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Masao Yamaguchi

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*Corresponding author: Faculty of Economics, Osaka University of Economics, 2-2-8, Osumi, Higashiyodogawa-ku, Osaka 533-8533, Japan. Email: m.yamaguchi@osaka-ue.ac.jp.

abstract

The OB decomposition method is a popular and useful tool for analyzing the multiple factors for changes in wage inequality and distribution. It entails the measurement error of regression and the omitted (reference) group problem. This paper develops a new inequality decomposition method which extends the inequality decomposition method presented by Mookherjee and Shorrocks (1982) to identify multiple factors for inequality changes. This method does not need to estimate the wage equation, and can easily decompose the wage inequality just as in Mookherjee and Shorrocks (1982). This paper also present an empirical application of this method to examine factors behind the changes in the Japanese labor income inequality based on a micro-level data set obtained from the Employment Status Survey (1992-2002).

KEYWORDS: Wage inequality, factor decomposition

1 Introduction

This paper shows the new inequality decomposition method, to which is extended the method presented by Mookherjee and Shorrocks (1982).

Wage inequality has been increasing in many developed countries since the 1980s. In the United States and Britain, the growth in inequality has been significant (Katz and Autor 1999, Atkinson 2008).[1] Many researchers have tried to clarify the factors for the growth in inequality (Atkinson 2008). For example, the increase in the Unites States'

[1]Lemieux (2009) states that it is now widely accepted that the growth in within-group inequality in the 1970s is not robust to the choice of data.

wage inequality in the 1980s was brought about by a relative decrease in the supply of skilled labor, and the wage inequality increase from the late 1980s to the early 2000s was accompanied by a polarization of employment growth: employment was bifurcated into high-wage and low-wage jobs at the expense of traditional middle-class jobs (Goldin and Katz 2007,Autor et al. 2008). On the other hand, the increase in within-group inequality (residual wage inequality) is attributed to factors such as the decrease in the real minimum wage rate, de-unionization, the dissemination of performance-pay, and the skill composition change linked to the secular increase in experience and education (Lemieux 2006, Firpo et al. 2009, Card and Dinardo 2002, Lemieux et al. 2009).

As low-income groups have been increasing in number in the 2000s in Japan, the term "economically stratified society" (*Kakusa shakai* in Japanese) has been frequently used to describe income or wage inequality. The tendency of family income inequality to increase continued from the first half of the 1980s to the first half of the 2000s (Otake 2005, Otake and Ohara 2010).

Wage inequality for full-time workers tended to increase in the 1980s (Shinozaki 2006), but was on the decline in the first half of the 1990s. In the second half of the 1990s, wage inequality began increasing again (Kambayashi et al. 2008). Furthermore, the wage inequality for all workers, including part-time workers, has tended to increase since the second half of the 1990s (Shinozaki 2006).

To examine the factors for change in income or wage inequality in Japan, many studies

have focused on the relationships between income or wage inequality and population aging by using the inequality decomposition method. Because income and wage inequality increased in the advanced age layer, especially in Japan, widening income inequality will be easily caused by population aging. Otake (2005), Oshio (2006), and Oishi (2006) showed that population aging was the main factor for the increase in family income inequality in the 1980s and 1990s.[2]

In many Japanese studies, factor decomposition of inequality is performed by using an inequality decomposition method similar to Mookherjee and Shorrocks (1982).[3] However, this method has a fatal shortcoming: it identifies only a single factor (for example, change in age composition) for the change in inequality. In other words, it omits the effects of other factors on income inequality change. Therefore, we must adopt another method to identify multiple factors such as the age and education qualifications of workers, for the changes in wage inequality.

There are two approaches to identify the multiple factors. One is the method often called the Oaxaca-Blinder (OB) decomoposition method. This method estimates a wage equation that can identify the changes in the returns to each attribute of workers' human capital, such as age, educational qualifications, years of tenure, and firm size. Using the

[2]Oishi (2006) and Yamaguchi (2011) showed that the influence of population aging on family income inequality decreased during the first half of the 2000s, but the influence of the widening within-group inequality among each age group increased.

[3]Using this method, Jenkins (1995) analyzed income inequality change by considering such factors as the age composition and family structure.

estimated results of the wage equation, the dataset, and distributional statistics such as its mean, variance, and quantile, the OB decomposition method can decompose the difference in a distributional statistic between two groups or its change over time into various explanatory factors. The OB decomposition method is a popular and useful tool for analyzing the factors for changes in wage inequality and distribution. However, it has two disadvantages. One is the occurrence of the measurement error of regression. Whenever we estimate the regression, it always includes the measurement error. The other problem is the omitted (reference) group problem.[4] The OB decomposition method cannot identify the separate contributions of categorical covariates to the wage inequality decomposition, which was demonstrated by Oaxaca and Ransom (1999).

The other method to identify the multiple factors for inequality changes is that proposed by this paper. The main purpose of this paper is to show this new method by extending the method presented by Mookherjee and Shorrocks (1982). This method has several advantages. It does not need to estimate the wage equation, and therefore, the measurement error of regression does not occur. Moreover, it can easily decompose the wage inequality just as in Mookherjee and Shorrocks (1982).

Using this new method, this paper analyzes the factors for the changes in wage inequality from 1992 to 2002, on the basis of the Employment Status Survey (ESS) which covers a wider range than the Basic Structure Wage Survey (BSWS). [5]

[4]Oaxaca and Ransom (1999) calls this an identification problem.

[5]Although the BSWS data provides only approximately 40-60 % coverage of all the workers, the

Considering workers' attributes such as age, education qualifications, and firm size, this paper shows that the effect of the decrease in between-group inequality has a negative impact on overall wage inequality among full-time male workers from 1992 to 1997, and that the remarkable increase in within-group inequality was the main factor for the widening of overall male wage inequality from 1997 to 2002. These results among full-time workers are supportive of the results of Kambayashi et al. (2008) who analyzed the change in wage inequality using the OB decomposition method.

Further, when the coverage of workers is extended to part-time workers, contingent workers, etc., the male wage inequality increased both from 1992 to 1997 and from 1997 to 2002.

In this case the factors behind the expanding overall wage inequality from 1992 to 1997 were mainly caused by the increase in the change in skill composition (such as age, education, and firm size), and the factors behind the expanding overall wage inequality from 1997 to 2002 were mainly caused by within-group inequality among identical group of age, education and firm size. The change in the coverage of the workers makes the results change easily, and it is important for any analysis of wage inequality to define the range of workers with caution.

