavioral changes of households in response to the reform compared with a scenario in which such behavioral changes do not occur.

One reason for the use of a structural model in this study is the complicated nature of the Japanese tax-and-transfer system. As demonstrated in the second section of this paper, the old child benefit was calculated according to a complex formula based on the income and structure of a household. The tax allowance for dependents is only one ingredient of a convoluted income taxation system that complicates the computation of changes in each household's after-tax income. A structural model thus seems appropriate for an analysis of the Japanese tax-and-transfer system. While some discrete-choice structural models explicitly account for childcare options (Brink et al., 2007; Haan and Wrohlich, 2011; Kornstad and Thoresen, 2007), I employ a standard consumption leisure model here, mainly because of data limitations. To validate the results, I assume two specifications: a translog and a quadratic utility function. The estimation in this study generates a number of coefficients. To interpret the estimation results, I use these coefficients to compute the labor supply elasticity with respect to the pretax wage rate.

One contribution of this study is its explicit consideration, through a micro-simulation, of the behavioral changes pertaining to labor supply associated with the child benefit and tax allowance reforms. A number of previous studies have investigated the various effects of child benefit. For example, Abe (2003), while examining the corrective effects of child benefit and the tax allowance on income disparity, found that child benefit had a much smaller effect than the tax allowance. By estimating the effect of child benefit on household consumption, Kobayashi (2011) showed that the child benefit provision neither decreased Engel's coefficients nor increased the proportion of educational expenditure, thus implying that it did not improve child welfare. Unayama (2011) utilized frequent changes to the child benefit system to identify its effect, finding that a major part of child benefit is used to accumulate savings rather than to change consumption patterns. Only those households facing liquidity constraints tend to increase consumption when receiving child benefit. Stephens and Unayama (2015) employed a similar identification strategy to investigate the impact on wealth accumulation. Their empirical results are consistent with their theoretical predictions in the sense that the cumulative benefits received to date raise household assets and that increases in future benefits lower the stock of wealth. The micro-simulation performed by Takayama and Shiraishi (2009), by using micro-data obtained from the National Livelihood Survey, demonstrated an increase in after-tax income for 38% of households, that is, for most of the households with pre-high school children.

However, none of these studies has considered the effects of child benefit on labor supply. Although child benefit in Japan is not explicitly intended to either stimulate or depress households' labor supply,[6] it is possible that the tax-and-transfer structure affects labor supply behavior, which could in turn change tax revenues and government expenditure. Therefore, a study of the reform's effect on labor supply should be of economic significance.

The results of the present study are summarized as follows. Based on the estimated coefficients, the average labor supply elasticity is found to range from −0.01 to 0.08 for husbands and from 0.106 to 0.138 for wives, which was largely attributed to the extensive margin. The child benefit reform and abolition of the tax allowance for dependents were found to jointly depress household labor supply by between 0.29% and 1.41% in terms of labor income. The decrease in labor income was not considerable. While disregarding behavioral changes resulted in a decrease of net tax payments per household of 44,150 yen (i.e., the benefits increased), incorporating behavioral changes by means of the translog utility function raised this amount to 53,720 yen. That is, changes in labor supply increased the government expenditure required to implement the reform by 22%. In addition, the reform was shown to raise the utility level of all households with incomes of less than 3 million yen (USD 30,000) and with children aged 14

[6] Kita (2004) pointed out that the Japanese government, especially the Ministry of Welfare, tried to use child benefit as a tool to promote home childcare by non-working mothers when it was first introduced.

years and below, whereas it decreased the utility level of more than half of the households with incomes of more than 13 million yen (USD 130,000).

The rest of this paper is organized as follows. Section 2 introduces the institutional background of the study. The econometric specifications are described in Section 3. Section 4 presents the data and Section 5 explains the simulation method. The results are reported in Section 6 and the conclusions in Section 7.

2. Institutional background

This section provides an overview of the child benefit and tax allowance systems for dependents in Japan.[7]

2.1. Child benefit

Japanese child benefit, which is based on the Child Benefit Act of 1971, comprises a cash benefit. The allowance is paid to the custodians of eligible children.[8] In many cases, the recipients are fathers, considered to be the heads of the households to which children belong. The government has revised the criteria for payment on several occasions based on the number of children in a household, their ages, and the recipient's income. Until FY 1999, however, total child benefit expenditure did not change drastically, ranging from 140 to 180 billion yen, an exceptional year being FY 1992, which reached 214 billion yen.

[7] See Suzuki (2009, 2011) and Kita (2002a, 2002b) for further details of these systems and their history. I do not discuss the revenue aspects of these systems, focusing instead on their effects on household behavior.

[8] A "child" was defined as being 18 years or below.

After a further revision in 2000, the government anticipated that child benefit would function as a countermeasure to the falling birth rate through its mitigation of the economic burden of childcare. This revision expanded the benefit for children aged between 3 and 6 years: whereas the benefit for the first or second child was fixed at 5,000 yen, that for the third child or subsequent children was 10,000 yen. This was followed by the raising of the upper age limit to the third grade (aged 9 years) in 2004 and to elementary school graduation (aged 12 years) in 2006. The income limitation was also gradually raised, and add-ons for babies (aged 3 years and below) were provided for in 2007.

In 2009, the DPJ took office, offering reform of child benefit as an eye-catching policy. In 2010, the DPJ established a new child benefit system that abolished the income test, raised the upper age limit to junior high school graduation (aged 15 years), and increased the monthly benefit to 13,000 yen. This amount was further revised in October 2011 to 15,000 yen for children aged 3 years and below, 10,000 yen for children aged between 3 and 12 years (elementary school graduation) (15,000 yen in the case of the third child or subsequent children), and 10,000 yen for junior high school students. However, the Liberal Democratic Party, which defeated the DPJ in 2012, reintroduced the income test.[9]

The successive expansion of child benefit since 2000 has resulted in increased government expenditure from 159 billion yen in FY 1999 to 800 billion yen in FY 2006, and up to 996 billion yen in FY 2009. The DPJ's reform doubled total expenditure, raising this figure to 2.29 trillion yen in FY 2010, with a further increase to 2.26 trillion yen in FY 2013.

2.2. Tax allowance for dependents

[9] The benefit amount is 5,000 yen if income is above the upper limit.

In Japan, individual income tax includes national “income tax,” local “inhabitants’ tax,”[10] and the social insurance premium. The principle used to compute the amount of tax is similar for income tax and inhabitants’ tax. First, “employment income” is derived as the salary received by an individual, minus any “employment income deductions.” Second, “taxable income” is defined as employment income minus certain allowances, including the allowance and special allowance for spouses and taxable non-labor income (non-labor income minus necessary expenses). The allowance for dependents, which is the focus of my study, is applied at this step in the process. Third, tax rates are applied to taxable incomes to compute the gross tax amounts. Finally, some tax credits and breaks are subtracted from the gross tax amounts to obtain the tax amounts. The social insurance premium is virtually a fixed-rate payroll tax with an upper limit. Child benefit is not taxable.

Tax credit based on the number of dependents was introduced in 1950. In 1989, the current structure of tax allowances was established with allowances for “special dependents” aged between 16 and 23 years. Keeping pace with inflation, the allowance amounts from taxable income have been steadily raised, reaching 380,000 yen for dependents and 630,000 yen for “special dependents” in 2010.

Tax allowances for dependents were revised at the same time as the child benefit reform by the DPJ in 2010. Because tax allowances for dependents were designed as allowances from taxable income, under progressive taxation, an increase in pretax income led to a more than proportionate decrease in the tax payment. The DPJ considered the reduced tax payments to be

[10] In practice, the amount of inhabitants’ tax is calculated based on the income of the previous year. However, since my dataset was not panel data, inhabitants’ tax was assumed to be computed by using current income. In addition, while prefectures and municipalities can charge their own tax rates, I used the standard tax rates uniformly set by national law. This should not cause a major problem since most local governments abide by these standard rates.

undesirable and replaced tax allowances with child benefit. In 2011, the allowance for dependents aged 15 years and below was abolished and that for "special dependents" aged between 16 and 18 years was reduced from 630,000 yen to 380,000 yen, in concurrence with the waiving of high school tuition fees.

