Economic Studies of Taxation in Japan: The Case of Personal Income Taxes*

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Abstract

We argue that tax policy in Japan is on a shaky empirical ground. First, until recently, no serious attempts had been made to estimate labour responses to taxation, especially with respect to prime-age male workers. Second, while there is some stock of empirical analysis on labour supply response of female workers, few studies have appropriately allowed for the budget constraint structure implied by the tax system. Third, as a corollary, there is not a reliable stock of empirical estimates to quantify the frequently employed concepts of "disincentives to work" or "distortion." Forth, despite this paucity of empirical estimates, there are a number of tax simulation studies, most of which are relied on arbitrary sets of labor response elasticities and other related parameter values. Given this state of the literature, we introduce our estimates, and calculate the degree of distortion using the concept of the marginal cost of public funds.

1 Introduction

Tax reform involves winners and losers, and as such, frequently faces difficult political obstacles in democracy. However, sound reasoning and constructive dialogues should

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help making a progress toward better reform and economic policy. Economic theory seems to have contributed to policy dialogue concerning the reform of the Japanese tax system. For example, in the report submitted to the Prime Minister, the Tax Commission (2002) lists 'five viewpoints for establishment of a desirable tax system' as follows:

- Taxation should not distort free economic activities.
- Tax treatments that cause distortion and a sense of inequity in the tax system should be rationalized.
- Tax system should be simple and easily understandable for taxpayers.
- Tax system should provide stable revenue structure.
- Local taxation should meet needs of enhanced local autonomy.

With the word of 'distortion' as a prime example, economic thinking is apparent in the statements above. In fact, the Japanese government has made 'flatter' its personal income tax system in a series of tax reform. For example, the system of national personal income tax had 19 brackets with the top marginal tax rate of 0.75 in 1975.[1] After a series of tax "reforms," the tax system is "simplified." The number of brackets is reduced to as few as four, and the marginal tax rate of the top bracket is reduced to as low as 0.37. The detail of the tax system over time is provided in Table 1. The key words for the series of tax reduction included "incentives to work" and "neutrality (no distortion)"[2] As these catch copies indicate, modern economic thoughts played a force.

Table 1

Sound economic policy requires a proper understanding of economic theory as well as a rich stock of empirical analysis. One of the purposes of this paper is to examine if such condition holds for the case of Japanese personal income taxation. In other words, we will examine if policy debates concerning income tax reform in Japan were based on evidence substantiated by solid empirical studies on the Japanese economy.

[1] Note that this excludes local income taxes that shares the same personal income as a base, which made the effective top marginal tax rates hike up to 0.89.

[2] Another catch copy is "the vitalization of the economy".

An easy way to do that is to survey what Japanese economists provided in the relevant areas of economic studies, which we will do in what follows.

We argue in this paper that the tax studies in Japan are characterized as follows. First, until recently, no serious attempts had been made to estimate labour responses to taxation, especially with respect to prime-age male workers. Second, while there is some stock of empirical analysis on female labour supply, no studies, except the recent study by Akabayashi (2004), have appropriately allowed for the budget constraint structure implied by the Japanese income tax system. Third, as a corollary of the first two, there is not a large and reliable stock of empirical estimates to quantify the frequently employed concepts of "disincentives to work" or "distortion." Forth, despite a paucity of empirical estimates, there are a number of tax simulation studies, which necessarily rely on arbitrary sets of labour response elasticities and other relevant parameter values. We will therefore claim that tax policy in Japan is on a rather shaky ground.

We further speculate that this would be due to a unique separation of labour economists and public economists in Japan. While many labour economists do not seriously consider how taxes affect the behaviour of consumers through changes in their budget constraints[3], many public economists tend to believe that labour is responsive to taxes without confirming empirical evidence. Another contributing factor to this sad state of the art is a lack of reliable micro-data base. The central government does conduct large scale surveys regularly, but obtaining the *permission* to use original micro data set is difficult, if not possible, unless a researcher has a strong tie with the central government bureaucracy.[4] Independently surveyed data sets are growing. But the size and scope of the data base might not be good enough to obtain reliable results.

We, however, had the chance to access the micro-data from *Syugyo Kozo Kihon Chosa* [Employment Status Survey] by the Statistical Bureau of the Japanese Government, arguably the most comprehensive labour survey in Japan. The survey, conducted every five years, contains a large sample of approximately 11 million individual observations with a variety of household characteristics. Taking advantage of this data set, we estimated the labour supply function of prime-age males (Hayashi

[3] An exception would be Akabayashi (2004), who has also utilized the Hausman method we use in this paper.

[4] Even if you are so, obtaining the data requires cumbersome procedures and screening, as we actually did experienced.

and Bessho 2004, Bessho and Hayashi 2005). In this paper, we will utilize these estimates we obtained in the said studies to see how distortionary the Japanese personal income taxes are. The measure of distortion we use is marginal one: the marginal cost of public funds (MCPF) which shows the net welfare loss of a consumer caused by a unit increase of their tax burden.

Our arguments in this paper develop as follows. In the next section (section 2), we set up a base-line model to discuss the distortionary effects of labour income tax, and present a formla for the MCPF. In section 3, we then survey the empirical literature on labour responses to tax chagnes, and summerize the state of the art in Japan. In setion 4, we proceed to examine the tax simulation literature that deals with welfare effects of a tax reform. In section 5 we introduce our empirical studies on labour supply and utilize our estimates to calculate the MCPFs.

2 Labour-income tax and distortion

2.1 Base-line model

Modern public economics shows that an increase in tax on a tax base leads to a loss in individual welfare, over and above the loss equivalent to the increased tax payments, to the extent that the tax base is responsive to price changes. In a simple partial equilibrium diagram for labour market as Figure 1, the lost welfare corresponds to what is called the Harberger triangle (ABC), defined as an area surrounded by a vertical line that corresponds to a difference between before-tax wage rate and after-tax wage rate (AB), horizontal labour demand (DD) and upward labour supply curve (SS). As the figure shows, the size of the triangle (lost welfare) is dependent on the degree of responsiveness of labour supply to a change in after-tax wage rate.[5]

Figure 1

Rather than looking at the amount of lost welfare, however, it may also be instructive to see marginal changes in welfare when additional tax revenue is raised from an individual worker. Such a welfare measure is called the *marginal cost of public funds* or MCPF. The MCPF then shows the marginal degree of distortion, and may be conceptualized as follows for the case of labour income taxes.

[5]Note that for simplicity we are assuming that labour demand is perfectly elastic.