This paper is organized as follows. In section 2, I provide an overview of decomposition methods and explain the mean log deviation (MLD), which is the indicator of inequality,

Japanese wage inequality has often been analyzed among full-time workers using the BSWS data. See, for example, Kambayashi et al. (2008), Sakurai (2004), and Ota (2010).

and the decomposition method presented by Mookherjee and Shorrocks (1982) in detail. In addition, I derive a new method for simultaneously decomposing two or more factors for changes in wage inequality. Section 3 presents an empirical application of the new method derived in section 2 to analyze the factors behind Japanese wage inequality after showing the discriptive statistics of the trend of wage inequality on the basis of the coverage of workers. Section 4 features the conclusion.

2 The method

In this section, I review some of the decomposition methods that have been developed since the 1970s and give a detailed account of the decomoposition method of Mookherjee and Shorrocks (1982). I then propose a new method for simultaneously decomposing two or more factors for changes in inequality by extending the method of Mookherjee and Shorrocks (1982).

2.1 Overview of decomposition methods

To analyze the factors behind wage inequality in detail, decomposition methods were developed in the 1970s. There are two notable methods.

The first method is the Oaxaca-Blinder (OB) decomposion method, which uses the regression parameter, covariance matrices, and error term estimated from the wage equation. The change in variance over the two periods can be decomposed into (i) changes

in the wage structure that are captured by the changes in the estimated coefficients of the wage equation, (ii) the changes in the variance of workers' attributes, which are captured by the change in the variance of the explanatory variables of the wage equation, and (iii) the changes in the variance of the error term of the wage equation. The OB decomposition method has advanteges. Practitioners can simultaneously extract many factors behind the change in inequality by choosing the explanatory variables of the wage equation such as gender, age, experience, education, and firm size. Fortin et al. (2011) reviewed a comprehensive overview of OB decomposition methods, including the refined method introduced by Firpo et al. (2007) that showed the change in other distributional statistics such as quantiles and the Gini coefficient could be also decomposed. Recently, progress has been made in OB decomposition method research. However, the OB decomposition method has two drawbacks. One is the measurement error caused by wage-estimating equation. Whenever we estimate the regression, it always entails measurement error. The other is the omitted (reference) group problem. The changes in the estimated coeffeicients in the term in decomposition arbitrarily depends on the choice of the categrorical covariates in the regression; this was demonstrated by Oaxaca and Ransom (1999), who explained that conventional decomposition methodology cannot identify the separate contributions of dummy variables to the wage decomposition because it is only possible to estimate the relative effects of a dummy variable.

The other method is the inequality decomposition method without regression proposed

by Mookherjee and Shorrocks (1982). This method can decompose measeures such as Theil index, mean log deviation, and log variance into within- and between-group component considering the workers' attributes. Mookherjee and Shorrocks (1982) applied this method to the analysis of inequality in the UK. This method is useful to show a specific factor behind the change in inequality. However, this method has a fatal drawback; it cannot perform simultaneous decomposition into multiple attributes. When this decomposition method identifies multiple factors for the change in inequality, it decomposes inequlity measeures into only a single factor over and over again. In the next subsection I explain the method of Mookherjee and Shorrocks (1982) in detail.

2.2 The inequality decomposition method by Mookherjee and Shorrocks

There are many indices for expressing inequality. As Mookherjee and Shorrocks (1982) used the mean log deviation (MLD), which has the desirable additively decomposability properties among subgroups, this paper also uses the MLD. The MLD is defined as follows:

$$MLD \equiv \frac{1}{n} \sum_{i=1}^{m} \sum_{a=1}^{n_i} \ln \left(\frac{\mu}{x_{ia}} \right), \tag{1}$$

where μ is the overall mean wage and x_{ia} is the wage of the worker a belonging to the subgroup i. The MLD is the average value of the log deviation width of the wages of each worker from the mean wage. If the MLD is large, it implies that the wage inequality is large.

Equation (1) decomposes the two terms as follows.[6]

$$MLD = \sum_{i=1}^{m} \frac{n_i}{n} MLD_i + \sum_{i=1}^{m} \frac{n_i}{n} \ln\left(\frac{\mu}{\mu_i}\right), \tag{2}$$

where μ_i is the mean wage of the group i, n represents the number of overall workers, and n_i represents the number of workers in group i. The first term of equation (2) is a "within-group component" (the weighted sum of the inequalities within each subgroup). The second term is the "between-group component," which reflects the inequality contribution due solely to differences in the subgroup means. Therefore, the total inequality equals the sum of these two contributions.

Following Mookherjee and Shorrocks (1982), the change in MLD between the two years, t and $t+1$, can be written as

$$\begin{aligned}
\Delta MLD &= MLD(t+1) - MLD(t) \\
&= \sum_i \bar{s}_i \Delta MLD_i + \sum_i \overline{MLD}_i \Delta s_i - \sum_i \overline{\ln \lambda}_i \Delta s_i - \sum_i \bar{s}_i \Delta \ln \lambda_i, \\
&\approx \underbrace{\sum_i \bar{s}_i \Delta MLD_i}_{term\ A} + \underbrace{\sum_i \overline{MLD}_i \Delta s_i}_{term\ B} + \underbrace{\sum_i \left[\bar{\lambda}_i - \overline{\ln \lambda}_i\right] \Delta s_i}_{term\ C} + \underbrace{\sum_i \left[\bar{\theta}_i - \bar{s}_i\right] \Delta \ln \mu_i}_{term\ D}.
\end{aligned} \tag{3}$$

$s_i \equiv \frac{n_i}{n}$: workers' share of group i

MLD_i : MLD of group i

$\lambda_i \equiv \frac{\mu_i}{\mu}$: group i's mean wage relative to the overall mean

[6] Mookherjee and Shorrocks (1982) explained that generalized entropy indices that have additive decomposability, such as the Theil index, are able to decompose similarly.

$\theta_i \equiv s_i \lambda_i$: group i's wage share of the total wage of all workers

Δ is the difference operator between the two years t and $t+1$. A bar over the variables indicates the average of the base and current period values ($\bar{s}_i = \frac{s(t)+s(t+1)}{2}$). Overall inequality changes can be decomposed into (1) within-group inequality changes (term A), (2) changes resulting from changes in the compostion of workers (term B and C) and (3) changes resulting from changes in the relative wages of different groups (term D: between-group inequality changes). In fact, the term B indicates the compositional effect caused by the change in the within-group component, while the term C indicates the compositional effect caused by the change in the between-group component in equation (3).

2.3 Extending the inequality decomposition method

Many previous studies analyzed the factors for income and wage inequality changes using equations (2) and (3).[7] They paid attention to only one attribute such as age. This method omits the effects of other factors on the inequality change. Therefore, when we analyze the factors for the change in wage inequality caused by the changes in the composition of both workers' age and education qualifications, we must use another method.

[7] E.g., Oshio (2006), Oishi (2006), Yamaguchi (2011), and Jenkinz (1995).