The tax-and-transfer code in 2002, when the data used in this study were collected, is in Table 1. The codes just before and after the reform, in 2009 and 2011, respectively, are outlined in Table 2. In the following sections of this paper, I quantify the effects of this package of reforms (i.e., increase in child benefit and abolition of the tax allowance) on the behavior of households.

3. Econometric specifications

Following van Soest (1995),[11] I apply a structural discrete-choice household labor supply model. According to this model, household i consumes numeráire x_i and the leisure of husband l_{hi} and of wife l_{wi} to obtain utility $u_i = u_i(x_i, l_{hi}, l_{wi})$. I assume a unitary model in the sense of the joint maximization of utility u_i by household members given the pretax wage rate and tax codes. The decision-making of children is not explicitly considered here. The time endowment is expressed as T, meaning that the husband's working hours, denoted as $h_{hi} = T - l_{hi}$, and the wife's working hours, denoted as $h_{wi} = T - l_{wi}$. x_i, are equal to the family's income (including both the husband's and wife's earnings) after tax. Denoting the parameters of the tax-and-transfer code as τ, the household's income after tax is represented as

$$x_i = [W_{hi}h_{hi} - T(W_{hi}h_{hi}, W_{wi}h_{wi}; \boldsymbol{Z}_i, \tau)] + [W_{wi}h_{wi} - T(W_{wi}h_{wi}, W_{hi}h_{hi}; \boldsymbol{Z}_i, \tau)], \quad (1)$$

[11] See Löffler et al. (2014) for details on the assumptions and variations of discrete-choice models of household labor supply. Another type of structural model is based on Hausman's (1979) design and assumes a linear labor supply function.

where $T(\cdot)$ denotes an income tax-and-transfer function, including child benefit; $\mathbf{Z}_i$ is a vector of the household's characteristics; and W_{hi} and W_{wi} are the respective pretax wage rates of the husband and wife. Notably, in Japan, the husband's (or wife's) income tax depends on the wife's (or husband's) income through, for example, allowance for spouses. Because the household's utility depends on the tax-and-transfer code, I calculate utility as $u_i = u(x_i, l_{hi}, l_{wi}; \mathbf{Z}_i, \tau)$.

The choice of labor supply is discretized so that each household is assumed to choose among the alternatives provided in the choice set of income leisure combinations $\{(x_{ij}, l_{hij}, l_{wij}) : j = 1, 2, ..., J\}$ to maximize $u(x_{ij}, l_{hij}, l_{wij}; \mathbf{Z}_i, \tau)$. Since I set up eight choice sets of hours worked for the wife and husband, J is set to be $8\times8 = 64$ here. I work with two types of standard specifications of the direct utility function, namely the translog function and the quadratic function. The translog utility function is

$$\begin{aligned} u^t(.;.) &= V^t\left(x_{ij}, l_{hij}, l_{wij} \middle| Z_i, \tau\right) + \varepsilon_{ij}^q \\ &= \beta_x^t \ln x_{ij} + \beta_h^t \ln l_{hij} + \beta_w^t \ln l_{wij} + \beta_{xx}^t \left(\ln x_{ij}\right)^2 + \beta_{hh}^t \left(\ln l_{hij}\right)^2 + \beta_{ww}^t \left(\ln l_{wij}\right)^2 \\ &\quad + \beta_{xh}^t \left(\ln x_{ij}\right)\left(\ln l_{hij}\right) + \beta_{xw}^t \left(\ln x_{ij}\right)\left(\ln l_{wij}\right) + \beta_{hw}^t \left(\ln l_{hij}\right)\left(\ln l_{wij}\right) \\ &\quad + \beta_{hf}^t 1\left(h_{hij} > 0\right) + \beta_{wf}^t 1\left(h_{wij} > 0\right) + \varepsilon_{ij}^t \end{aligned}, \qquad (2)$$

and the quadratic utility function is

$$\begin{aligned} u^q(.;.) &= V^q\left(x_{ij}, l_{hij}, l_{wij} \middle| Z_i, \tau\right) + \varepsilon_{ij}^q \\ &= \beta_x^q x_{ij} + \beta_h^q l_{hij} + \beta_w^q l_{wij} + \beta_{xx}^q \left(x_{ij}\right)^2 + \beta_{hh}^q \left(l_{hij}\right)^2 + \beta_{ww}^q \left(l_{wij}\right)^2 \\ &\quad + \beta_{xh}^q \left(x_{ij}\right)\left(l_{hij}\right) + \beta_{xw}^q \left(x_{ij}\right)\left(l_{wij}\right) + \beta_{hw}^q \left(l_{hij}\right)\left(l_{wij}\right) \\ &\quad + \beta_{hf}^q 1\left(h_{hij} > 0\right) + \beta_{wf}^q 1\left(h_{wij} > 0\right) + \varepsilon_{ij}^q \end{aligned}, \qquad (3)$$

where the ε_{ij}s are additive random disturbances and βs are the coefficients to be estimated. The last two terms before ε_{ij} reflect the fixed cost associated with working. Thus, the expected signs of $\beta_{hf}{}^q$, $\beta_{wf}{}^q$, $\beta_{hf}{}^t$, and $\beta_{wf}{}^t$ are negative.

These specifications did not impose a priori restrictions such as the positive marginal utility of income or quasi-concavity of preferences. If utility increases with income, the partial derivative of u with respect to x, u_x, is positive (van Soest, 1995, Eq. (4)). If utility is quasi-concave, HC in Eq. (3) in van Soest (1995) is positive definite. HC is defined as

$$\mathrm{HC} = -u_x^{-1} \begin{pmatrix} -u_{lh}/u_x & 1 & 0 \\ -u_{lw}/u_x & 0 & 1 \end{pmatrix} HU \begin{pmatrix} -u_{lh}/u_x & 1 & 0 \\ -u_{lw}/u_x & 0 & 1 \end{pmatrix}',$$

where HU denotes the matrix of the second-order partial derivatives of the utility function.

I assume that the household characteristics linearly affect all the coefficients, βs. The coefficients of terms that included a husband's leisure l_{hi} and a wife's leisure l_{wi} are assumed to depend on their respective ages and educational backgrounds. Similarly, the coefficients of the terms that include consumption x_i are assumed to depend on the husbands and wives' respective ages, educational backgrounds, number of children, and place of residence. The coefficients of fixed costs are assumed to depend on the number of children aged 6 years and below. While I consider other cases in which the coefficients of the quadratic terms are independent of the household characteristics, the likelihood ratio tests emphatically reject these restricted models.

The random disturbances ε_{ij}^q and ε_{ij}^t are assumed to identically and independently follow the type I extreme value distribution as in the literature. This assumption about random disturbances implies that the ratio of the probabilities of two alternatives does not depend on any other alternatives (independence from irrelevant alternatives assumption). If all the coefficients, βs, are assumed to be functions of only the constant and the household characteristics, the probability of each alternative is the same for all households conditional on the household characteristics. One direction toward a more flexible model is to allow some of the coefficients, βs, to be randomly distributed. This random coefficient model or mixed logit model is often used to cope with unobserved heterogeneity (e.g., Brink et al., 2007; Haan and Wrohlich, 2011;

van Soest, 1995).[12] In this study, I assume that the coefficient of after-tax income, β_x, is random and employ the mixed logit model to estimate the βs (Hole, 2007; van Soest, 1995).[13]

4. Data

4.1. Sample

The data sample was obtained from *Syugyo Kozo Kihon Chosa* (the Employment Status Survey) conducted by the Japanese government's Statistical Bureau in 2002. This survey, the most comprehensive labor survey in Japan, is conducted every 5 years. It produces a large dataset containing approximately 440,000 household observations reflecting a variety of household characteristics. Although the data in 2002 may be unsuitable to evaluate the reform in 2010/2011, this is not a major problem for estimating the parameters of the utility function, which are not considered to change drastically over time. The price level does not rise or fall during this period as the CPI (all items less imputed rent) was 101 in 2002 and 100 in 2010.