Individual i consumes a numeráire x_i and leisure l_i to obtain utility $U_i = u_i(x_i, l_i)$.[6] His net wage rate (after-tax wage rate) is given as $w_i = (1 - m_i)W_i$ where W_i is gross wage rate (before-tax wage rate) and m_i is marginal tax rate individual i faces. His time endowment is expressed as T so that his hours worked is given as $h_i = T - l_i$. The tax codes may grant him tax credits and exemptions which, with an assumption of no no-labour income, constitute virtual income y_i, the "intercept" for a linear budget line with slope w_i tangent on his consumption point[7]. We therefore obtain individual i's indirectly utility function as

$$V_i(w_i, y_i) \equiv \max_{x_i, h_i} \{U(x_i, l_i) \mid x_i + w_i l_i = I_i,\ I_i \equiv w_i T + y_i, h_i \leq T\}. \tag{1}$$

We then express revenue raised from individual i as R_i, and average tax rate a_i is given as

$$a_i \equiv \frac{R_i}{W_i h_i}. \tag{2}$$

The MCPF is then defines as

$$\mathrm{MCPF} \equiv \frac{\mathrm{d}V_i/(\partial V_i/\partial I_i)}{\mathrm{d}R_i}. \tag{3}$$

Note that this definition uses income/consumption as a numeráire. As such, to the extent that MCPF exceeds unity, we see that there will be a higher degree of distortion caused by a unit increase in tax revenue.

Given (1) – (3) and some mathematical manipulations, we obtain the following expression where the second term shows the degree of marginal distortion:

$$\mathrm{MCPF} \equiv 1 + \left(\eta_i^c \frac{\mathrm{d}m_i}{\mathrm{d}a_i} + \phi_i\right) \cdot \left(\frac{1-m}{m} - \eta_i^c \frac{a_i}{m_i} \frac{\mathrm{d}m_i}{\mathrm{d}a_i} - \phi_i\right)^{-1} \tag{4}$$

where $\eta_i^c \equiv (\partial h_i/\partial w_i|_u)(w_i/h_i)$ is the compensated wage elasticity of labour and $\phi_i \equiv w_i \partial h_i/\partial I_i$ is what we call income effect. Note that the uncompensated wage elasticity of labour is given as $\eta_i \equiv (\partial h_i/\partial w_i)(w_i/h_i) = \eta_i^c + \phi_i$. As this formula shows, the distortion depends on labour response to labour-price (wage) change as well as level of tax rate.[8] Specifically, we expect more distortion to the extent that labour

[6] We follow Dahlby (1998) to set aside the revenue effect of public services in calculating MCPF. We therefore set the level of public service fixed in our analysis so that it does not appear in our expression of utility function.

[7] The linear budget constraint can account for a piece-wise linear budget under the progressive income tax system. When choices are made off the kinks of the piece-wise linear budget constraint, the constraint can be represented as a linear budget constraint with slope w_i and virtual income y_i.

[8] We are assuming away for simplicity the demand side of labour market by assuming that the price elasticity of labour demand is infinity. Of course, we can relax this assumption and derive the corresponding formula accordingly. For a more complete analysis, see Snow and Warren (1996).

supply is responsive to tax changes. The labour response consists of two components: substitution effect and income effect, i.e., $\eta_i^c > 0$ and ϕ_i. The latter expression is negative if leisure is normal. This then directs us to the empirical literature on labour supply response which estimates these two values for the Japanese economy. Are we equipped with reliable empirical evidence to evaluate welfare loss caused by our tax system?

3 Empirical studies on labour supply in Japan

Unfortunately, there are a relatively small number of empirical studies on labour responses in Japan. Except our studies to be cited later, we have found only 21 published studies that explicitly estimate the wage effects on labour supply, which are summarized in Table 2. Among them nine studies employed micro-data (Shimada and Sakai 1980, Higuchi and Hayami 1984, Okamoto 1988, Takayama and Arita 1992, Abe and Ohtake 1995, Ogawa and Ermisch 1996, Nagase 1997, Ohishi 2003, Akabayashi 2004), while the others utilized macro data aggregated either at national or prefectural level. Among the latter group, only Okamoto (1984), Asano (1997) and Yamada et al. (1999) consider hours worked as a dependent variable, whereas the others utilized aggregate labour participation ratio.

Table 2

There are two distinctive features of these Japanese labour response studies. First, none of them properly consider the effect of tax system on the budget constraint of consumers with an exception of Akabayashi (2004). Second, little interest has been shown in the labour supply of prime age male workers. We will elabourate on these two features as follows.

3.1 Consideration of personal income tax system

The most important regressor in the labour response study is wage rate. Among the 21 studies, only Akabayashi (2004) properly allows for the effects of personal income taxes on a consumer's budgent constraint. While Okamoto (1984) uses net-wage rate, 17 studies employ gross wage rate and the remaining two (Yamada et al. 1999, Okamoto 1988) do not provide any explanation if their wage rates are net or gross. This should pose a problem since using the gross rate yields a quite different interpretation of the wage coefficient as follows (Blomquist 1988, Blomquist and Hasson-Brusewitz 1990).

Under a typical personal income tax system, revenue raised from individual i is conditioned on his/her earnings $W_i h_i$, non-labour income N_i, and other household characteristics $\mathbf{Z}_i$:

$$R_i = R(W_i h_i, N_i, \mathbf{Z}_i).$$

When we compare the above expression to the optimization problem (1), we have the following correspondence:

$$R(W_i h_i, N_i, \mathbf{Z}_i) = m_i\left(W_i h_i, N_i, \mathbf{Z}_i\right) \cdot W_i h_i + y_i\left(W_i h_i, N_i, \mathbf{Z}_i\right)$$

where $m_i(\cdot)$ and $y_i(\cdot)$ indicate that marginal tax rate as well as effective non-labour income may depend on labour income, non-labour income and household characteristics. Formulated as such, we obtain a function given as

$$h_i = Q(W_i, N_i, \mathbf{Z}_i) \equiv \arg\max_{h_i} \left\{U\left(W_i h_i + N_i - R(W_i h_i, N_i, \mathbf{Z}_i), T - h_i\right)\right\} \tag{5}$$

which is an optimal labour supply as a function of gross-wage rate, non-labour income and household characteristics.

It is then evident that labour supply function that contains gross wage rate as a explanatory variable mixes the structure of individual preferences $U(\cdot)$ and that of tax revenue function $R(\cdot)$, and so dose the coefficient on gross wage rate $\partial Q_i/\partial W_i$. As such, the function is not what we call labour supply function, a function that reflects only consumer's preferences. Rather, (5) shows how labour responds to a change in gross wage rate *when the tax structure is held fixed.* Therefore, it is invalid to use the estimates from (5) in a tax reform simulation where we want to see the effect of *a change in tax structure.*

Furthermore, taking account of only net-wage rate like Okamoto (1984) falls short of an appropriate specification. Given the progressivity of personal income tax, the budget constraint of a consumer is not linear in the textbook sense without a due consideration of "intercept." As Hall (1973) shows, the budget constraint is piece-wise linear, with kinks defined by brackets of the tax system and net-wage rates of the consumer. If individuals consume off those kinks, the piece-wise linear budget line can be represented by the linear budget line with slope w_i and virtual income y_i, the later of which of course depends on parameters implied by relevant tax codes. See Figure 2. Only Akabayashi (2004) allows for this type of piece-wise linearity of the budget constraint.