One is the OB decomposition method. It estimates wage equations to explore changes in the returns to each attribute of workers' human capital such as age, educational qualification, years of tenure, and firm size. Using the estimation results, its variance, and the dataset, the variance (wage inequality) can be decomposed between its change over time into various explanatory factors. The OB decomposition method has been used by many studies.[8] For instance, Kambayashi et al. (2008) used this method to analyze the factors for the changes in wage inequality among full-time workers in Japan.

The other method is the new method that this paper proposes by extending the method of Mookherjee and Shorrocks (1982). This new method can simultaneously decompose two or more factors for changes in wage inequality. This method has advanteges: it does not suffer from a mesurement error in the regression analysis and it is user-friendly. An equation based on the new method can be derived from equation (2).

Subgroup i is divisible by another subgroup k in equation (2): therefore, equation (2) can be written as follows:

$$\begin{aligned} MLD &= \sum_{i=1}^{m} \frac{n_i}{n} \left[\sum_k \frac{n_{ik}}{n_i} MLD_{ik} + \sum_k \frac{n_{ik}}{n_i} \ln\left(\frac{\mu_i}{\mu_{ik}}\right) \right] + \sum_{i=1}^{m} \frac{n_i}{n} \ln\left(\frac{\mu}{\mu_i}\right), \\ &= \sum_{i=1}^{m} \sum_k \frac{n_{ik}}{n} MLD_{ik} + \sum_{i=1}^{m} \sum_k \frac{n_{ik}}{n} \ln\left(\frac{\mu_i}{\mu_{ik}}\right) + \sum_{i=1}^{m} \frac{n_i}{n} \ln\left(\frac{\mu}{\mu_i}\right), \end{aligned}$$

[8] Fortin et al. (2011) reviewed the empirical papers of the OB decomoposition method and discussed the assumptions required for identifying the different elements of the decomposition, as well as the various estimation methods.

$$= \sum_{i=1}^{m}\sum_{k}\frac{n_{ik}}{n}MLD_{ik} + \sum_{i=1}^{m}\sum_{k}\frac{n_{ik}}{n}\ln\left(\frac{\mu}{\mu_{ik}}\right), \tag{4}$$

where MLD_{ik} is the MLD of the subgroup ik which is divided by subgroup i into subgroup k; μ_{ik} represents the mean wage of the group ik; and n_{ik} represents the number of workers in group ik. I have used $MLD_i = \sum_k \frac{n_{ik}}{n_i}MLD_{ik} + \sum_k \frac{n_{ik}}{n_i}\ln\left(\frac{\mu_i}{\mu_{ik}}\right)$ to derive the first equation in (4). Equation (4) represents the decomposition of two attributes of workers (e.g. age and education qualifications) into within- and between-group components. The change in the MLD between the two years, t and $t+1$, as in (3), can be also derived from (4), which can identify two factors for the change in the MLD.

Further, considering subgroup l in subgroup k, equation (4) can be written as follows:

$$MLD = \sum_{i=1}^{m}\sum_{k}\sum_{l}\frac{n_{ikl}}{n}MLD_{ikl} + \sum_{i=1}^{m}\sum_{k}\sum_{l}\frac{n_{ikl}}{n}\ln\left(\frac{\mu}{\mu_{ikl}}\right), \tag{5}$$

where MLD_{ikl} is the MLD of the subgroup ikl, which is divided by subgroup ik into group l; μ_{ikl} represents the mean wage of subgroup ikl; and n_{ikl} represents the number of workers in subgroupikl.

Equation (5) indicates the decomposition three worker attributes into within- and between-group component. Repeating the substitution similarly with equations (4) and (5), the division of a subgroup can be increased without limit. However, it becomes impossible to perform the decomposition analysis, when the division of a subgroup is increased too much, and sufficient sample cannot be secured for actual analysis.

Similar to the derivation of equation (3), equation (5) can be written as follows:

$$
\begin{aligned}
\Delta MLD &= MLD(t+1) - MLD(t), \\
&= \sum_i \sum_k \sum_l \bar{s}_{ikl} \Delta MLD_{ikl} \\
&\quad + \sum_i \sum_k \sum_l \overline{MLD}_{ikl} \Delta s_{ijl} - \sum_i \sum_k \sum_l \overline{\ln \lambda}_{ijl} \Delta s_{ijl} - \sum_i \sum_k \sum_l \bar{s}_{ikl} \Delta \ln \lambda_{ikl}, \\
&\approx \underbrace{\sum_i \sum_k \sum_l \bar{s}_{ikl} \Delta MLD_{ikl}}_{term\ A} + \underbrace{\sum_i \sum_k \sum_l \overline{MLD}_{ikl} \Delta s_{ikl}}_{term\ B} \\
&\quad + \underbrace{\sum_i \sum_k \sum_l \left[\bar{\lambda}_{ikl} - \overline{\ln \lambda}_{ikl} \right] \Delta s_{ikl}}_{term\ C} + \underbrace{\sum_i \sum_k \sum_l \left[\bar{\theta}_{ikl} - \bar{s}_{ikl} \right] \Delta \ln \mu_{ikl}}_{term\ D}.
\end{aligned}
\tag{6}
$$

$s_{ikl} \equiv \frac{n_{ikl}}{n}$: workers' share of group ikl

MLD_{ikl} : MLD of group ikl

$\lambda_{ikl} \equiv \frac{\mu_{ikl}}{\mu}$: group ikl's mean wage relative to the overall mean

$\theta_{ikl} \equiv s_{ikl}\lambda_{ikl}$: group ikl's wage share of the total wage of all workers

Overall inequality changes in (6) consist of within-group inequality changes (term A), changes resulting from changes in the composition of workers (term B and C) and between-group inequality changes (term D). This deviation of multiple factors decomposition method can be applied to another indices of inequality measurement such as Thiel index and logarithmic variance, which have additive decomposability properties.

As stated above, an advantage of this proposed method is that it can easily analyze the factors behind the change in inequality without regression. This method is useful for

analyzing the impact of composition effects such as education, age and skill composition. However, the drawback of this method is that it cannot analyze the change in the distribution or quantiles caused by the composition effects. The further development of this method is required.

Using this new method, empirical application is performed to analyze the factors for wage inequality in Japan in the next section.