I focused on the labor supply of nuclear families with the following characteristics: male heads of prime age (25–55 years) with children aged 14 years and below. I omitted the following observations from the sample: (a) self-employed workers, (b) board members of private companies and non-profit organizations, (c) family workers in small and medium-sized enterprises, (d) those who were unemployed due to illness, (e) those who had changed their

[12] As Haan (2006) showed, the results do not change dramatically if random coefficients models are used. Pacifico (2013) pointed out that the estimation results can change significantly if other types of unobserved heterogeneity are assumed.

[13] I failed to find convergence in the parameter estimates when I assumed the other coefficients to be randomly distributed in addition to the after-tax income coefficient. As Pacifico (2013) pointed out, this may be because of the computational difficulties that arise when using gradient-based maximization algorithms.

residence or job within the last year, and (f) those who had had children within the last year. These omissions reduced the sample size to 18,961 respondents.

The Employment Status Survey's codes hours worked as interval data. By using these intervals, I set up eight choice sets of the hours worked per year (see Table 3). Because of the significant variations in the observed distribution of hours worked, I applied different choice sets of hours worked for husbands and wives to avoid a concentration of the distribution on particular choices. In sum, the choice sets contained $8 \times 8 = 64$ alternatives of hours worked for nuclear households with $T = 16 \times 365 = 5,840$ hours per year.

The variables included in the vector of the household's characteristics $\mathbf{Z}_i$ were standard ones cited in the literature. Dummies were included for the following variables: (1) five age groups (30–34, 35–39, 40–44, 45–49, and 50–54); (2) residence in one of the three major urban areas of Japan (the Greater Tokyo area, the Chukyo area, and the Kinki area); (3) three educational backgrounds (junior high school graduates, junior college graduates, and university graduates or higher); and (4) numbers of each of the three groups of children; aged 6 years and below, 7–14 years , and 15 years and above. The sample statistics are shown in Table 4.

4.2. Pretax wage rate

I used predicted values as the pretax wage rates.[14] Given the availability of data for days worked (per year) and hours worked (per week) and the provision of annual labor incomes as intervals, I first calculated the pretax wage rate as a quotient of the middle values of hours worked (per year) and labor income. The predicted pretax wage rate was defined as a fitted value of a wage

[14] Other wage imputation procedures include predicting wage rates only for non-workers (van Soest, 1995), adding a single random draw to predicted wage rates (Bargain et al., 2012), and estimating pretax wage rates jointly with the utility parameters (Blundell and Shephard, 2012).

rate regression for each gender, where the dependent variable was the log of the pretax wage rate and the explanatory variables included dummies for age, residence, education, and their cross-terms. Since a non-negligible proportion of wives selected zero hours worked, the wage rate regression for women was estimated by using the Heckit sample selection model, wherein excluded instruments were the quadratic terms of residuals obtained from the regression analysis for non-labor income (household income minus the husband's labor income).

4.3. Income tax code

The household budget, based on the computation of the household's after-tax income, x_{ij}, for each alternative in the choice set was required to estimate the direct utility function. Once pretax income was known, after-tax income could be obtained by following the tax code outlined in Section 2. However, the available allowances or tax credits differed according to individual characteristics, and I could not account for some of them because of data limitations. The categories I selected were basic allowance, allowance for spouses, special allowance for spouses, allowance for dependents, employment income deduction, and deduction for social insurance premiums. Necessary expenses were assumed to be subtracted from non-labor income at the rate of 20%. I further assumed that social insurance consisted of public pension insurance, public health insurance, and public unemployment insurance. However, I could not calculate the social insurance premium because it differed according to the place of work, and this information was not included in the data. I therefore made the following assumptions: the social insurance premium was 13.3% if the firm where the individual worked employed fewer than 1,000 people; 14.3% if the firm employed more than 1,000 people; and 12.9% if the individual was a public servant. I also considered the upper limit of the social insurance premium.

5. Micro-simulation method

5.1. Tax-and-transfer system reform

I was able to simulate labor supply behavior when the tax-and-transfer code τ changed by using a structural labor supply model. In particular, I simulated the model by using the tax-and-transfer codes before and after the reform (see Table 2) as well as the estimated parameters of the utility function based on the data in 2002.

In 2009, before the reform, the upper age limit for child benefit was 12 years (graduation of elementary school) and the monthly amount was 5,000 yen for the first and second children, which increased to 10,000 yen for the third child and subsequent children. The benefit was also income-tested. For example, a parent with one eligible child could receive the benefit if his or her annual income minus employment income deductions amounted to less than 5 million yen. Because the benefit is paid to the person who has custody of the eligible children, the income test was based on the highest labor income of the parents. The tax allowance for young dependents during this period was 380,000 yen and the allowance for "special dependents," aged between 16 and 23 years, was 630,000 yen.

After the reform was implemented in 2010/2011, monthly child benefit increased to 13,000 yen for all children who were not yet junior high school graduates (aged 15 years). The reform ended the income test, but it also abolished the tax allowance for young dependents and reduced the allowance for "special dependents" to 380,000 yen.

Overall, my simulation consisted of three phases. First, I estimated the parameters of the utility function based on the tax-and-transfer code in existence in 2002. Second, by using the estimated utility parameters, I simulated household behavior under the tax-and-transfer code before the reform (i.e., in 2009). Third, by using the same utility parameters, I simulated household behavior under the tax-and-transfer code after the reform in 2010/2011 and then compared the results with those in 2009. The method used to perform the simulation is explained in detail in the next subsection.

5.2. Simulation method

I based my calculation on a behavioral discrete-choice model micro-simulation (Creedy and Kalb, 2006). This approach starts from the labor supply observed in the data to compute a distribution after a specified reform.[15] Readers may recall that utility (Eqs. (2) and (3)) consisted of a deterministic part and random components, β_x, ε_{ij}^q, and ε_{ij}^t. Therefore, I first estimated the parameters of the utility functions (2) and (3), as explained in Section 3.

In the second step, I calibrated the random components so that they became the observed labor choices. I drew vectors of J+1 random numbers, one of which followed the normal distribution and the others followed the type I extreme value distribution, for each household i. Hereafter, the superscripts q and t are not noted since the same procedure was used for the quadratic and translog utility functions. Let τ^{02} denote the tax-and-transfer code in 2002 and β_{xi}^r and $\varepsilon_i^r \equiv [\varepsilon_{i1}^r, \varepsilon_{i2}^r, \cdots, \varepsilon_{iJ}^r]'$ the r-th draw for such numbers, which yields $u_i^r \equiv [u_{i1}^r, u_{i2}^r, \cdots, u_{iJ}^r]'$ where $u_{ij}^r \equiv V(x_{ij}, l_{hij}, l_{hij} | \mathbf{Z}_i, \tau^{02}) + \varepsilon_{ij}^r$ and $V(x_{ij}, l_{hij}, l_{hij} | \mathbf{Z}_i, \tau^{02})$ is evaluated by using β_{xi}^r. $(\beta_{xi}^r, \varepsilon_i^r)$ was stored as a "successful" draw if the labor choice from this draw $(h_{hi}^{r*}, h_{wi}^{r*}) \equiv \operatorname{argmax}\{u_i^r\}$ coincided with the observation (h_{hi}, h_{wi}). If not, $(\beta_{xi}^r, \varepsilon_i^r)$ was discarded and the process was repeated until either a "successful" draw was obtained in which these coincided, or else the household was excluded from the exercise.[16] Through my repetition of this process, I obtained

[15] There is a closed-form solution for the predicted choice probabilities under the multinomial logit model in this study. This solution, however, cannot give a distribution after a reform conditional on the observed pre-reform labor supply.

[16] If a "successful" draw was not obtained after 1,000 trials, such a household was discarded. Less than 10% of the sample was discarded for each draw.

K successful draws $\boldsymbol{\beta}_{xi} \equiv vec[\beta_{xi}^{1}, \cdots, \beta_{xi}^{k}, \cdots, \beta_{xi}^{K}]$ and $\boldsymbol{\varepsilon}_i \equiv vec[\varepsilon_i^{1}, \cdots, \varepsilon_i^{k}, \cdots, \varepsilon_i^{K}]$, where k indexed the draws in place of r. Here, I set the value $K = 200$.