Figure 2

Therefore, most of the Japanese studies should be inappropriate for the evaluation of tax reform. This state of the art is rather surprising, since Japanese economists are very sensitive to what are developing with their counterparts in the United States, and keen to absorb new ideas willingly. Note that these empirical studies were conducted after mid 1980s. By that time, the celebrated paper by Burtless and Hausman (1978) and several other important contributions had been widely known. And it should have been the common understanding in the literature that a proper consideration of the effects of tax codes on consumers' budget constraints would be an essential part of the estimation of labour supply function.

3.2 Labour supply of prime-aged male

The major sources of personal income taxation include prime-age males, which constitutes more than a majority of total earnings in Japan. However, Japanese labour economists have paid as little attention to prime-age male. This may partly be due to the fact that they may have believed that it would be evident that prime-age males would not respond to leisure prices, and that as such, the study of such labour is of less interest. Such a view is strongly reflected by the group of labour economists associated with Keio University, among whom Higuchi and Hayami (1984) is an example. They are typically critical of the standard neoclassical model of labour-leisure choice where consumers can freely choose their consumption of leisure (supply of labour) for a given level of leisure price (net wage). The dominant model has been what they call *designated labour hour model*, which postulates that consumers can only either reject or accept a job which designates a given length of labour under a given value of wage rate. In other words, consumers cannot freely choose the length of labour. Labour is fixed and no welfare loss follows.

We know however that the typical neoclassical model does not necessarily require consumers to be able to freely choose working-hours for a given level of wage rate. In fact, the neoclassical model can also be regarded as an approximation to a situation where consumers can freely choose among sets of working-hours and wage rates (e.g., Blundell and MaCurdy 1999). Of course, this may require an environment where, on average, a worker can change his jobs without "frictions" once he sees that his set of working-hours and wage rate is less than optimal and finds another set which is better than the current one.

We may still argue that the popular view of the Japanese-style employment may have dominated the minds of labour economists and led them to believe that even the above interpretation of the neoclassical model would be invalid especially for prime-age male workers. The popular view characterizes the Japanese-style employment with *lifetime employment* and *seniority-based wage system*, which seems to hardly fit the profile of the neoclassical labour supply model. However, such a popular view is partly a myth. The Japanese-style employment mainly applies to those employed in large established corporations, not necessarily to a majority of those in small and medium sized enterprises (SMEs). Only 46.5% and 40.0% of prime-age males in SMEs are respectively under lifetime employment and the seniority-based wage system. Given that the SMEs occupy about 70% of the Japanese total employments, it is difficult to claim that the neoclassical model does not fit the Japanese labour market better than it does the North-American or European counterparts.[9]

4 Tax simulations in Japan

Applied general-equilibrium (AGE)[10] modelling is a useful tool for a tax simulation with which we can numerically examine welfare effects of a given tax reform (Shoven and Whalley 1992). In an AGE model, an economy in an equilibrium is translated into a system of equations. These equations include demand and supply functions derived from optimization problems where consumers and firms maximize their objectives (utility and profits) for a given set of prices, taxes and other relevant variables that face them. Once we have constructed the system of equations where individual behavior and optimization are embedded, an equilibrium is found as a solution to a system of equations. The solution constitutes a set of endogenous variables which are then functions of given set of values of exogenous parameters, which include taxes.

A series of tax simulation in Japan was initiated and has been conducted by a group of economists associated with Osaka University and Kwansei Gakuin University (Honma et al. 1985, Honma et al. 1987, Hashimoto et al. 1989, Honma 1991, Yamada 1991, Konishi 1997, Hashimoto 1998, Uemura 2001). They constitute the main stream of the Japanese tax simulation studies, and the lead figure of the group (Honma) has been one of the most influential economists in Japanese public policy making.

[9] Given that these figures are a little outdated (the figures are for 1986), and that these two characteristics have been eroding recently, the claim should be even more difficult to assert now.

[10] This is also called computable general equilibrium (CGE) model.

Labour supply function is, of course, one of the important equations in the system for a tax simulation with an AGE model. When an effect of personal income tax is examined, we are to see how an exogenous change in that tax would disturb an existing equilibrium and yield a new one. Again, how labour supply responds is an important ingredient in this sort of simulation and, as such, it will be instructive to review how the above-cited simulation studies model the labour response.

4.1 The characterization of labour supply

A majority of the simulation studies (Honma et al. 1987, Hashimoto et al. 1989, Honma 1991, Hashimoto 1998) follows a common framework.[11] They assume that there are n_j identical agents within income class j with identical preferences of the CES type:

$$U_j = \left[(1-\alpha) \cdot x_j^{-\frac{1-\varepsilon_j}{\varepsilon_j}} + \alpha \cdot (T - h_j)^{-\frac{1-\varepsilon_j}{\varepsilon_j}} \right]^{-\frac{\varepsilon_j}{1-\varepsilon_j}} \tag{6}$$

where x_j is a composite good (numeraire), T is an endowment of leisure, h_j is labour, $\alpha \in (0,1)$ is a weight on leisure consumption and ε_j is constant elasticity of substitution. The budget constraint is given as

$$x_j = (1 - m_j) W_j h_j - m_j W_j h_j + y_j \tag{7}$$

with notation explained in the previous sections.

From the above setup, the following labour supply is derived

$$h_i = \frac{T - \left(\frac{1-\alpha}{\alpha}\right)^{-\varepsilon_j} w_j^{-\varepsilon_j} y_j}{1 + \left(\frac{1-\alpha}{\alpha}\right)^{-\varepsilon_j} w_j^{1-\varepsilon_j}} \tag{8}$$

where $w_j \equiv (1 - m_j) W_j$. Uncompensated elasticity $\eta_i \equiv (\partial h_i / \partial w_i)(w_i / h_i)$, income effect $\phi_i \equiv w_i \partial h_i / \partial I_i$ and compensated elasticity $\eta_i^c = \eta_i - \phi_i$ follows from (8). We then see that the labour response depends on (a) preference parameters (α, ε_j), (b) actual tax system (m_j, y_j), and (3) net-wage rates w_j.