3 Empirical application: Wage inequality in Japan from 1992 to 2002

3.1 Data

The data used for this study is resampled micro data from the Employment Status Survey (ESS), which is conducted every five years by the Statistics Bureau of the Ministry of Internal Affairs and Communications in Japan.[9] The ESS is a large-scale cross sectional survey that was conducted with adults in 440,000 households in 2002. It covers all workers in Japan. The ESS obtained detailed records of the properties of workers: it includes income, sex, education qualifications, age, type, employment status, and the size of their

[9]Eighty percent of the original sample was randomly chosen as anonymous resampled data excluding households of eight or more persons, households with three or more persons of the same age of which is less than 15-year-old household membership, and the households of a specific institution. I have obtained this data from the Research Centre for Information and Statistics of Social Science, Institute of Economic Research, Hitotsubashi University.

firms, as well as work hours in a week, and the number of working days in a year. In the ESS, respondents answered queries about their annual income (i.e., their wage) by choosing one option from among given wage ranges. Therefore, the class value of each bracket of given annual wage is used to calculate the MLD.[10]

In some previous works, Japanese wage inequality was analyzed using BSWS data. For example, Kambayashi et al. (2008) analyzed the factors for the changes in Japanese wage inequality with a BSWS sample confined to full-time workers ("permanent ordinary workers") in the private sector.[11]

Insert Figure. 1 Composition of the male workforce

[10]For the annual wage bracket, there were 14 classifications in 1992, 14 classifications in 1997, and 17 classifications in 2002. To compare wage inequality over this period, the annual wage classification in each year is unified into 14 classifications. In addition, it was not possible to obtain an annual income of family members working in family business for 1997; therefore, I have excluded this sample from the income data for 1992 through 2002.

[11]In the BSWS, the types of workers are classified into (1) ordinary workers who have general scheduled working hours and (2) part-time workers who are regular workers whose daily or weekly scheduled working hours are fewer than those of ordinary workers in firms. Kambayashi et al. (2008) explained that permanent workers are classified as (1) workers on contracts that do not clearly specify a contractual time period, (2) workers on contracts lasting more than a month, and (3) workers on contracts lasting less than a month on which the workers worked 18 or more days over the previous two months. This classification includes part-time workers if one of the criteria above is satisfied.

Insert Figure. 2 Composition of the female workforce

The permanent ordinary workers, however, are part of the total workerforce. Figure. 1 shows the composition of the workforce in 2002 from the ESS. In 2002, the proportion of ordinary workers was 70.0 % among males and 61.1 % among females.[12] The proportion of workers with 200 or more working days a year and 35 or more working hours a week is 90.7 % for male ordinary workers and 68.7 % for female ordinary workers. Therefore, the permanent ordinary workers defined in BSWS make up almost 63.5 % of total workers for males and 41.9 % for females.[13] This is why changes in the overall wage inequality in Japan cannot be obtained only for permanent ordinary workers in BSWS.

In the next subsection, I show the changes in wage inequality from 1992 to 2002 and how the wage inequality changes when the range of workers is extended.

3.2 Wage inequality among full-time workers

First, I focus on the wage inequality among full-time workers. Table 1 shows the transition of the MLD of each group of full-time workers. The first row shows the MLD among full-time workers in firms with five or more employees, whose trend is similar to

[12]In the ESS, ordinary workers are employees other than executives, temporary employees, and daily employees. Temporary employees are employed on a contractual basis for a month or more but for less than a year. Daily employees are employed on a daily basis or on a contract for less than a month.

[13]Furthermore, it can be expected that the ratio of permanent ordinary workers becomes still smaller than this value, because the BSWS data is confined to establishment of five or more persons.

the log variance among permanent ordinary workers in Kambayashi et al. (2008). Among male workers, wage inequality had a constant or slightly decreasing trend from 1992 to 1997, but it increased from 1997 to 2002. Although there were differences between BSWS and ESS in wages and time when the survey was conducted, the trends of wage inequality were similar to those found by Kambayashi et al.[14]

Among female workers, wage inequality increased both from 1992 to 1997 and from 1997 to 2002.

Insert Table 1 Wage inequality (MLD) of each group of full-time workers

Next, I examine the changes in wage inequality when the range of workers for the analysis is extended. The second row and below in Table 1 indicate (2nd row) the MLD among full-time workers in firms at least five employees, including executives, (3rd row) full-time workers in firms that with at least one employee, (4th row) full-time workers in firms with at least one employee and self-employed workers, and (5th row) full-time workers in firms with at least five employees and public workers. Even if the range of the workers for analysis is extended, the changes in wage inequality are similar to the results in the first row.[15]

[14]The BSWS was conducted in June and the ESS was conducted in October. Kambayashi et al. used the real hourly wage rate deflated by the consumer price index. This paper uses the nominal annual wage rate.

[15]Specifically, from 1997 to 2002, the change in wage inequality was the largest; this is why we added

Insert Figure. 3 Percentage of male workers classified by annual wage bracket

I next examine how the income distribution changes among full-time workers parallel the changes in wage inequality. Figure. 3 shows the proportion of the male full-time workers ranked based on 14 income brackets.[16] From 1992 to 1997, the proportion of among male full-time workers earning less than 3 million yen decreased slightly. The proportion of workers earning 3-5 million yen also decreased slightly, while the proportion of workers earning 6-15 million yen increased greatly. The wage inequality became constant or decreased slightly as the proportion of woerkers in the lower-income groups decreased, but those in higher-income groups increased from 1992 to 1997.

In contrast, from 1997 to 2002, The proportion of workers earning less than 3 million yen increased slightly, the proportion of workers earning 4-7 million yen decreased greatly, and the proportion of workers earning the more than 7 million yen decreased slightly. The wage inequality increased as the proportion of workers in the lower-income groups increased, while the proportion of workers in the middle-income groups decreased from 1997 to 2002.

Insert Figure. 4 Percentage of female workers classified by annual wage bracket

the self-employment data (fourth row) among male workers.

[16]The income brackets are, in tens of thousands of yen, 0-50, 50-99, 100-149, 150-199, 200-249, 250-299, 300-399, 400-499, 500-699, 700-999, 1000-1499, and 1500 and above. Figure. 3 is depicted with a class mark.

Figure. 4 shows the proportion of female full-time workers classified by annual wage bracket. From 1992 to 1997, among female workers, the proportion of workers earning less than 2.5 million yen decreased, whereas the proportion of workers earning 3-10 million yen increased substantially. Both the reduction in the proportion of low-income workers and the rise in the proportions of middle- and high-income workers are more noticeable than that of male workers. From 1997 to 2002, the proportion of workers earning 2-4 million yen decreased a little, and the proportion of workers earning 4-10 million yen increased. The proportion of full-time male workers in the middle- and high-income groups decreased greatly, but that of females increased notably.

Next, I analyze the factors for changes in wage inequality among full-time workers. Using equations (5) and (6), inequality factor decomposition analysis is performed. In the analysis, workers are divided into groups (432 classifications) on the basis of their age (12 classifications),[17] education qualifications (4 classifications),[18] and the size of the workers' firms (9 classifications).[19]

[17]Age groups were 12 classifications of 15-19 years old, $\cdots$(5 years old interval)$\cdots$, 65-69 years old, and 70 or more years old.

[18]The educational background groups are 'elementary school or junior high school graduates(9 years of compulsory schooling),' 'high school graduates (12 years of schooling),' 'junior college or college of technology graduates(usually 14 years of schooling),' and 'university and graduate school graduates(16 years or more of schooling).'