In the third step, I calibrated the other sets of the tax parameters that effect changes for child benefit and tax allowances for dependents, as explained in Section 5.1. Let τ^{09} denote the tax-and-transfer code before the reform in 2009 and τ^{11} that after the reform in 2011. τ^{09} is shown in the second and third columns and τ^{11} is in the fourth and fifth columns of Table 2. To simulate the households' choice before the reform, utility for alternative j with the k-th draw was calculated as $u_{ij}^{09k} \equiv V(x_{ij}, l_{hij}, l_{wij} | \mathbf{Z}_i, \tau^{09}) + \varepsilon_{ij}^{k}$ evaluated by using β_{xi}^{k}. The optimal choice became $(h_{hi}^{09*}, h_{wi}^{09*}) \equiv \text{argmax}\{u_i^{09k}\}$. The same procedure was applied to obtain the optimal choice under the tax-and-transfer code after the reform in 2011, $(h_{hi}^{11*}, h_{wi}^{11*})$. Since K successful draws occurred, there were two sets of, at most, K pairs, $(h_{hi}^{09*}, h_{wi}^{09*})$ and $(h_{hi}^{11*}, h_{wi}^{11*})$ for each household.[17] These K pairs constituted the empirical distributions of the labor supply before and after the tax change.

The estimation in this study generates a number of coefficients. To interpret the estimation results, I calculated the labor supply elasticity with respect to the pretax wage rate for reference, using the same micro-simulation method whereby I raised the pretax wage rates by 1%. I computed the after-tax income for each alternative, x_{ij}, under the tax-and-transfer code in 2002 with the increased pretax wage rates by 1% to obtain the optimal choice. Focusing on aggregate labor supply, I calculated the intensive and extensive margin elasticities, as defined by Kleven and Kreiner (2006), for K successful draws. Let superscript 0 denote a variable before the increase in the wage rate and superscript 1 denote a variable after the increase. Aggregate labor supply, H, is the product of the proportion of individuals who participate in the labor market, P,

[17] Successful draws could not be obtained for a small proportion of the sample for each draw after the trials. Thus, there were fewer than K pairs for many households. See also footnote 16.

and the average labor supply of the participants, $\bar{h}$. The rate of change of aggregate labor supply, $(H^1 - H^0)/H^0$, is decomposed into the sum of the participation rate, $(P^1 - P^0)/P^0$, corresponding to the extensive margin, and the average labor supply of participants $(\bar{h}^1 - \bar{h}^0)/\bar{h}^0$, corresponding to the intensive margin. As the pretax wage rates were increased by 1%, the extensive margin elasticity is defined as $[(P^1 - P^0)/P^0]/0.01$ and the intensive margin elasticity is $[(\bar{h}^1 - \bar{h}^0)/\bar{h}^0]/0.01$. Since both the husband and the wife could work in this setting, I also calculated the "cross" elasticity, namely the husband's labor supply elasticity with respect to the wife's wage rate and the wife's elasticity with respect to the husband's wage rate.

6. Results

6.1. Labor supply elasticity

The translog and quadratic specifications used in this study did not impose a priori restrictions such as the positive marginal utility of income or quasi-concavity of preferences. I used the parameters shown in Tables A-1 and A-2 to check these two properties based on u_x and HC shown in Section 3, for all individual households in my sample. Hence, I report the statistics of those households that satisfied these two properties herein.

I computed the elasticities of aggregate labor supply by using the micro-simulation method, described in Section 5.2, which provided K = 200 sets of the simulated elasticities. Table 5 presents the averages and standard deviations of these elasticities. This table shows the elasticities with respect to the husband's or the wife's own wage rate, the average being 0.075 for husbands and 0.138 for wives in the case of the quadratic utility function. The translog specification generated smaller and even negative estimates for husbands; these did not deviate significantly from zero. This negative elasticity suggests that the income effect dominated the substitution effect in case of the translog utility function.

The average elasticity of the intensive margin, i.e., the hours-of-work elasticities, was 0.058 for husbands and 0.061 for wives in the case of the quadratic utility function. The respective values for husbands and wives were −0.016 and 0.045 in the case of the translog utility function. These values were small compared with those obtained by using the discrete-choice model, which ranged between 0.0 and 0.3 for husbands and 0.1 and 0.7 for wives, with a few exceptions (see Tables 1, 2, and 4 in Bargain et al., 2011). The similarity of the results of these two specifications is consistent with that provided by Löffler et al. (2014), who ran a meta-analysis and found that the estimated elasticities are robust to the specification of the utility function.[18]

The average elasticity of the extensive margin, i.e., the participation elasticities, was 0.017 and 0.009 for husbands and 0.077 and 0.062 for wives, which were also modest results. Indeed, the discrete-choice labor supply model showed larger elasticities, ranging between 0.0 and 0.2 for husbands and 0.1 and 1.0 for wives (see Tables 1, 2, and 4 in Bargain et al., 2011). Although my results for the elasticities of the extensive margin are small in comparison with those presented in the discrete-choice literature, they seem comparable with the corresponding values for the intensive margin mentioned above. This non-negligible magnitude of the participation elasticities may have been caused by the fixed utility cost of working.

Because this study assumes that a couple jointly maximizes the household's utility, a change in the husband's gross wage rate can affect the wife's labor supply behavior and vice versa. Thus, cross-elasticities, i.e., those of the wife's labor supply with respect to the husband's wage rate and those of the husband's labor supply with respect to the wife's wage rate, should be defined. These cross-elasticities, shown in Table 5, were −0.002 and −0.010 for husbands and 0.527 and 0.328 for wives. These results imply that a husband responded to an increase in his wife's wage

[18] The slight difference obtained in this study may come from the differences in the magnitude of the income effect. When non-labor income is raised by 10,000 yen, the labor supply of husbands decreases by 0.1% (0.01%) in the case of the translog utility (quadratic utility) function.

by reducing his working hours, whereas a wife conversely responded to a similar increase in her husband's wage in the opposite manner. Although Bargain et al. (2011) did not list cross-wage elasticities, van Soest (1995, Table 4) indicated negative cross-elasticities for husbands. The average cross-elasticity (−0.010), in terms of absolute value, was lower for husbands than that obtained by van Soest (1995) (−0.015), which does not necessarily seem unrealistic.

6.2. The effects of the reform *without* the inclusion of behavioral responses

Although this study examines the effects of the reform based on the parameters shown in Tables A-1 and A-2, here I briefly note the simulated effects when behavioral responses were disregarded. This type of micro-simulation was used by Takayama and Shiraishi (2009). Figure 1 shows the average changes in tax payments for each income class based on pre-reform after-tax incomes. Each panel shows the average values of K = 200 successful draws in the case of the translog utility function. The white bars in Figure 1 show the changes in the gross tax payments, excluding the changes in child benefit, while the gray bars indicate the changes in child benefit.

Because the allowance for dependents was deducted from taxable income, the effect of this allowance on tax payments was greater when pretax income was relatively large and was equal to almost zero when pretax income was sufficiently low. The white bars in Figure 1 represent this situation where the changes in the tax payments were shown to be negligible for households with an annual income of less than 3 million yen. Changes in the tax payments for households did not monotonically increase with annual income because the average number of children for each income bracket differed.

The joint effects of the tax allowance, which were correspondingly larger as pretax income grew, and the provision of child benefit without income testing operated in favor of the lower income classes. The reform resulted in increased child benefit, decreasing the net tax payments of households with annual incomes below 12 million yen on average, ranging from the lowest to the upper-middle-income classes. Note that the average decrease in the net tax payments is larger for the upper-middle-income classes than for the middle-income classes because the former benefit from the abolition of the income test for child benefit, while the increase in child benefit for children aged 3 years and below, who are often in middle-income households, is relatively small (36,000 yen; see Table 2). While the average changes in the net tax payments shown in Figure 1 are positive for the middle-income classes, for some of these households they are negative since the increase in child benefit is less than the increase in income tax.