4.1.1 Preference parameters

The leisure share is set as $\alpha = 0.000001$. Given this value, the elasticity of substitution was calculated from the first order condition from the optimization of (6) subject to

[11] They also employ another specification which allows for intertemporal substitutions. Since the point is made with the simpler model in the text, we simply forgo the intertemporal version of the simulation model.

(7) as:

$$\varepsilon_j = [\ln x_j - \ln (T - h_j)] \cdot \left\{ \ln \left[\left(\frac{\alpha}{1-\alpha} \right) \cdot (1 - m_j) \cdot W_j \right] \right\}^{-1} \tag{9}$$

which requires actual values of consumption x_j, labour h_j, marginal tax rate m_j and gross-wage rate W_j.

4.1.2 Gross wage and labour

Gross wage and labour are calculated with several specific assumptions. They assume that gross wage W_j is proportional to ability Q_j with coefficient W ($W_j = WQ_j$), and that ability Q_j equals of a natural log of total income Y_j ($Q_j = \ln Y_j$). Furthermore, the coefficient W, or gross wage per ability, takes on a common value across income classes as $W = E_H/(0.5 \ln Y_H)$ where E_H and Y_H respectively denote earned income and total income for the top income class H. Finally, labour supply is calculated as

$$h_j = 0.5 \cdot \frac{E_j}{E_H} \cdot \frac{\ln Y_H}{\ln Y_j} \tag{10}$$

which takes advantage of the relations $E_j = W_j h_j$, $W_j = WQ_j$, $Q_j = \ln Y_j$, and $W = E_H/(0.5 \ln Y_H)$.

4.1.3 Tax system

The income tax system is assumed to be linear, and characterized with a set of single marginal tax rate m and tax base exemption z, both of which are assumed to be common across income classes. Individual tax burden R_j is then specified as

$$R_j = mW_j h_j - y \tag{11}$$

where $y = mz$. The estimates for m and z are obtained as least square estimates from a cross section of per capita R_j and $E_j = W_j h_j$ across income classes.

4.2 Critiques

The tax simulation studies based on the above setup have a scant empirical basis. First, the only empirical basis is found in setting the value for the leisure share α, but the evidence itself may be invalid for tax simulation. Honma et al. (1987) argue that their leisure share $\alpha = 0.000001$ is obtained with reference to Shimada and Sakai (1980). However, since Shimada and Sakai (1980) do not provide estimates for prime-age males, and Honma et al. (1987) do not elabourate on the details of their procedure, we are not sure what sort of estimates were actually referred to. Even if the reference is made correctly, the estimates by Shimada and Sakai (1980) should not be used for a tax reform simulation, since their study is, as we have argued in the previous section, one of the studies that do not appropriately allow for the piece-wise structure of personal income tax system.[12]

Second, the values for gross wages and labour hours are assumed, rather than observed or statistically estimated. As we saw above, wages and labour hours are calculated with a specific assumption of efficiency wage and, specifically the latter are dependent on relative magnitudes of income variables of a given income class to those of the top income class. All values depend on the assumption that $W_j = \ln Y_j E_H / (0.5 \ln Y_H)$. But no empirical justification for this specification was provided. In addition, readers would wonder how the calculated values for (10) fare with other estimated labour hour (8) or actually observed one. And the same applies to the comparison between calculated gross wage $W_j = \ln Y_j E_H / (0.5 \ln Y_H)$ and the actual distribution of gross wage. Such a comparison was not explicitly made either.

Third, the tax system specified in the simulation does not reflect the actual Japanese income tax system. As we have described in the previous section, the actual income tax system yields a piece-wise linear budget constraint which takes on a rather complicated form depending on the tax codes. Any tax reform simulation would start from the tax system in place and see how welfare changes after a change is made to the existing tax system. Such a simulation should require an appropriate representation of the actual tax system. For example, an increase in a marginal tax rate in a given bracket reduces the virtual incomes for those who consume in the upper brackets. The linear budget implied by (11) apparently does not allow for such a change.

5 How distortionary Japanese income taxes are?

We have so far shown, as anticipated in Introduction, that (1) no serious attempts have been made to estimate labour responses to taxation, especially with respect to prime-age male workers; (2) few empirical studies have appropriately allowed for the budget constraint structure implied by the Japanese income tax system; and (3) most of the tax simulations rely on arbitrary assumptions and parameter values. As such,

[12] In the studies that follow (e.g., Honma 1991, Hashimoto 1998), the same value of $\alpha = 0.000001$ is used, but without any explanation why such a value is employed.

we may be allow to argue that we do not have reliable empirical evidence to justify the frequently employed concepts of "disincentives to work" or "distortion."

We speculate that this sad state of the art would be due to a unique separation of labour economists and public economists in Japan. While many labour economists may not care much about the intricacies of the tax system, many public economists tend to believe that labour is responsive to taxes without confirming empirical evidence. Another contributing factor is a lack of reliable micro-data base. The central government does conduct a large scale survey regularly, but obtaining the *permission* to use original micro data is difficult and cumbersome, if not possible, unless a researcher has a strong tie with the central government bureaucracy. Independently surveyed data sets are growing. But the size and scope of the data base might not be enough to obtain reliable results.

We therefore may not emphatically justify our criticism against the tax studies in Japan as we did in the previous sections. After all, as we have argued, the Japanese tax simulation studies cannot rely on labour economists for reliable preference parameters. And, the labour economists do not have an easy access to reliable data that contain prime-age male workers as well as detailed household information.

The data source we have in mind here is *Syugyo Kozo Kihon Chosa* [Employment Status Survey] conducted by the Statistical Bureau of the Japanese Government. This is the most comprehensive labour survey in Japan. The survey, conducted every five years, contains a large sample of approximately 11 million individual observations with a variety of household characteristics. We had the chance to access the micro-data from the survey and estimate the labour supply function of prime-age males (Hayashi and Bessyo 2004, Bessho and Hayashi 2005). In what follows, we utilize the estimates we obtained in the said studies to see how distortionary the Japanese personal income taxes were at the time of the survey (i.e., 2002). The measure of distortion we use is marginal one. That is, we employ the marginal cost of public funds (MCPF) derived as equation (4) to measure how distortionary the Japanese personal income taxes are.