[19]Sizes of firms are nine classifications of 5-9 persons, 10-19 persons, 20-29 persons, 30-49 persons, 50-99 persons, 100-299 persons, 300-499 persons, 500-999 persons, and 1000 or more persons.

Insert Table 2 Decomposition of age, education, and firm size among full-time workers

Table 2 shows the results of the inequality decomposition of full-time workers which covers the workers in the first row of Table 1. The MLD decreased by 0.001 from 1992 to 1997, but increased by 0.004 from 1997 to 2002 among male workers. From 1992 to 1997, the decreasing within-group (term A) and between-group inequality (term D) and the positive compositional effect (terms B and C) contributed to the change in overall wage inequality. From 1997 to 2002, the strongly positive within-group inequality and weakly positive between-group inequality dominated the negative compostional effects. These results show that the factors for the expanding overall inequality of full-time workers from 1997 to 2002 are mainly attributed to the increase in within-group inequality for groups of identical age, education, and firm size. The increase in within-group inequality may be caused by the extensive introduction of performance-pay in the late 1990s.[20]

In comparison with previous studies, the trend of the decrease in between-group inequality from 1992 to 1997 and the increase in within-group inequality from 1997 to 2002, shown in Table 2, is very similar to that in Kambayashi et al. (2008) which used the OB decomposition method of variance.[21]

[20]Increasing wage inequality might be caused by reforms in the wage system, such as the introduction of performance pay and the weakining wage negotiation attitude of labor unions.

[21]Kambayashi et al. said, "We show that the modest decline in the variance of the log wage in the first half of the 1990s is attributable to the smaller variance between groups caused by lower returns to

Moreover, the result of the increase in within-group inequality from 1997 to 2002 is similar to the result of Shinozaki (2001, 2006) who carried out factor decomposition of the wage inequality changes by considering only age groups.[22] This implies that even if the analysis considered education qualifications and firm size in addition to age groups, as in this paper, the result would be similar to the analysis of taking only age groups into consideration. Worker's age may be the a more influential factor for the change in the wage inequality than education qualifications, or firm size because of the system of seniority-based wages for the Japanese full-time workers.

Next, I analyze the change in wage inequality among female workers. The factors for the wage inequality expansion were explained by the compositional effects both from 1992 to 1997 and from 1997 to 2002. Within-group inequality among female workers was almost constant in the same period. The increasing trend of the compositional effects among female workers is similar to the findings of Shinozaki (2006) and Kambayashi et al. (2008). Kambayashi et al. explained that the residual variance (within-group inequality), which increased in the late 1990s, was mainly attributed to a shift in the population weight

education and years of tenure for both sexes. The expansion of the variance among males after 1997 is explained by a larger variance within the group" (p.1332).

[22] According to Shinozaki (2001) who studied wage inequality among individuals using the Basic Survey on Wage Structure (BSWS), the male wage inequality reduction in the first half of the 1990s was caused by a decrease in the effect of within-group inequality among each age group that dominated the increase in the effect of population aging. Shinozaki (2006) showed that the main factor for the male wage inequality expansion from the late 1990s to the early 2000s was the increase in within-group inequality among each age group.

toward groups with intrinsically larger residual variance. This is natural because more educated and experienced workers tend to have higher within-group variance.[23]

3.3 Wage inequality among workers including full-time workers and non-regular employees

In the previous subsection, I focused on wage inequality among full-time workers. In the 1990s, Japanese economy suffered a severe recession, and the Japanese labor market underwent significant change. The erosion of the lifetime employment system decreased the number of full-time workers and increased the number of non-regular employees such as short-term employment and part-time workers, which are defined in the following. This subsection analyzes the influence of the increase in non-regular employees on wage inequality, and the factors behind the wage inequality among workers including full-time workers and non-regular employees.

Insert Table 3 Wage inequality (MLD) of each group of workers (including non-regular employees)

Table 3 indicates the transition of the MLD of each groups of workers including part-time workers. The first row shows the MLD among full-time workers, which is the same

[23]The change in the distribution of X which represents workers' attributes in Figure. 3 Panel B in Kambayashi et al. (2008, p.1343).

as the first row in Table 1. The second row indicates the MLD among full-time workers including those working fewer than 35 hours a week and fewer than 200 days a year (second row).[24] The MLD among workers on contracts that last less than a year and workers on daily contracts in addition to the range of workers is shown in the third row. These added workers, including part-time workers, are often called non-regular employees in Japan (and, hereafter, in this paper).[25] The MLD among all worker is shown in the fourth row. Wage inequality increased both from 1992 to 1997 and from 1997 to 2002 among each group of workers of both sexes. Although the wage inequality among female full-time workers was low compared to that among male full-time workers, when part-time and short-term contracts workers were added, the degree of inequality for female workers became larger than that for male workers. This is because the proportion of a part-time and short-term employment among female workers was much higher than that among male workers.[26]

The MLDs among all workers including non-regular employees, workers in small firms, the self-employed, executives, and public workers also increased both from 1992 to 1997 and from 1997 to 2002.

Insert Table 4 Decomposition of work days and work hours among full-time workers and non-regular employees

[24]These workers are often called part-time workers in Japan.

[25]Note that the term "non-regular employee" has another definition in Japan.

[26]Actually, the number of non-regular employees increased saliently since the 1990s (see Table 4).

I next analyze the direct influence of the increase in the number of non-regular employees on wage inequality among the workers represented in the third row of Table 3. Using equation (3), the inequality factor decomposition is performed for the workers divided into five groups on the basis of hours and days worked.[27] Table 4 shows that the compositional effects (terms B and C), – the increase in non-regular employees– accounted for 0.006 of the 0.008 difference of overall wage inequality among male workers from 1992 to 1997 and for 0.014 of the 0.021 difference from 1997 to 2002. Among females, the compositional effects accounted for 0.013 of the 0.024 difference of overall wage inequality from 1992 to 1997 and for 0.014 of the 0.017 difference from 1997 to 2002. These results imply that the expansion of the wage inequality over the periods was mostly due to the increase in the worker percentage of short-time workers (part-time workers) and short-term employment agreement workers. These results are almost the same as those of Ohta (2005) and Shinozaki (2006).[28]

However, the analyses of the wage inequality in Ohta and Shinozaki do not take into account the changes in the composition of workers' attributes such as age, education

[27]In Table 4, the category "others" includes workers on contracts that last less than a year and workers on daily contracts.

[28]Using the dataset of the Employment Status Survey (ESS) which covers a wider range of workers, including part-time workers, than the BSWS, Ota (2005) showed that the increase in wage inequality among young workers was caused by the increase in non-regular employees. By using the data from Special Survey of Labor Force Survey, Shinozaki (2006) showed that the expansion of the wage inequality between 1985 and 2005 could be attributed to the drastic increase in the percentage of non-regular employees.

qualifications, and firm size where workers are employed.