6.3. The effects of the reform *with* the inclusion of behavioral responses

The reform of the tax-and-transfer system resulted in behavioral changes regarding labor supply when households obtained utility from leisure. This effect is examined below. As described in Section 6.1, both the translog and the quadratic utility specifications generate similar results. Thus, I report the results based on the translog utility function only.[19]

Given that this study included the options of both a husband and a wife being able to control their labor supply, the changes in the pretax household income and labor supply of both the husband and the wife are shown in Figure 2. As noted above, the combination of the abolition of the tax allowance and increased child benefit increased the after-tax incomes of the lowest to the

[19] The results based on the quadratic utility function are available upon request. The data were collected in 2002, not around 2010. Nevertheless, even if the distribution is adjusted based on the household characteristics in 2010/2011, the results are similar to those reported in this paper.

upper-middle-income households if behavioral changes were disregarded. This reform affected parents' labor supply through three pathways. First, because child benefit is a lump-sum benefit that only depends on the number of children, which is exogenous in a static setting, households raised their leisure consumption and decreased their labor supply because of the income effect. Second, the abolition of the tax allowance reduced after-tax incomes. Thus, the income effect decreased leisure consumption and increased labor supply. Third, the abolition of the tax allowance generated bracket creep that resulted from the increase in taxable income. The marginal after-tax wage rate correspondingly declined and substitution effect increased leisure consumption, which, in turn, led to a decrease in labor supply.

The third effect was irrelevant for low-income households. Because institutional changes in net tax payments negatively influenced them, the income effect should have decreased labor supply. As Figure 2 shows, there was a decrease in parents' labor supply in some low-income classes. The magnitude of this decrease, less than 20 hours per year, is quite small considering the average working hours per year is more than 1,000 hours. This result is consistent with the aforementioned low labor supply elasticity.

The higher-income classes were affected by all three effects. The decrease in labor supply might have reflected the dominance of the third effect, i.e., the substitution effect created by bracket creep. The degree of the pretax income decrease was greater for the middle-income classes than for the lower-income classes. The rate of income decrease, at almost 2%, was perhaps due to the estimated small labor elasticity discussed in Section 6.1. The average rate of the decrease was 1.41% (translog) for households with children aged 14 years and below.

Figure 3 shows the simulated changes in the after-tax incomes of the different income classes, their decomposition into the effects of the reform itself, and the behavioral responses to it. For low-income households, the reform resulted in a rise in their after-tax incomes (pretax incomes minus income tax, plus child benefit), and their behavioral responses, in turn, caused a decrease or a slight increase in their incomes. Since this behavioral response was minimal, their resultant after-tax incomes rose. For the higher-income classes with annual incomes exceeding 13 million yen, the abolition of the tax allowance and their behavioral responses reduced their after-tax incomes. Whereas the reform was advantageous for the upper-middle-income classes, the reduction in their labor supply because of the income effect cancelled out this advantage.

Figure 1 also decomposes the changes in the net tax payments for the different income classes into the effect of the reform itself and of the behavioral responses to it. Notably, the increase in the net tax payments (including child benefit) was equal to the decrease in after-tax incomes if behavioral responses were disregarded. As discussed earlier, the reform reduced the net tax payments for low-income households. Although the behavioral responses negatively influenced net tax payments, the magnitude was small. For middle-income households, while the directions of the reform and labor supply change were the same as those for low-income households, the relative magnitude of the behavioral effect was greater. The reform resulted in higher taxes for high-income households; however, the rise in the tax payments was partially cancelled out by the reduction in labor supply. As Table 6 shows, while the average tax payment (including child benefit) decreased by 44,150 yen without considering the behavioral responses, it decreased by 53,720 yen when labor supply changes were considered in the case of the translog utility function. This difference corresponded to 21.7% of the tax decrease generated by the reform. In the case of the quadratic utility function, these values were 44,560 yen and 45,120 yen, respectively, resulting in a difference of 1.3%. In other words, the behavioral changes scaled up the budget needed to implement the reform by 1.3% to 21.7%.

Because of my use of a structural model, I was able to simulate the changes in utility created by the reform. Figure 4 indicates the proportion of households whose utility did not decrease for each income class. Most low-income households experienced utility gain. Utility lowered for more than half of households with children aged 6 years and below (shown by white circles) for the middle-income classes because the increase in child benefit is less than that in income tax, as explained in Section 6.1. On the other hand, utility rose for more than 90% of households with children aged 7 years and above (shown by black circles) for the same income classes. More than half of the higher-income households were detrimentally affected by the reform, even considering their labor supply responses.

7. Concluding remarks

In this study, I used a micro-simulation method to investigate the combined effects of the abolition of the tax allowance for dependents and the increase in child benefit on the labor supply, after-tax incomes, and utility of households. I adopted a structural discrete-choice model of labor supply for the presented estimations, assuming a unitary household model. Based on the estimated utility parameters, the average labor supply elasticity ranged from −0.01 to 0.08 for husbands and from 0.106 to 0.138 for wives. These elasticities were largely attributed to the extensive margin. The simulation results of the tax allowance and child benefit reforms suggested the following findings. The reform reduced the labor supply of households with children aged 14 years and below for most income classes, which corresponded to a labor income decrease of between 0.29% and 1.41%. Although this labor income decrease was not drastic, the changes in the net tax payments, including child benefit, were not negligible for middle- and high-income households. Although the average net tax payments decreased by 44,150 yen when behavioral responses were disregarded, they decreased by 53,720 yen when labor supply changes were considered in the case of the translog utility function. In other words, the behavioral changes scaled up the budget needed to implement the reform by 22%. Further, the simulation of utility changes based on the structural model indicated that all low-income households and more than half of those with children aged 14 years and below and annual incomes of less than 12 million yen enjoyed utility gain, whereas more than half of the upper-income households experienced utility loss as a result of the reform.

This analysis has some limitations. First, labor supply was evidently static; therefore, dynamic decision-making was not considered (Unayama, 2011). Second, I assumed unitary households whose members jointly maximized the household's utility. However, strategic interactions within a household may also matter, as discussed in Bargain et al. (2006). Third, I assumed perfect knowledge of and compliance with tax codes and did not factor in the possibility of tax avoidance or evasion by households. All these are topics for future research.

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Table 1. Outline of tax codes in 2002

(1,000 yen)

	National income tax	Local inhabitants tax
Basic exemption	380	330
Exemption for spouse	380	330
Special exemption for spouse	380	330
Exemption for dependents	380	330
Exemption for special dependents	630	450
Employment income deduction	≤ 1,800, 40%	≤ 1,800, 40%
	≤ 3,600, 30%	≤ 3,600, 30%
	≤ 6,600, 20%	≤ 6,600, 20%
	≤ 10,000,10%	≤ 10,000, 10%
	> 10,000, 5%	> 10,000, 5%
Lower limit	650	650
Tax rate	≤ 3,300, 10%	≤ 2,000, 5%
	≤ 3,300, 20%	≤ 2,000, 10%
	≤ 9,000, 30%	> 7,000, 13%
	> 18,000, 37%	
Special tax break	20%	15%
Upper limit	250	40
Child benefit (income tested)		
1st and 2nd children	60	
3rd and subsequent children	120	
Upper limit	Aged 6	

Note: Standard rates are shown for local inhabitants' tax.

Table 2. Outline of tax codes before and after the reform in 2010/2011

(1,000 yen)

	Before reform (2009)		After reform (2011)	
	National income tax	Local inhabitants tax	National income tax	Local inhabitants tax
Basic exemption	380	330	[unchanged]	[unchanged]
Exemption for spouse	380	330	[unchanged]	[unchanged]
Special exemption for spouse	380	330	[unchanged]	[unchanged]
Exemption for dependents	380	330	0	0
Exemption for special dependents	630	450	380	330
Employment income deduction	Same as 2002	Same as 2002	[unchanged]	[unchanged]
Tax rate	≤ 1,950, 5% ≤ 3,300, 10% ≤ 6,950, 20% ≤ 9,000, 23% ≤ 18,000, 33% > 18,000, 40%	10%	[unchanged]	[unchanged]
Special tax break	No	No	[unchanged]	[unchanged]
Child benefits				
1st and 2nd children	60		156	
3rd and subsequent children	120		156	
Aged less than 3	120		156	
Income test	Yes		No	

Note: Standard rates are shown for local inhabitants' tax.