5.1 Estimation

We have chosen the Hausman method which utilizes the principle of maximum likelihood (ML) to estimate the labour supply function (Burtless and Hausman 1978, Hausman 1981). There are of course alternative methods which include the IV estimation of the standard model and that of the difference-in-difference model. We have not opted for them for the following reasons. First, while it is quite extensive and large, our data set is cross-section and does not have a panel structure which may be necessary for the difference-in-difference model. Second, while the IV estimation as well as the difference-in-difference model requires point-values for the dependent variable, hours worked are coded as intervals in the survey. Therefore, we are forced to perform a variant of interval regression, for which the ML is the only available principle of estimation. The Hausman method, which utilizes the ML estimation, is therefore a convenient tool for our estimation.[13]

5.1.1 The model

We assume a linear labour supply function in level:

$$h_i = \alpha w_i + \beta y_i + \mathbf{Z}_i \gamma + u_i \tag{12}$$

where h_i is hours worked, w_i is net wage rate, y_i is the virtual income, $\mathbf{Z}_i$ is a vector of observable individual characteristics, and u_i is error term. Note that w_i and y_i are constructed with wage and no-labour income data combined with a detailed examination of the Japanese tax codes. We assume that $u_i = \eta_i + \varepsilon_i$ where η_i is unobserved difference in preferences that is not explained by $\mathbf{Z}_i$, and ε_i is other unspecified type of error that include optimization errors by consumers as well as measurement errors by observers. These two components are assumed to be independently distributed with $\eta \sim N(0, \sigma_\eta^2)$ and $\varepsilon \sim N(0, \sigma_\varepsilon^2)$. Furthermore, by defining $v \equiv \varepsilon + \eta \sim N(0, \sigma_v^2)$, the correlation coefficient between v and η is obtained as $\rho(v,\ \eta) = \sigma_\eta / \sigma_v$ since $E(v\varepsilon) = \sigma_\varepsilon^2$ and $E(v\eta) = \sigma_\eta^2$.

The progressive income taxation makes consumer's budget constraint piece-wise linear. Let $h_1^*, ..., h_{J-1}^*$ be labour supply on which the budget constraint kinks. Note that the linear budget is defined for segment j with a set of net wage rate and virtual income (w_j, y_j), $j = 1, 2, ..., J$. With $g_j \equiv \alpha w_j + \beta y_j + \mathbf{Z}\gamma$, the dependent variable h

[13] The Houseman method is well explained elsewhere, we simply provides the basic assumption we took and the modification our date necessitated. For more see Moffit (1986, 1990) for a good summary of the Hausman method and MaCurdy et al. (1990) and Blundell and MaCurdy (1999) for its limitation.

is characterized as follows:

$$h = \begin{cases} g_1 + \eta + \varepsilon & \text{if } g_1 + \eta < h_1^* \\ h_1^* + \varepsilon & \text{if } g_2 + \eta < h_1^* < g_1 + \eta \\ g_2 + \eta + \varepsilon & \text{if } h_1^* < g_2 + \eta < h_2^* \\ \vdots & \\ h_{J-1}^* + \varepsilon & \text{if } g_J + \eta < h_{J-1}^* < g_{J-1} + \eta \\ g_J + \eta + \varepsilon & \text{if } h_{J-1}^* < g_J + \eta. \end{cases}$$

We can then assign the probability for each of the events. First, for hours worked on the segment between two kinks, we obtain:

$$\begin{aligned} & \Pr[h = g_j + \eta + \varepsilon, h_{j-1}^* < g_j + \eta < h_j^*] \\ = \ & \Pr[v = h - g_j, h_{j-1}^* - g_j < \eta < h_j^* - g_j] \\ = \ & \Pr[v = h - g_j] \cdot \Pr[h_{j-1}^* - g_j < \eta < h_j^* - g_j | v = h - g_j] \\ = \ & \frac{1}{\sqrt{\sigma_v^2}} \phi(\mathbf{Z}_j) \left[\Phi\left(\frac{t_{j,j} - \rho \mathbf{Z}_j}{\sqrt{\sigma_\eta^2 (1-\rho^2)}} \right) - \Phi\left(\frac{t_{j,j-1} - \rho \mathbf{Z}_j}{\sqrt{\sigma_\eta^2 (1-\rho^2)}} \right) \right] \end{aligned}$$

where $\phi(\cdot)$ and $\Phi(\cdot)$ are respectively the density and cumulative standard normal distribution, and $\mathbf{Z}_j \equiv (h - g_j)/\sqrt{\sigma_v^2}$, $t_{j,j} \equiv (h_j^* - g_j)/\sqrt{\sigma_\eta^2}$, and $t_{j,j-1} \equiv (h_{j-1}^* - g_j)/\sqrt{\sigma_\eta^2}$.

Second, for hours worked on the kinds, we have:

$$\begin{aligned} & \Pr[h = h_j^* + \varepsilon, g_{j+1} + \eta < h_j^* < g_j + \eta] \\ = \ & \Pr[\varepsilon = h - h_j^*, h_j^* - g_j < \eta < h_j^* - g_{j+1}] \\ = \ & \frac{1}{\sqrt{\sigma_\varepsilon^2}} \phi\left(\frac{h - h_j^*}{\sqrt{\sigma_\varepsilon^2}} \right) \cdot \left[\Phi\left(\frac{h_j^* - g_{j+1}}{\sqrt{\sigma_\eta^2}} \right) - \Phi\left(\frac{h_j^* - g_j}{\sqrt{\sigma_\eta^2}} \right) \right] \\ = \ & \frac{1}{\sqrt{\sigma_\varepsilon^2}} \phi(s_j) \left[\Phi(t_{j+1,j}) - \Phi(t_{j,j}) \right] \end{aligned}$$

where $s_j \equiv (h - h_j^*)/\sqrt{\sigma_\varepsilon^2}$.

However, our data do not contain a point value h but an interval $[h_L, h_H]$ such that $h \in [h_L, h_H]$. This requires us to derive the probability of h falling between a specific interval as follows.

$$
\begin{aligned}
&\Pr[h_L < g_j + \eta + \varepsilon < h_H, h_{j-1}^* < g_j + \eta < h_j^*] \\
&= \Pr[h_L - g_j < v < h_H - g_j, h_{j-1}^* - g_j < \eta < h_j^* - g_j] \\
&= \Psi\left(\frac{h_H - g_j}{\sigma_v}, \frac{h_j^* - g_j}{\sigma_\eta}, \rho\right) - \Psi\left(\frac{h_L - g_j}{\sigma_v}, \frac{h_j^* - g_j}{\sigma_\eta}, \rho\right) \\
&\quad -\Psi\left(\frac{h_H - g_j}{\sigma_v}, \frac{h_{j-1}^* - g_j}{\sigma_\eta}, \rho\right) + \Psi\left(\frac{h_L - g_j}{\sigma_v}, \frac{h_{j-1}^* - g_j}{\sigma_\eta}, \rho\right)
\end{aligned}
$$

where $\Psi(x_1, x_2, \rho)$ is a joint cumulative distribution of two random variables x_1 and x_2 that follow the standard normal distribution with correlation coefficient ρ.