Insert Table.5 Decomposition of age, education, and firm size among full-time workers and non-regular employees

Next, considering those workers' attributes, inequality factor decomposition analysis is performed by using equations (5) and (6). Table 5 shows the results. First, I consider males. From 1992 to 1997, within-group inequality (term A) and compositional effects (terms B and C) contributed to the increase in overall wage inequality. From 1997 to 2002, within-group inequality (term A) and between-group inequality (term D) contributed to the increase in overall wage inequality, but compositional effects negatively contributed. These results imply that the factors behind the expanding overall inequality from 1992 to 1997 were mainly caused by the increase in the change in skill compostion, and those from 1997 to 2002 were mainly caused by the within-group inequality.

These results are essentially similar to the results obtained for male full-time workers in Table 3, however, there are some differences. First, the increasing breadth of the within-group inequality is different. The increase in the non-regular employees among identical workers group that are same age, education qualifications, and firm size, leads to a greater expansion of the wage variance in the group of identical workers. Therefore, the within-group wage inequality shown in Table 5 is larger than that shown in Table 3. In other

words, when the coverage of workers is extended to non-regular employees, the expansion width of the within-group wage inequality becomes larger. The second difference is that between-group inequality effects vanishes including non-regular employees. Further, the increasing breadth of compositional effects becomes much larger. These differences between the results imply that whether non-regular employees are included or not, the results of the analysis can be altered.

Secondly, I consider females. The MLD increased by 0.024 from 1992 to 1997 and by 0.017 from 1997 to 2002 as shown in Table 5. The contribution of widening within-group inequality (term A) and the compositional effects (terms B and C) accounted for almost all the increase in the the overall inequality from 1992 to 1997. In contrast from 1997 to 2002, wage inequality expansion was mostly explained only by compositional effects. The trend of the compositional effects of wage inequality for female workers is similar when non-regular employees are not included. However, the increasing breadth of the within-group inequality is very different from 1992 to 1997.

4 Conclusion

This paper shows the new inequality decomposition method which extends the method proposed by Mookherjee and Shorrocks (1982). In contrast with the single-factor decomposition method of Mookherjee and Shorrocks, this method is able to identify multiple factors for the changes in inequality. The advantage of this method is that it does not

occur measurement errors of regression because it is not necessary to estimate wage equations by regression.

Using this method, this paper analyzed the factors for the change in wage inequality in Japan from 1992 to 2002, based on a micro-level data set from the Employment Status Survey (ESS). The advantage of using the ESS is that it has wider coverage of workers than the Basic Survey on Wage Structure (BSWS). The conclusions obtained from our analysis are summarized below.

Among male full-time workers, wage inequality had a constant or slightly decreasing trend from 1992 to 1997, however, wage inequality increased from 1997 to 2002. The factors for the expanding overall inequality of full-time workers from 1997 to 2002 mainly attributed to the increase in within-group inequality for groups of identical age, education, and firm size. The increase in within-group inequality may be caused by the extensive introduction of performance-pay in the late 1990s. Especially, the trend of the decrease in the between-group inequality from 1992 to 1997 and the increase in the within-group inequality from 1997 to 2002 in the results in Table 2 is supportive of Kambayashi et al. (2008) who used the OB decomposition method.

Among male workers including full-time workers and non-regular employees, wage inequality increased both from 1992 to 1997 and from 1997 to 2002. The factors behind the expanding overall wage inequality among full-time and non-regular employees from 1997 to 2002 were mainly caused by the within-group inequality. This result is essen-

tially similar to that among full-time workers, however, the increasing breadth of the within-group inequality is amplified. This is because the increase in the proportion of non-regular employees among identical workers group that are same age, education qualifications, and firm size, leads to a greater expansion of the wage variance among identical workers groups. In addition, the increase in the percentage of non-regular employees also accounted for some of the widening overall inequality from 1992 to 1997 and from 1997 to 2002.

The Japanese labor market underwent significant change in the late 1990s. The erosion of the lifetime employment system and the introduction of paformance-pay almost certainly caused the change in the wage distribution and increasing wage inequality.[29] Strict empirical analysis of the relation between increasing wage inequality and institutional change or technical change are left for future research.

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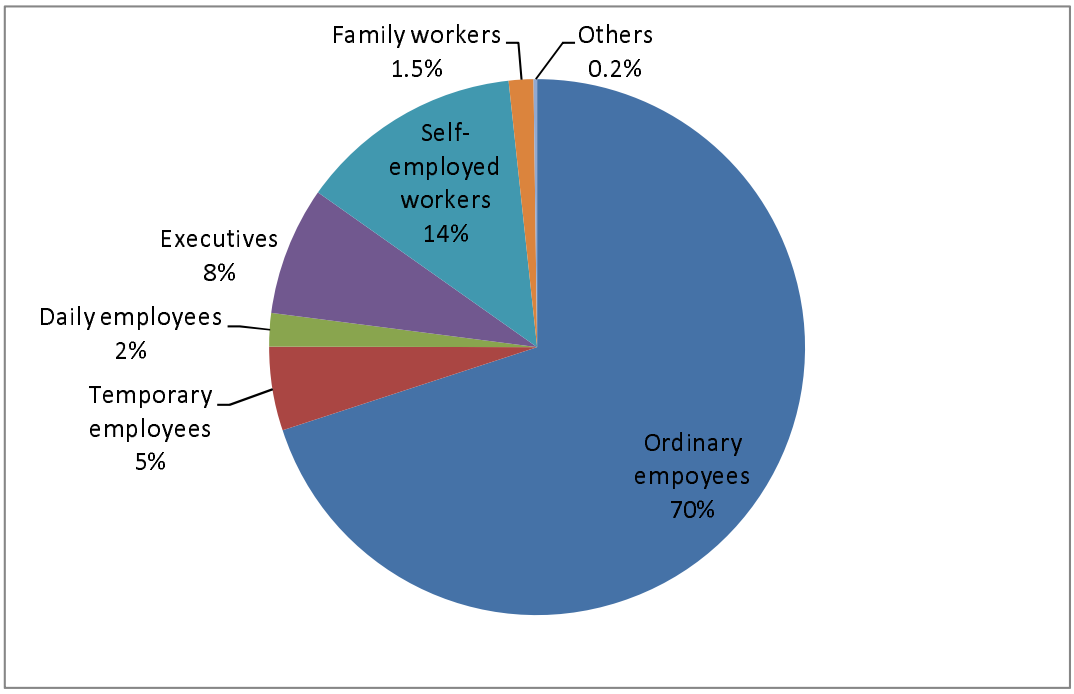