Table 3. Discretized distribution of hours worked.

Alternatives	Husband				Wife			
	Annual hours worked	Lower Limit (hours)	Upper Limit (hours)	Relative frequency	Annual hours worked	Lower Limit (hours)	Upper Limit (hours)	Relative frequency
1	0.0	0	0	3.06	0.0	0	0	46.48
2	615.2	1	900	2.15	274.2	1	500	7.82
3	1033.1	901	1,240	2.68	615.8	501	800	7.12
4	1249.2	1,241	1,400	16.35	850.2	801	1,000	6.58
5	1488.2	1,401	1,600	21.91	1034.6	1,001	1,200	4.05
6	1782.5	1,601	2,000	22.91	1278.6	1,201	1,500	12.37
7	2166.8	2,001	2,500	16.78	1644.5	1,501	2,000	12.17
8	2785.7	2,501	3,000	14.16	2338.6	2,001	3,000	3.41

Table 4. Sample statistics.

	mean	s.d.	min	median	max
Husband: aged 25–29 years [D]	0.074	0.262	0	0	1
Husband: aged 30–34 years [D]	0.179	0.383	0	0	1
Husband: aged 35–39 years [D]	0.234	0.423	0	0	1
Husband: aged 40–44 years [D]	0.249	0.432	0	0	1
Husband: aged 45–49 years [D]	0.184	0.388	0	0	1
Husband: aged 50–44 years [D]	0.081	0.272	0	0	1
Wife: aged 25–29 years [D]	0.097	0.296	0	0	1
Wife: aged 30–34 years [D]	0.244	0.429	0	0	1
Wife: aged 35–39 years [D]	0.276	0.447	0	0	1
Wife: aged 40–44 years [D]	0.253	0.435	0	0	1
Wife: aged 45–49 years [D]	0.107	0.309	0	0	1
Wife: aged 50–44 years [D]	0.016	0.124	0	0	1
Urban area [D]	0.664	0.473	0	1	1
Husband: junior high school[D]	0.065	0.247	0	0	1
Husband: high school [D]	0.443	0.497	0	0	1
Husband: junior college [D]	0.095	0.293	0	0	1
Husband: university [D]	0.396	0.489	0	0	1
Wife: junior high school [D]	0.018	0.132	0	0	1
Wife: high school [D]	0.500	0.500	0	1	1
Wife: junior college [D]	0.345	0.475	0	0	1
Wife: university [D]	0.137	0.343	0	0	1
# of children aged 0–6 years	0.711	0.775	0	1	4
# of children aged 7–14 years	0.952	0.866	0	1	5
# of children aged 15+	0.273	0.569	0	0	4
Husband: Annual hours worked	1835.985	545.520	53.571	1749.357	2785.714
Wife: Annual hours worked	1054.578	561.658	53.571	1033.286	2785.714
Husband: Annual labor income (thousand yen)	5,833.25	3,324.01	0	5,500	30,000
Wife: Annual labor income (thousand yen)	982.19	1712.50	0	25	30,000
Annual household income (thousand yen)	6,973.72	4,306.45	500	6,500	30,000

Notes: [D] represents indicator variables. The middle points of intervals are shown for annual hours worked, annual labor incomes, and household incomes. The sample size is 18,961.

Table 5. Estimated gross wage elasticity of labor supply

A. Quadratic utility

	1% change in gross wage rate	Total	Intensive margin	Extensive margin
Husband	Own wage rate	0.0750	0.0576	0.0174
		(0.0203)	(0.0184)	(0.0103)
	Wife's wage rate	-0.0018	-0.0014	-0.0004
		(0.0086)	(0.0078)	(0.0031)
Wife	Own wage rate	0.1383	0.0609	0.0774
		(0.0531)	(0.0292)	(0.0324)
	Husband's wage rate	0.5168	0.1740	0.3422
		(0.0985)	(0.0547)	(0.0705)

B. Translog utility

	1% change in gross wage rate	Total	Intensive margin	Extensive margin
Husband	Own wage rate	-0.0073	-0.0160	0.0086
		(0.0186)	(0.0157)	(0.0089)
	Wife's wage rate	-0.0092	-0.0038	-0.0055
		(0.0081)	(0.0068)	(0.0058)
Wife	Own wage rate	0.1065	0.0448	0.0617
		(0.0502)	(0.0268)	(0.0313)
	Husband's wage rate	0.3276	0.1058	0.2216
		(0.0816)	(0.0426)	(0.0564)

Note: Only for those who satisfy monotonicity.

Figure 1. Effects on net tax payment (translog utility function)

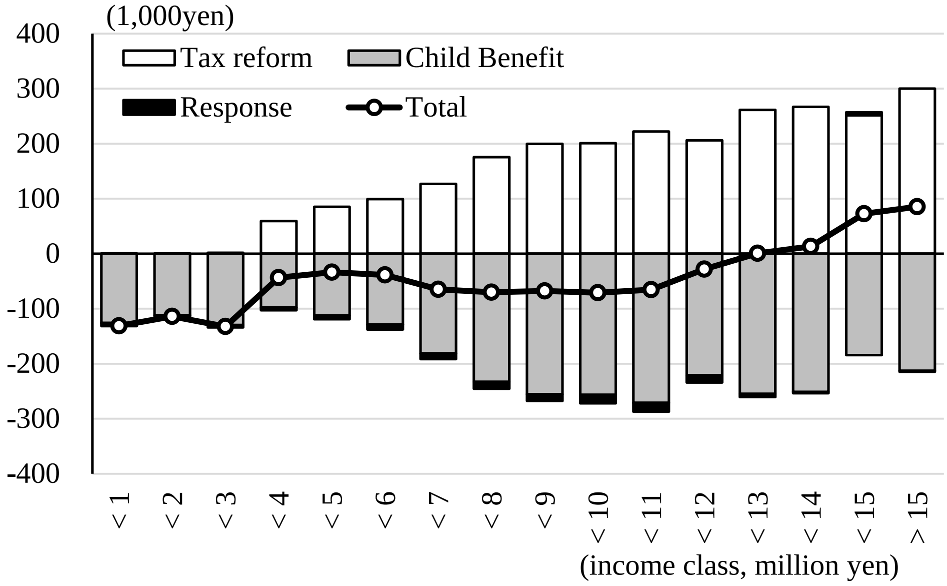

Figure 2. Effects on labor supply pre-tax income (translog utility function)

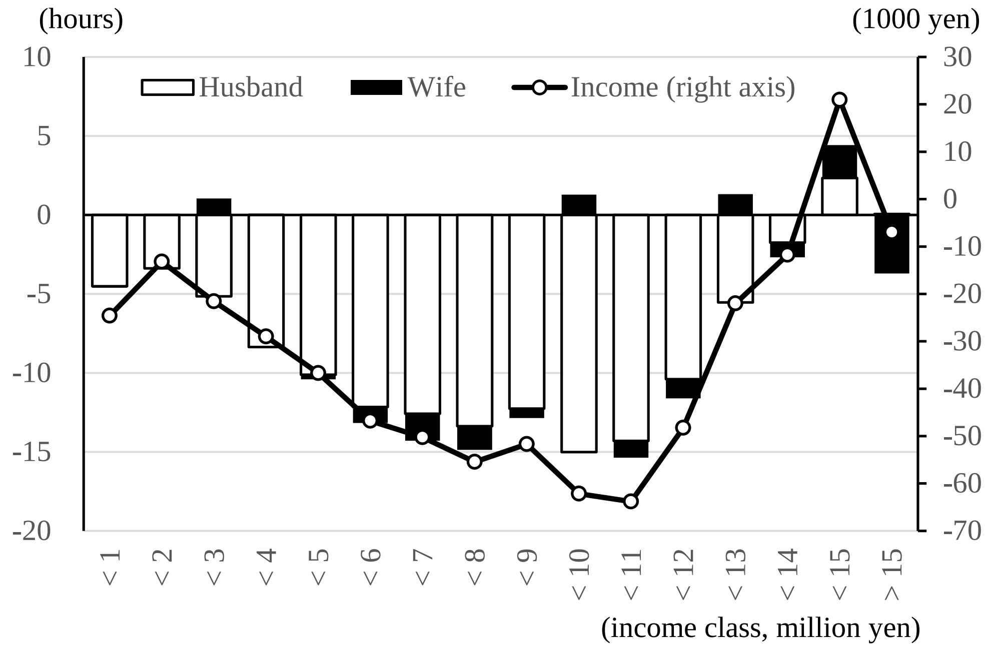

Figure 3. Effects on after-tax income (translog utility function)