For hours worked on the kinks, the analogous probabilities are given as

$$
\begin{aligned}
&\Pr[h_L < h_j^* + \varepsilon < h_H, g_{j+1} + \eta < h_j^* < g_j + \eta] \\
&= \Pr[h_L - h_j^* < \varepsilon < h_H - h_j^*, h_j^* - g_j < \eta < h_j^* - g_{j+1}] \\
&= \left[\Phi\left(\frac{h_H - h_j^*}{\sqrt{\sigma_\varepsilon^2}}\right) - \Phi\left(\frac{h_L - h_j^*}{\sqrt{\sigma_\varepsilon^2}}\right)\right] \cdot \left[\Phi\left(\frac{h_j^* - g_{j+1}}{\sqrt{\sigma_\eta^2}}\right) - \Phi\left(\frac{h_j^* - g_j}{\sqrt{\sigma_\eta^2}}\right)\right]
\end{aligned}
$$

We can then ML estimate parameters α, β, γ, ρ, σ_v, and σ_η, taking advantage of the probabilities above.

5.1.2 Data

As mentioned, the data source we utilize for our sample is *Syugyo Kozo Kihon Chosa* [Employment Status Survey] conducted in 2002.[14] We focus on the labour supply of prime age (25-55) males who are classified as the head with non-working spouse, and exclude the following observations from the sample: (a) self-employed workers, (b) board's members of private companies and non-profit organization, (c) family workers for SMEs, (d) the unemployed due to illness, (e) those who had changed residence or job within one year, and (f) those who had children within one year. We also leave out those with non-labour income since the survey does not provide the point value for that variable (therefore the sample consists of those only with labour income). These omissions reduces the sample size down to $63,717$.

[14] In Hayashi and Bessho (2004), we utilized the data from 1997 survey. The estimate below is based on Bessho and Hayashi (2005) which employ the latest 2002 survey as well as the 1997 survey. It also uses a somewhat different construction of piece-wise linear budget constraints, which results in a different estimates for compensated elasticities as well as income effects.

The dependent variable (hours worked) is provided as interval data in the survey, which requires us to employ the ML method as explained above. The hours are measured as an annual flow. On the other hand, our independent variables are standard and consist of after-tax (net) wage, virtual income, age, age squared, the number of children below 15 years old, and the number of dependents other than said children. The net wage is calculated as a product of gross wage and one minus marginal tax rate. Since the data for hours worked are provided as intervals, we could not obtain gross wage as a ratio of annual income to annual hours worked. We instead follow Shimada and Sakai (1980) to construct gross wage data from *Chingin Kozo Kihon Tokei Chosa* [Basic Survey on Wage Structure] and match them with the observations used in our sample. Specifically, we construct a tabulation of gross wages sorted by (a) sex, (b) educational background, (c) age, and (d) place of living (47 prefectures) and assign them with the observations that share the same combination of the four items. The marginal tax rate and virtual income are calculated with a close examination of the Japanese tax codes in 2002. Note that the virtual income excludes non-labour income since our sample consists of those with only labour income. As such, variations in virtual income come from those in gross wages as well as household characteristics that affect exemptions and credits. Table 3 shows the summary statistics of the said variables.

Table 3

5.1.3 Result

Table 4 lists the estimation results. We have expected signs on pre-tax wage and virtual income, which are all statistically significant at the standard levels of significance.

Table 4

Estimates for uncompensated elasticities $\hat{\eta}_i$ and income effects $\hat{\phi}_i$ are obtained as follows. Recall that the data for hours h_i worked are coded as intervals in our sample. Since uncompensated elasticities and income effect requires point values, we employ the predicated values for labour hours, i.e., $\hat{h}_i = \hat{\alpha} w_i + \hat{\beta} y_i + \mathbf{Z}_i \hat{\boldsymbol{\gamma}}$ where $(\hat{\alpha}, \hat{\beta}, \hat{\boldsymbol{\gamma}})$ are estimated parameters, and calculate $\hat{\eta}_i$, $\hat{\phi}_i$ and $\hat{\eta}_i^c$ as $\hat{\eta}_i = \hat{\alpha} w_i / \hat{h}_i$, $\hat{\phi}_i = \hat{\beta} w_i$, and $\hat{\eta}_i^c = \hat{\eta}_i - \hat{\phi}_i$. Note that, given the linear specification of (12), these values of course vary among observations. Table 5 provides summary statistics of our estimates for

$\hat{\eta}_i$, $\hat{\phi}_i$ and $\hat{\eta}_i^c$. Compensated elasticity $\hat{\eta}_i^c$ ranges from .172 to 1.751 with average .668 and standard error .026; income effect $\hat{\phi}_i$ ranges from $-.186$ to $-.040$ with average $-.087$ and standard error .234; and uncompensated elasticity $\hat{\eta}_i$ ranges from .029 to .311 with average .113 and standard error .041.[15]

Table 5

5.2 The marginal cost of public funds

With the estimates given above, we calculate the MCPF for individual i:

$$\text{MCPF} \equiv 1 + \left(\eta_i^c \frac{\mathrm{d}m_i}{\mathrm{d}a_i} + \phi_i\right) \cdot \left(\frac{1-m}{m} - \eta_i^c \frac{a_i}{m_i}\frac{\mathrm{d}m_i}{\mathrm{d}a_i} - \phi_i\right)^{-1} \tag{4}$$

Note that we calculate the MCPFs individually so that each household in our sample is associated with its own MCPF. It is possible to obtain the social marginal cost of public funds (SMCF) by aggregating all individual MCPFs with distribution weights that are derived form some specific social welfare function of the Bergson-Samuelson type, as we did Hayashi and Bessho (2004). In what follows, however, we are more interested in how an individual consumer additionally suffers from an increase in his tax burden, and in how such marginal welfare losses are distributed over the individuals in our sample.

The last line of Table 5 shows the results.[16] The individual MCPFs range from 1.005 to 2.002 with average 1.101 and standard error .0085. The distribution of the individual MCPFs is given in Figure 3 which shows that most of the values cluster between 1.00 and 1.15. We note however that our estimates of the elasticities for the prime-age males are rather large, when compared to analogous studies in North America and Europe. Table 6 shows simple average values for the elasticities listed in surveys by Pencavel (1986) and Blundell and MaCurdy (1999). We see that the simple average values for uncompensated elasticities are almost zero, with $-.08$ for Pencavel (1986), 0.09 for Blundell and MaCurdy (1999) and -0.01 when they are put together. The average values for compensated elasticities are 0.11, 0.21, and 0.15 in the same order. Given the fact that Hausman method tends to render higher

[15] The linear specification of (12) restricts the values of elasticities a priori. That is, to the extent that w/h (w) is larger, the compensated elasticities (income effect) will be more positive (negative).