Figure 1: Composition of the male workforce

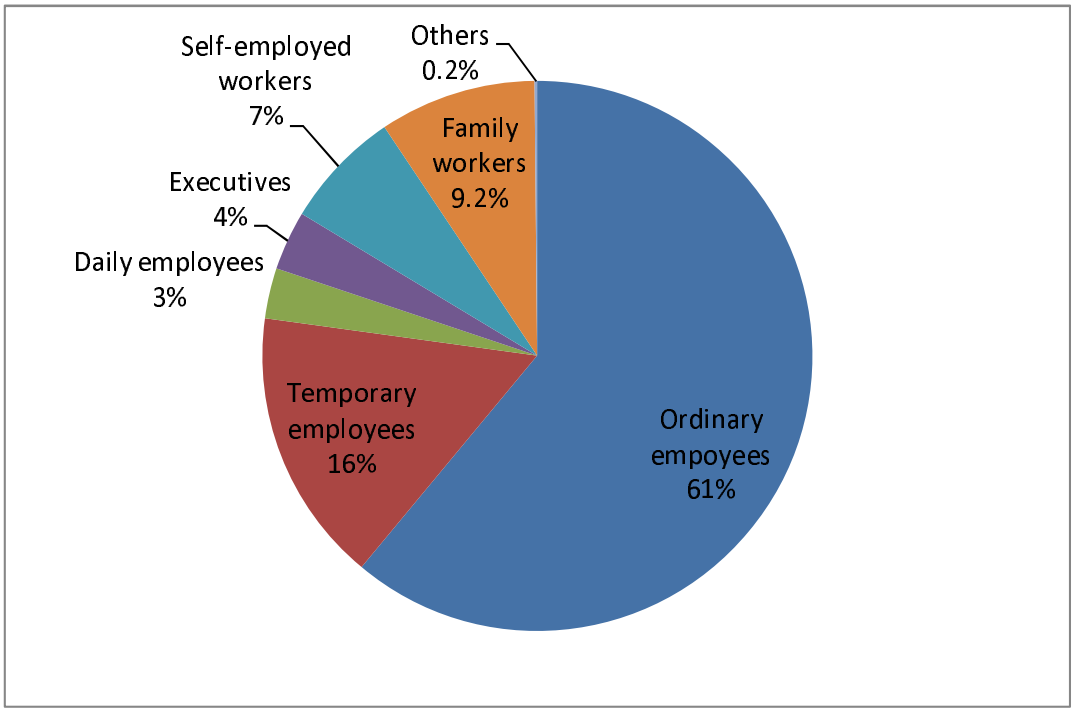

Figure 2: Composition of the female workforce

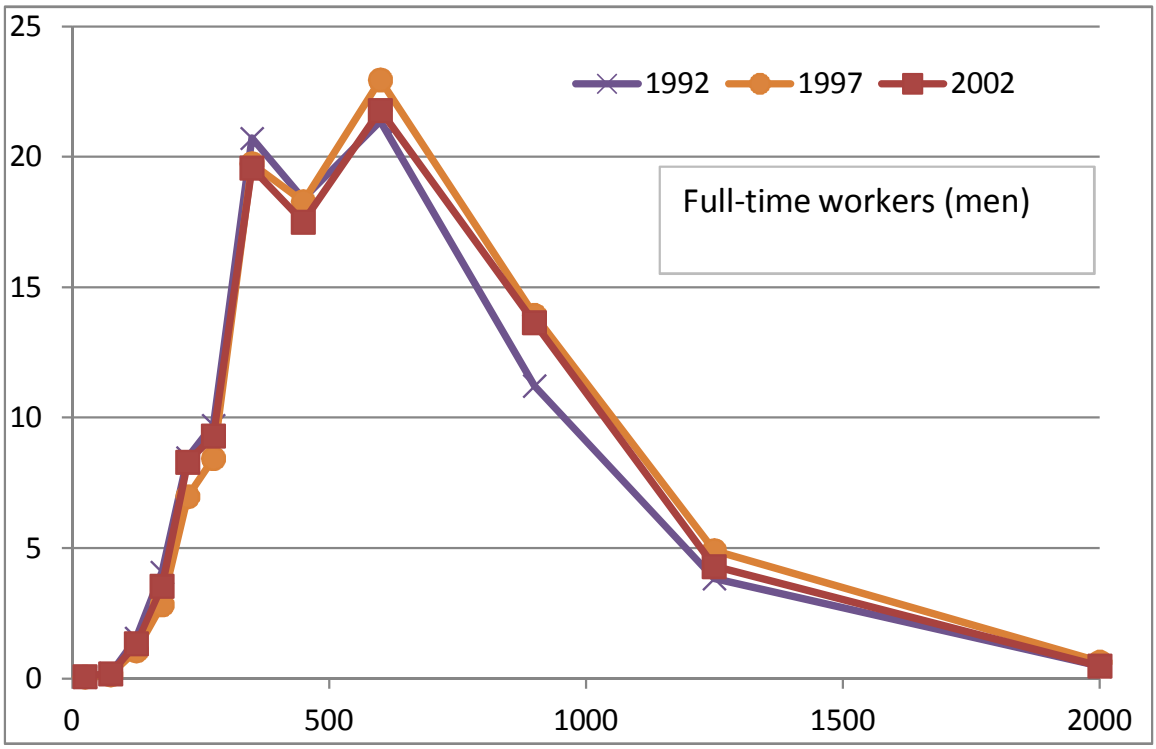

Figure 3: Percentage of male workers classified by annual wage bracket

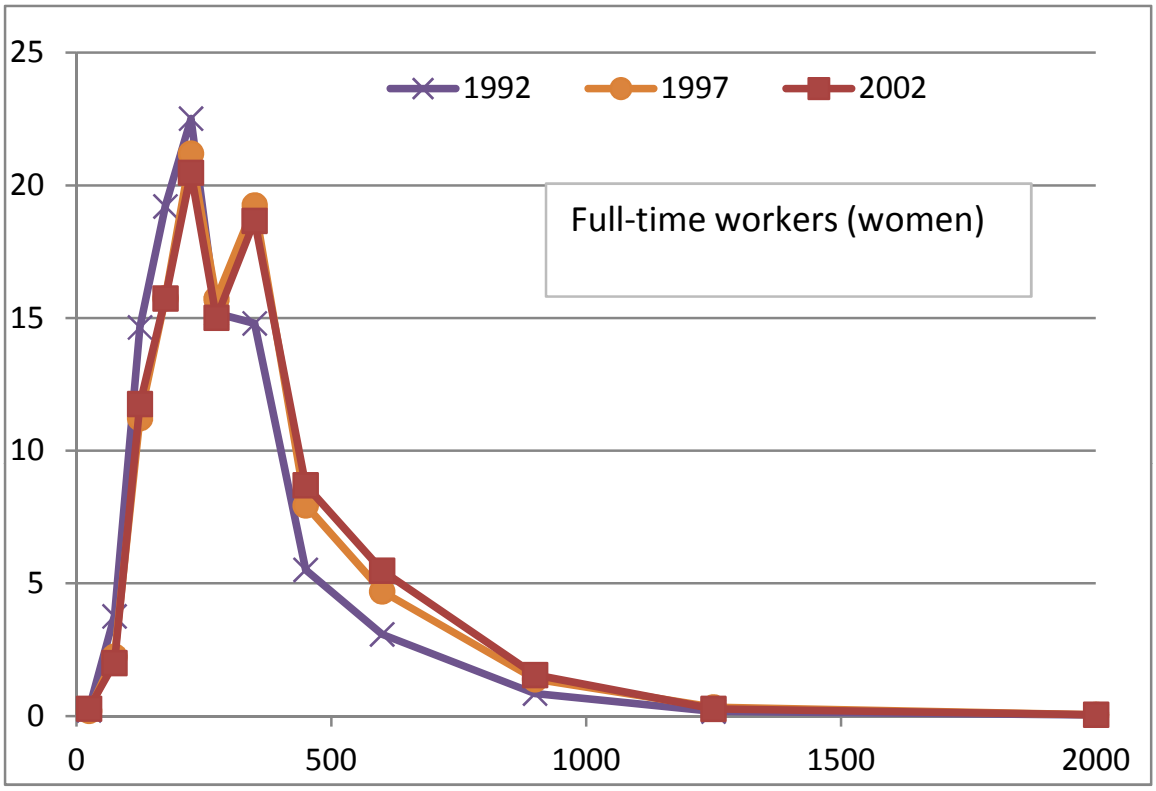

Figure 4: Percentage of female workers classified by annual wage bracket

	Men			Women		
Year	1992	1997	2002	1992	1997	2002
Full-time workers in firms with 5 or more employees	0.135	0.134	0.138	0.118	0.121	0.127
Full-time workers in firms with 5 or more employees plus executives	0.158	0.151	0.155	0.135	0.136	0.140
Full-time workers in firms with at least 1 employee	0.137	0.136	0.141	0.125	0.127	0.134
Full-time workers in firms with at least 1 employe plus self-employed workers	0.163	0.161	0.174	0.155	0.153	0.161
Full-time workers in firms with 5 or more employees plus public workers	0.133	0.133	0.139	0.136	0.145	0.154

Table 1: Wage inequality (i.e., MLDs) for each group of full-time workers

	Men			Women		
Year	1992	1997	2002	1992	1997	2002
Mean (yen)	496.1	533.6	515.6	252.4	282.6	286.5
MLD	0.135	0.134	0.138	0.118	0.121	0.127
Within-group inequality component	0.063	0.063	0.069	0.090	0.092	0.095
Between-group inequality component	0.072	0.071	0.070	0.028	0.029	0.031
Change in aggregate inequality from 5 years ago		-0.001	0.004		0.003	0.005
TermA (within-group inequalities)		-0.001	0.005		-0.001	0.001
TermB (composition)		0.001	0.000		0.003	0.002
TermC (composition)		0.001	-0.002		0.002	0.003
TermD (between-group inequalities)		-0.002	0.001		-0.001	-0.001

Table 2: Decomposition of age, education, and firm size among full-time workers

	Men			Women		
Year	1992	1997	2002	1992	1997	2002
Full-time workers in firms with 5 or more employees	0.135	0.134	0.138	0.118	0.121	0.127
Full-time workers in firms with 5 or more employees plus executives	0.158	0.151	0.155	0.135	0.136	0.140
Full-time workers in firms with at least 1 employee	0.137	0.136	0.141	0.125	0.127	0.134
Full-time workers in firms with at least 1 employe plus self-employed workers	0.163	0.161	0.174	0.155	0.153	0.161
Full-time workers in firms with 5 or more employees plus public workers	0.133	0.133	0.139	0.136	0.145	0.154

Table 3: Wage inequality (MLD) for each group of workers (including non-regular employees)