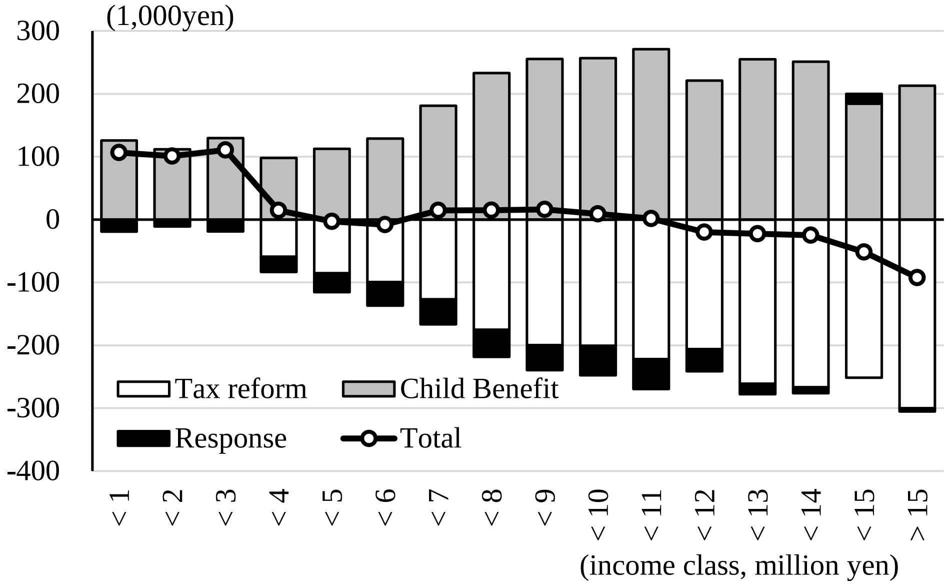

Table 6. Effects on after-tax income and net tax payment

Utility	Reform	labor supply		Before-tax	After-tax income		Net tax payment		
		husband	wife	income	Response	Total	Response	Total	share
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(7)/(1)
unit	1000yen	Hours	Hours	1000yen	1000yen	1000yen	1000yen	1000yen	%
Translog	-44.15	-11.47	-0.83	-45.55	-35.97	8.17	-9.58	-53.72	21.69
Quadratic	-44.56	-0.92	1.46	-3.75	-3.19	41.37	-0.56	-45.12	1.26

Note: Results are based on the specification with random effects. Only for those who satisfy monotonicity

Figure 4. Changes in utility: proportion of households whose utility do not go down

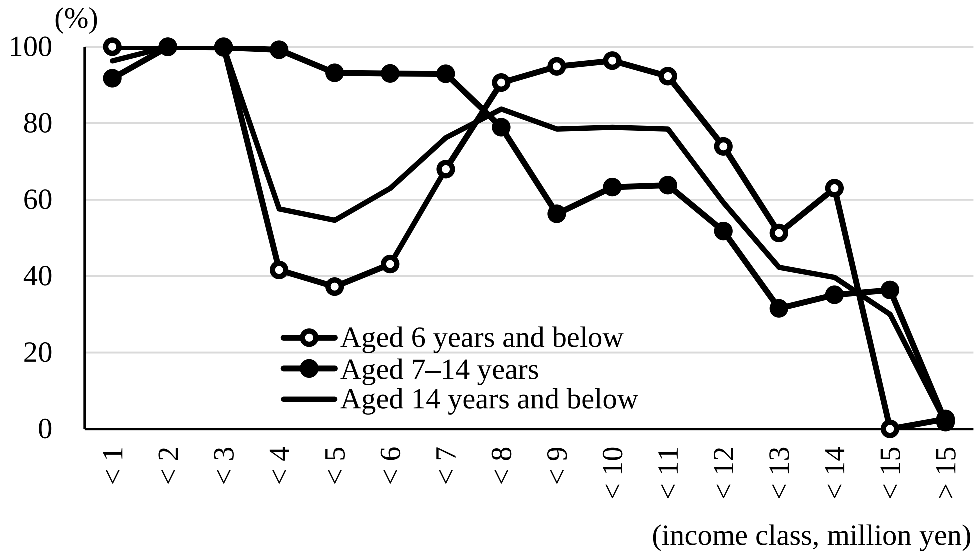

Table A-1. Estimation results: Quadratic utility function

	βx				βh		βw	
	Husband		Wife		Husband		Wife	
Constant	3.921	***			1.980	***	0.919	***
	(0.832)				(0.297)		(0.153)	
×(aged 30-34)	-0.533		0.636	***	-0.244		0.063	
	(1.044)		(0.218)		(0.337)		(0.142)	
×(aged 35-39)	-0.367		0.245		-0.144		-0.092	
	(0.777)		(0.180)		(0.262)		(0.131)	
×(aged 40-44)	-0.246		0.241		0.023		0.021	
	(0.596)		(0.166)		(0.218)		(0.127)	
×(aged 45-49)	0.251		0.188		0.098		0.021	
	(0.500)		(0.156)		(0.197)		(0.126)	
×(aged 50-44)	-0.533		0.318	**	-0.087		-0.069	
	(0.441)		(0.159)		(0.185)		(0.132)	
×(junior high)	1.826		-0.111		0.239		-0.386	***
	(1.156)		(0.204)		(0.391)		(0.149)	
×(high school)	-0.166		-0.067		-0.068		-0.209	***
	(0.604)		(0.076)		(0.176)		(0.045)	
×(University)	-0.352		-0.180		0.003		-0.243	***
	(0.338)		(0.120)		(0.106)		(0.063)	
×(children aged 0-6)	-0.812	**			-0.331	**	0.184	***
	(0.410)				(0.132)		(0.066)	
×(children aged 7-14)	-0.672	**			-0.236	**	0.070	
	(0.295)				(0.095)		(0.045)	
×(children aged 15+)	-1.257	***			-0.354	***	-0.018	
	(0.312)				(0.111)		(0.053)	
×(Urban area)	-0.930	**			-0.232	*	-0.180	***
	(0.382)				(0.131)		(0.067)	

Table A-1. Estimation results: Quadratic utility function (continued)

	βxx				βhh		βww	
	Husband		Wife		Husband		Wife	
Constant	-0.060	***			-0.016	***	-0.002	
	(0.016)				(0.002)		(0.001)	
×(aged 30-34)	0.013		-0.011		0.003		-0.001	
	(0.027)		(0.007)		(0.003)		(0.001)	
×(aged 35-39)	0.012		-0.007		0.002		0.000	
	(0.019)		(0.005)		(0.002)		(0.001)	
×(aged 40-44)	0.015		-0.011	***	0.000		-0.001	
	(0.014)		(0.004)		(0.002)		(0.001)	
×(aged 45-49)	0.001		-0.008	**	0.000		-0.001	
	(0.010)		(0.004)		(0.002)		(0.001)	
×(aged 50-44)	0.019	**	-0.008	**	0.001		0.000	
	(0.008)		(0.003)		(0.001)		(0.001)	
×(junior high)	-0.051	*	0.000		-0.001		0.004	***
	(0.027)		(0.005)		(0.003)		(0.001)	
×(high school)	0.003		-0.002		0.000		0.002	***
	(0.016)		(0.002)		(0.001)		(0.000)	
×(University)	0.008		0.002		-0.002	*	0.002	***
	(0.008)		(0.003)		(0.001)		(0.001)	
×(children aged 0-6)	0.014				0.002	**	-0.003	***
	(0.009)				(0.001)		(0.001)	
×(children aged 7-14)	0.013	**			0.001	*	-0.002	***
	(0.006)				(0.001)		(0.000)	
×(children aged 15+)	0.020	***			0.001	*	-0.002	***
	(0.006)				(0.001)		(0.000)	
×(Urban area)	0.015	**			0.001		0.000	
	(0.008)				(0.001)		(0.000)	