[16] The calculation of (13) requires additional values for a_i and dm_i/da_i. In this exercise, we simply assume that average tax rate elasticity of marginal tax rate as unity for convenience (i.e., $(a/m)dm_i/da_i = 1$).

values of labour responses (MaCurdy et al. 1990), it might be safe to think that our estimates constitute some upper bound of the MCPF. This conforms to our previous study (Bessho et al. 2003) that shows with some sensitivity analysis that the MCPF would be 1.1 *at most* under the assumption of the representative consumer.

Table 6

Figure 3

6 Concluding remarks

In this paper, we have argued as follows. First, until recently, no serious attempts had been made to estimate labour responses to taxation, especially with respect to prime-age male workers. Second, while there is some stock of empirical analysis on female labour, few studies have appropriately allowed for the piece-wise linear budget structure implied by the tax system. Third, as a corollary, there is not a reliable stock of empirical estimates to quantify the frequently mentioned concepts of "disincentives to work" or "distortion." Forth, despite this paucity of empirical estimates, there are a number of tax simulations, but with arbitrary sets of labour response elasticities and other related parameter values. We however may not emphatically justify our criticism against these Japanese studies. After all, the tax simulation studies cannot rely on labour economists for reliable preference parameters. And, the labour economists do not have an easy access to reliable data. The unique separation of labour economists and public economists in Japan has contributed to the state of the art. In the last section of the paper, we tried to build a bridge between the two. We introduced our estimates, calculated the degree of distortion, and found the MCPF about 1.1 on average.

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Table 1. Japanese Personal Income Tax Rates: 1975-2004

1975	1985	1995	2004
Income tax (national tax)			
Not over 600, 10%	Not over 500, 10.5%	Not over 3,300, 10%	Not over 3,300, 10%
Over 600, 12%	Over 500, 12%	Over 3,300, 20%	Over 3,300, 20%
Over 1,200, 14%	Over 1,200, 14%	Over 9,000, 30%	Over 9,000, 30%
Over 1,800, 16%	Over 2,000, 17%	Over 18,000, 40%	Over 18,000, 37%
Over 2,400, 18%	Over 3,000, 21%	Over 30,000, 50%	
Over 3,000, 21%	Over 4,000, 25%		
Over 4,000, 24%	Over 6,000, 30%		
Over 5,000, 27%	Over 8,000, 35%		
Over 6,000, 30%	Over 10,000, 40%		
Over 7,000, 34%	Over 12,000, 45%		
Over 8,000, 38%	Over 15,000, 50%		
Over 10,000, 42%	Over 20,000, 55%		
Over 12,000, 46%	Over 30,000, 60%		
Over 15,000, 50%	Over 50,000, 65%		
Over 20,000, 55%	Over 80,000, 70%		
Over 30,000, 60%			
Over 40,000, 65%			
Over 60,000, 70%			
Over 80,000, 75%			
Inhabitants tax (prefectural tax)			
Not over 1,500, 2%	Not over 1,500, 2%	Not over 7,000, 2%	Not over 7,000, 2%
Over 1,500, 4%	Over 1,500, 4%	Over 7,000, 4%	Over 7,000, 3%
Inhabitants tax (city/town/village tax)			
Not over 300, 2%	Not over 200, 2.5%	Not over 2,000, 3%	Not over 2,000, 3%
Over 300, 3%	Over 200, 3%	Over 2,000, 8%	Over 2,000, 8%
Over 500, 4%	Over 450, 4%	Over 7,000, 11%	Over 7,000, 10%
Over 800, 5%	Over 700, 5%		
Over 1,100, 6%	Over 950, 6%		
Over 1,500, 7%	Over 1,200, 7%		
Over 2,500, 8%	Over 2,200, 8%		
Over 4,000, 9%	Over 3,700, 9%		
Over 6,000, 10%	Over 5,700, 10%		
Over 10,000, 11%	Over 9,500, 11%		
Over 20,000, 12%	Over 19,000, 12%		
Over 30,000, 13%	Over 29,000, 13%		
Over 50,000, 14%	Over 49,000, 14%		
Inhabitants tax on a per capita basis (prefectural tax; unit yen)			
100	700	700	1,000
Inhabitants tax on a per capita basis (city/town/village tax; unit yen)			
600	2,500	2,500	3,000
400	2,000	2,000	3,000
200	1,500	1,500	3,000

Note: Inhabitants taxes on a per capita basis vary with city size.

Figure 1. Welfare loss

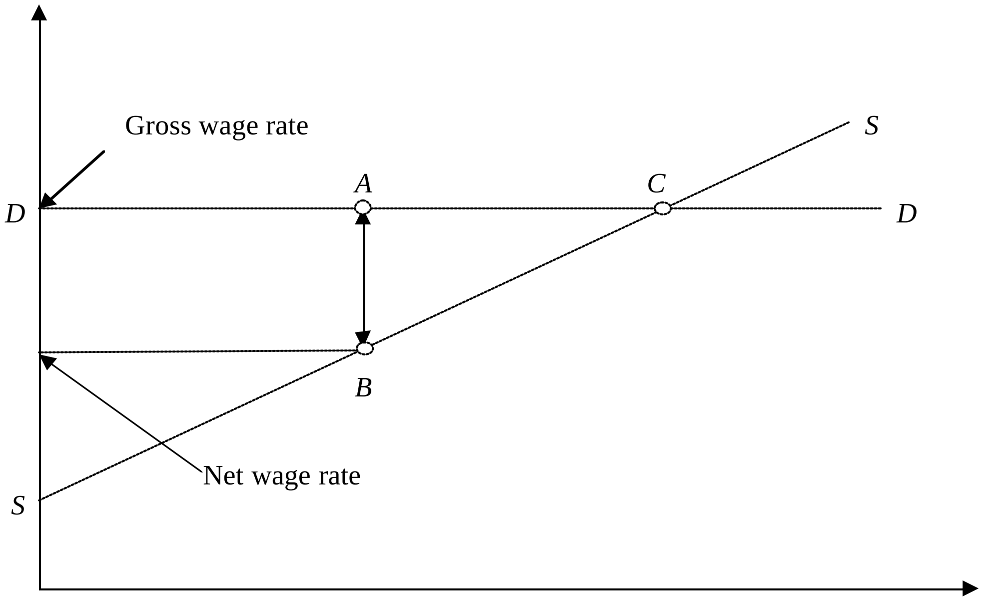

Table 2. Empirical studies on labour response in Japan

Data		Hours	Participation rates/probabilities
aggregate	time-series	【complete demand system】 Okamoto (1984)	Furugoori (1981) Shimada and Higuchi (1985) Bae (1995a)
	cross-section		Hill (1984) Yamada and Yamada (1986) Yamada and Yamada (1987a) Yamada and Yamada (1987b) Yamada et al. (1987), Bae (1995b)
	panel	【complete demand system】 Asano (1997)、Yamada et al. (1999)	
micro-data	cross-section	Shimada and Sakai (1980) Higuchi and Hayami (1984) Abe and Ohtake (1995) Nagase (1997)	【binomial logit】 Shimada and Sakai (1980), Okamoto (1988) 【binomial probit】 Okamoto (1988)
			【multinomial logit】 Okamoto (1988), Takayama and Arita (1992), Ogawa and Ermisch (1996)