		Men			Women		
Year		1992	1997	2002	1992	1997	2002
Mean (yen)		464.5	494.7	467.0	196.1	210.1	201.2
MLD	aggregate	0.187	0.195	0.215	0.241	0.265	0.282
	more than 200 days a year and fewer than 35 hours a week	0.139	0.138	0.144	0.125	0.127	0.131
	more than 200 days a year and fewer than 35 hours a week	0.354	0.399	0.383	0.183	0.167	0.150
	fewer than 200 days a year and more than 35 hours a week	0.216	0.204	0.213	0.188	0.194	0.194
	fewer than 200 days a year and fewer than 35 hours a week	0.514	0.450	0.402	0.188	0.192	0.188
	others	0.402	0.420	0.432	0.284	0.307	0.335
Workforce share							
	more than 200 days a year and fewer than 35 hours a week	0.880	0.870	0.841	0.645	0.604	0.547
	more than 200 days a year and fewer than 35 hours a week	0.020	0.020	0.026	0.125	0.143	0.162
	fewer than 200 days a year and more than 35 hours a week	0.046	0.047	0.055	0.053	0.049	0.050
	fewer than 200 days a year and fewer than 35 hours a week	0.021	0.027	0.039	0.108	0.131	0.169
	others	0.034	0.037	0.039	0.069	0.074	0.073
MLD		0.187	0.195	0.215	0.241	0.265	0.282
	Within-group inequality component	0.163	0.165	0.175	0.153	0.158	0.162
	Between-group inequality component	0.023	0.030	0.040	0.088	0.107	0.120
Change in aggregate MLD from 5 years ago			0.008	0.021		0.024	0.017
	TermA (within-group inequalities)		-0.001	0.004		0.002	0.001
	TermB (composition)		0.003	0.006		0.003	0.003
	TermC (composition)		0.003	0.008		0.010	0.011
	TermD (between-group inequalities)		0.003	0.002		0.010	0.002

Table 4: Decomposition of work days and work hours among full-time workers and non-regular employees

	Men			Women		
Year	1992	1997	2002	1992	1997	2002
Mean (yen)	464.5	494.7	467.0	196.1	210.1	201.2
MLD	0.187	0.195	0.215	0.241	0.265	0.282
Within-group inequality component	0.090	0.095	0.111	0.205	0.228	0.238
Between-group inequality component	0.096	0.100	0.104	0.036	0.037	0.044
Change in aggregate inequality from 5 years ago		0.008	0.021		0.024	0.017
termA (within-group inequalities)		0.003	0.016		0.013	-0.002
termB (composition)		0.002	0.000		0.010	0.012
termC (composition)		0.004	-0.002		0.002	0.005
termD (between-group inequalities)		0.000	0.006		-0.001	0.002

Table 5: Decomposition of age, education, and firm size among full-time workers and non-regular employees