Table A-1. Estimation results: Quadratic utility function (continued)

	βxh		βxw		βhw			
	Husband		Wife		Husband		Wife	
Constant	-0.039	***	-0.031	***	-0.010	***		
	(0.011)		(0.003)		(0.001)			
×(aged 30-34)	0.010		-0.006		-0.001	***	0.001	
	(0.016)		(0.004)		(0.000)		(0.001)	
×(aged 35-39)	0.008		0.003		-0.001	***	0.002	***
	(0.011)		(0.003)		(0.000)		(0.001)	
×(aged 40-44)	0.004		0.002		-0.001	***	0.001	**
	(0.009)		(0.003)		(0.000)		(0.001)	
×(aged 45-49)	-0.001		0.002		0.000	**	0.001	**
	(0.007)		(0.002)		(0.000)		(0.001)	
×(aged 50-44)	0.010		0.001		0.000		0.002	***
	(0.006)		(0.002)		(0.000)		(0.001)	
×(junior high)	-0.032	*	0.003		0.000		0.001	
	(0.018)		(0.004)		(0.000)		(0.001)	
×(high school)	0.002		0.001		0.000		0.000	
	(0.009)		(0.001)		(0.000)		(0.000)	
×(University)	0.005		0.002		0.001	***	0.000	
	(0.005)		(0.002)		(0.000)		(0.000)	
×(children aged 0-6)	0.012	**	0.004	**	0.002	**		
	(0.005)		(0.002)		(0.001)			
×(children aged 7-14)	0.007	*	0.003	**	0.001	***		
	(0.004)		(0.001)		(0.001)			
×(children aged 15+)	0.013	***	0.008	***	0.003	***		
	(0.004)		(0.001)		(0.001)			
×(Urban area)	0.009	**	0.006	***	0.002	***		
	(0.005)		(0.002)		(0.001)			
	βhf		βwf		sd(βx)			
	Husband		Wife					
Constant	-2.462	***	-1.795	***	-0.016			
	(0.122)		(0.053)		(0.039)			
×(children aged 0-6)	0.039		-0.864	***				
	(0.119)		(0.062)					
Log likelihood	-63546.3							

Table A-2. Estimation results: Translog utility function

	βx				βh		βw	
	Husband		Wife		Husband		Wife	
Constant	-3.959				95.839	***	55.386	**
	(7.628)				(18.418)		(22.385)	
×(aged 30-34)	15.889	**	3.608		12.221		23.306	
	(7.765)		(3.482)		(20.086)		(20.999)	
×(aged 35-39)	18.343	***	-2.710		20.435		3.548	
	(6.845)		(2.982)		(17.163)		(19.549)	
×(aged 40-44)	19.084	***	1.688		37.605	**	22.127	
	(6.340)		(2.911)		(15.610)		(19.080)	
×(aged 45-49)	19.775	***	2.294		24.655	*	19.052	
	(5.782)		(2.847)		(14.215)		(18.792)	
×(aged 50-44)	14.536	**	6.870	**	34.217	**	10.462	
	(5.791)		(3.120)		(14.070)		(19.722)	
×(junior high)	-0.240		-5.335	*	-11.506		-61.709	***
	(5.308)		(3.130)		(14.311)		(20.890)	
×(high school)	-1.265		2.859	**	-4.358		-29.202	***
	(3.448)		(1.315)		(10.985)		(6.691)	
×(University)	-1.623		9.790	***	21.382	***	-23.352	***
	(2.508)		(1.985)		(7.246)		(9.055)	
×(children aged 0-6)	-0.411				-5.172		49.697	***
	(2.397)				(7.622)		(9.502)	
×(children aged 7-14)	-3.906	**			-15.243	**	14.590	**
	(1.956)				(6.051)		(6.250)	
×(children aged 15+)	-5.376	*			1.567		19.932	***
	(2.827)				(7.739)		(7.539)	
×(Urban area)	-0.976				-2.791		11.410	
	(2.663)				(8.307)		(9.248)	

Table A-2. Estimation results: Translog utility function (continued)

	β_{xx} Husband		Wife		β_{hh} Husband		β_{ww} Wife	
Constant	-0.044	**			-10.820	***	-1.385	
	(0.018)				(1.952)		(2.624)	
×(aged 30-34)	0.041	**	0.011		0.158		-3.004	
	(0.018)		(0.013)		(2.371)		(2.665)	
×(aged 35-39)	0.031	*	0.030	**	-0.780		-0.830	
	(0.016)		(0.012)		(2.002)		(2.482)	
×(aged 40-44)	0.018		0.025	**	-3.234	*	-3.021	
	(0.015)		(0.012)		(1.811)		(2.419)	
×(aged 45-49)	0.042	***	0.028	**	-1.356		-2.601	
	(0.015)		(0.012)		(1.652)		(2.382)	
×(aged 50-44)	0.019		0.016		-3.212	**	-1.156	
	(0.014)		(0.013)		(1.620)		(2.493)	
×(junior high)	-0.030	***	-0.001		1.352		7.701	***
	(0.010)		(0.013)		(1.682)		(2.669)	
×(high school)	0.003		0.014	**	0.382		3.834	***
	(0.012)		(0.006)		(1.413)		(0.844)	
×(University)	0.003		0.018	*	-3.464	***	3.496	***
	(0.009)		(0.010)		(0.911)		(1.121)	
×(children aged 0-6)	0.017	**			0.466		-6.824	***
	(0.007)				(0.787)		(1.033)	
×(children aged 7-14)	-0.002				0.640		-3.059	***
	(0.005)				(0.635)		(0.619)	
×(children aged 15+)	0.008				-2.090	***	-4.613	***
	(0.008)				(0.809)		(0.754)	
×(Urban area)	0.015	**			0.024		-2.826	***
	(0.007)				(0.832)		(0.904)	

Table A-2. Estimation results: Translog utility function (continued)

	βxh		βxw		βhw			
	Husband		Wife		Husband		Wife	
Constant	5.470	***	-4.625	***	-8.693	***		
	(1.636)		(0.863)		(1.681)			
×(aged 30-34)	-3.807	**	-0.821		-0.489	***	0.339	**
	(1.883)		(0.860)		(0.137)		(0.154)	
×(aged 35-39)	-4.413	***	0.763		-0.453	***	0.470	***
	(1.657)		(0.739)		(0.119)		(0.146)	
×(aged 40-44)	-4.638	***	-0.307		-0.287	***	0.535	***
	(1.533)		(0.722)		(0.109)		(0.146)	
×(aged 45-49)	-4.735	***	-0.444		-0.163		0.552	***
	(1.396)		(0.708)		(0.101)		(0.145)	
×(aged 50-44)	-3.527	**	-1.611	**	-0.081		0.482	***
	(1.397)		(0.775)		(0.096)		(0.152)	
×(junior high)	-0.058		1.303	*	-0.112		0.083	
	(1.287)		(0.785)		(0.074)		(0.165)	
×(high school)	0.323		-0.660	**	0.101		0.097	*
	(0.833)		(0.326)		(0.071)		(0.059)	
×(University)	0.413		-2.360	***	0.539	***	0.064	
	(0.607)		(0.487)		(0.052)		(0.094)	
×(children aged 0-6)	0.081		0.092		0.484			
	(0.488)		(0.383)		(1.011)			
×(children aged 7-14)	0.555		0.397		2.180	***		
	(0.407)		(0.293)		(0.782)			
×(children aged 15+)	0.144		1.196	***	3.361	***		
	(0.590)		(0.363)		(0.977)			
×(Urban area)	-0.760		1.059	**	1.519			
	(0.532)		(0.427)		(1.120)			
	βhf		βwf		sd(βx)			
	Husband		Wife					
Constant	-2.410	***	-1.772	***	-0.008			
	(0.128)		(0.048)		(0.058)			
×(children aged 0-6)	-0.377	***	-0.863	***				
	(0.135)		(0.056)					
Log likelihood	-63646.5							