Figure 2. Piece-wise linear budget constraint

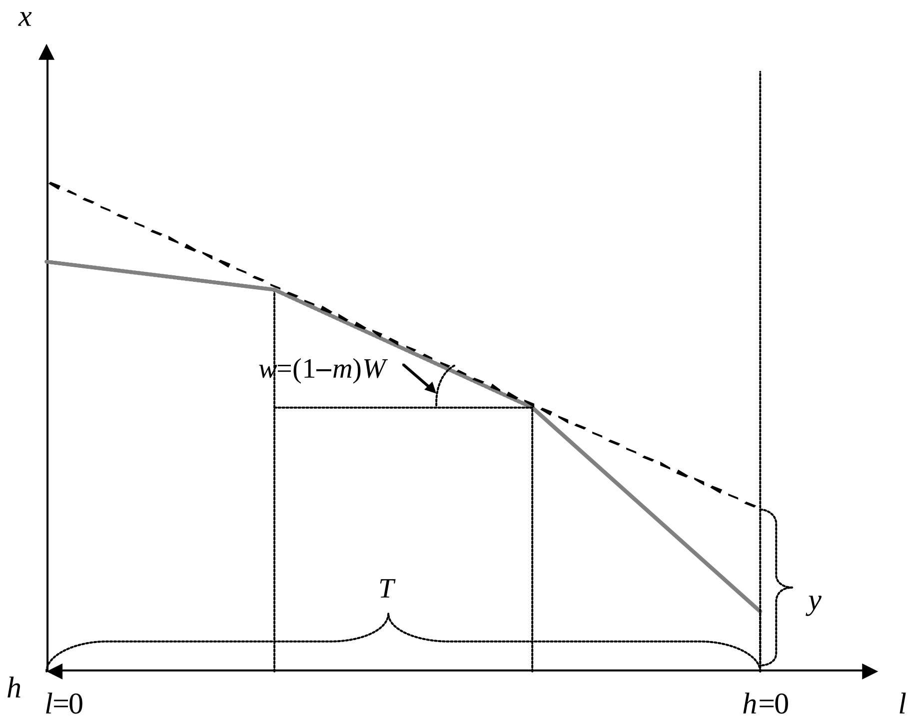

Table 3. Descriptive statistics

	Average	Std. err.	max	min
Before-tax wage rate	0.266	0.090	0.072	0.591
Hours worked (lower end)	1450.9	401.9	0	2142.9
Hours worked (upper end)	2659.6	1427.3	107.1	5840
Age	42.794	8.191	25	55
# of kids younger than 15	0.949	1.002	0	6
# of Specific dependent children	0.269	0.557	0	4

Note: Sample size is 63,717.

Table 4. Estimation Results

	Coefficients	Standard errors	P-values
After-tax wage rate	902.997	95.806	0.000
Virtual income	-2.510	0.307	0.000
Age	14.062	3.229	0.000
$(Age)^2$	-0.265	0.039	0.000
# of kids younger than 15	9.802	2.657	0.000
# of Specific dependent children	-11.194	4.312	0.009
Constant	1554.372	63.040	0.000
s_h	347.473	16.422	0.000
s_e	321.019	16.160	0.000
# of observation	63,717		
Log Likelihood	-68,272.28		

Table 5. Elasticities, income effects and individual MCPFs

Variable	Obs	Mean	Std. Dev.	Min	Max
h	63,680	0.104	0.032	0.029	0.253
h_c	63,680	0.615	0.183	0.172	1.377
f	63,680	-0.511	0.151	-1.132	-0.143
MCPF	63,680	1.090	0.068	1.005	1.725

Figure 3. Distribution of individual MCPFs

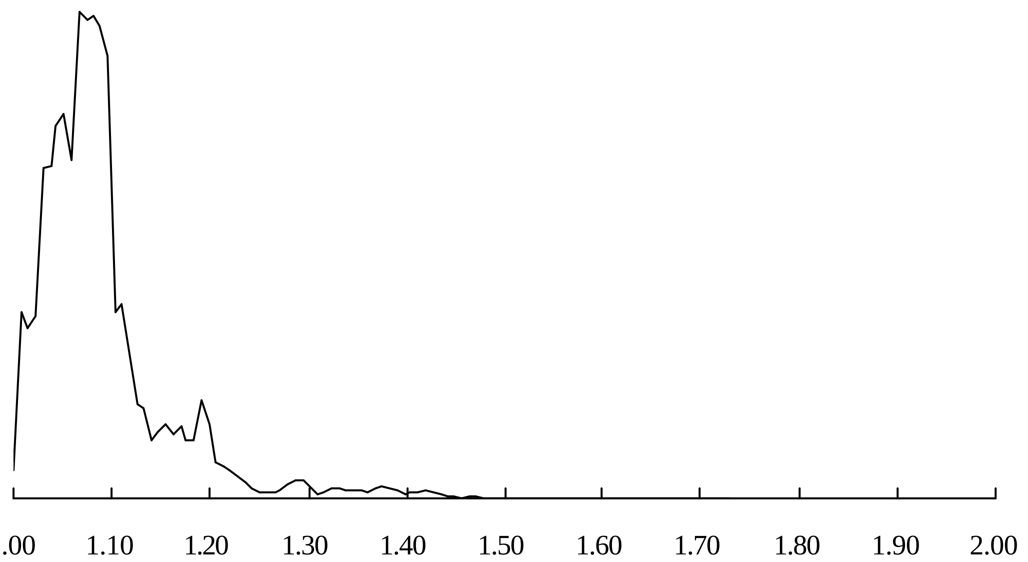

Table 6. Evidence from North American and European Studies

The number of studies		h	h_c	f
①	28	-0.08	0.11	-0.20
②	19	0.09	0.21	-0.12
①+②	47	-0.01	0.15	-0.17

①Pencavel, J., 1986. Labor supply of men: A survey. Ashenfelter, O., Layard, R., (Eds.) *Handbook of Labor Economics* 1, 49-101.

②Blundell, R., MaCurdy, T., 1999. Labor supply: A review of alternative approaches. Ashenfelter, O., Card, D., (Eds.) *Handbook of Labor Economics* 3A, 1559-1695.