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A New Approach to Measuring the Gap between Marginal Productivity and Wages of Workers

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Abstract

The idea that the productivity and wages of workers are not necessarily equal has long attracted the attention of many economists. Indeed, the lack of a method to measure the productivity-wage gap has hindered the development of research on labor economics, productivity analysis, and human capital study. This paper proposes a new empirical method to measure the gap between the value of a worker's marginal product (VMP) and wage. We first define this gap. The method then aggregates the Mincer-type function of each worker's human capital service to obtain the total labor input of a firm. The semi-log form of total labor input can be inserted into Cobb-Douglas and trans-log type production functions and enable expressing of the production function as a linear form of gap parameters. This linear functional form of production function, if applied to employer-employee matched panel data, can control for firm-level productivity differences that would otherwise cause biases in estimating the gap coefficients. We apply the new method to Japanese employee-employer matched panel data and find that the gap between the VMP and wage is not so large. The traditional way of measurement, in which wage acts as a proxy of worker productivity, could be a rough approximation.

Keywords: Productivity; Human capital; Production function; Wage
JEL classification: D24, J24, L23

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I. Introduction

The idea that worker productivity and wages are not necessarily equal has attracted the attention of many economists. The interest in the productivity-wage gap has indeed been the driving force behind developing the study of economics, including the studies by Adam Smith, David Ricardo, Karl Marx, and Leon Walras.

Modern economists have also developed theoretical models to explain the productivity-wage gap. Becker (1964) establishes a model in which the cost and return of firm-specific training are attributed to firms. This firm-sponsored training model predicts that wages are higher than net productivity during training periods because of firm-sponsored training costs. Once the training is completed, the productivity of workers will surpass their wages, and firms will earn returns from their training investment. Another explanation for the possible productivity-wage gap is the agency problem between employers and workers. Lazear (1979) proposes a model in which employers offer deferred compensation to workers in order to prevent them from shirking or quitting. In the deferred compensation model, the wage of a worker is lower than productivity in the earlier period of the worker's career and becomes higher in the later stages.

The theoretical models of Becker and Lazear predict a discrepancy between the spot wage and spot value of the worker's marginal product (VMP). Many empirical economists have investigated this discrepancy. Three main methods have been used to study the discrepancy between productivity and wages.

First, Lazear and Moore (1984) and Kawaguchi (2003) compare the age-earning profiles of wage and salary workers with those of the self-employed. Lazear and Moore (1984) assume identical human capital accumulation between salary workers and the self-employed. The steepness of wage and salary workers' age-earning profiles reflects the desire of employers to provide work incentives to them. Since the self-employed do not face agency problems, they are used as a benchmark to gauge productivity. Kawaguchi (2003) supports Lazear's contract theory, which argued that the deferred payment system is used to avoid agency problems. Owing to opportunity cost, the self-employed invest less in human capital accumulation in their jobs than do wage and salary workers. Kawaguchi (2003) shows that the self-employed are not necessarily a good "control" group to test Lazear's contract theory, since not only the incentive effect of Lazear's incentive effect produces steeper wage profiles of wage and salary workers but also the difference of human capital accumulation has this same effect.

Second, Medoff and Abraham (1980), Shaw and Lazear (2006), and Odaki and Kodama (2010) measure productivity and wages directly. Medoff and Abraham (1980) use the record of each individual's performance rating and salary in two U.S. manufacturing companies. In the companies, supervisors review each subordinate's performance once a year. Medoff and Abraham (1980) indicate that there is a positive association between experience and relative earnings, and there is either no association or a negative one between experience and its relative rated performance. The results imply that human capital in an on-the-job training model cannot explain a substantial part of the observed return to labor market experience. Shaw and Lazear (2006) use the data on the output and pay of individual workers involved in the installation of windshields. They show that pay profiles are much flatter than output profiles in the first year and a half on the job. Workers who stay longer have higher output levels and faster early learning, which is consistent with the worker selection model. Odaki and Kodama (2010) measure the relation between productivity and wages by using each individual's subjective qualitative answer to a question asking the employees to compare their wages and productivity.

Third, Hellerstein et al. (1999), Hellerstein and Neumark (2004), Ilmakunnas et al. (2004), Crepon et al. (2002), and Kawaguchi et al. (2007) estimate the contribution of workers to the production function of firms and compare their estimated productivity with wages. Using plant-level data, Hellerstein et al. (1999) estimate the relative marginal productivity differentials and relative wage differentials among the different types of workers. They use the share of workers in different characteristic groups defined by age, education, etc., to form a quality-adjusted labor input using nonlinear least squares methods. The higher pay of prime-aged and older workers is reflected in their higher point estimates of their relative marginal products, but the lower relative earnings of women are not reflected in their lower relative marginal products. Hellerstein and Neumark (2004) use the same approach of Hellerstein et al. (1999) with a larger data set and find that the estimated relative wage profiles are steeper than the relative productivity profiles.

Ilmakunnas et al. (2004) examine the relationships between worker characteristics and productivity using a matched worker-plant data set from the Finnish manufacturing industry. They calculate a multilateral total factor productivity (TFP) index and explain it with average employee characteristics such as age, seniority, and education in order to examine their productivity effects. A low plant average age improves productivity more than it does wages, but for higher ages, productivity and wage returns to age are fairly similar. The returns to education in terms of wages and productivity are fairly close to each other for higher levels of education, but mid-level education is underpaid.

Crepon et al. (2002) estimate the differences in relative marginal products and relative wages using both the production function and earning equation where the share of hours in Hellerstein et al. (1999) is replaced by the share of total cost. They find no or little wage discrimination against women, who appear to hold less productive jobs, while older workers are relatively overpaid, or equivalently, and younger workers are underpaid.

Kawaguchi et al. (2007) show the productivity-tenure profile and the wage-tenure profile by estimating the plant-level production function and the wage equation using employer-employee matched data of Japanese manufacturing firms. The production function and wage equation are separately estimated using nonlinear least-squares estimation under the moment condition that the error terms and explanatory variables are not correlated. Productivity is normalized at one for productivity at zero years of tenure, and the constant term of the wage profile is set so that total productivity and wages are equal after 40 years.

These studies compare the relative productivity and relative wages across workers in different demographic groups using the estimations of the production function and the wage equation. The problem with these approaches is that they draw the wage and productivity profiles on separate sheets; we need to see both profiles on the same diagram in order to examine the gap and crossing point. The lack of empirical methods to measure the gap between productivity and wages thus hinders the development of the study of labor economics, human capital, and productivity analysis.

This paper proposes a new empirical method to measure this gap. Starting with the standard Mincer-type function, we first define the productivity-wage gap function. We then add the gap and wage functions to obtain the human capital productivity function. Next, the human capital productivity function is aggregated for all workers within a firm in order to acquire the labor service input employed by the firm. The labor service input, together with the other inputs such as capital and materials, serves as the variables of the trans-log production function of the firm. The estimation of this production function yields the coefficients of the productivity-wage gap function.

The main contribution of this paper is to estimate the coefficients of the gap function between productivity and wages. In addition, this method is based on, and consistent with, the standard human capital equation and the standard production function. Furthermore, because our production function includes the coefficients of the gap function in a linear form, this method, if applied to panel data, can control for the firm-level productivity differences, which would otherwise be correlated with human capital distribution across firms. Also, this method can also control, to a large extent, for industry-specific business cycle effects, which would also generate a bias.

The outline of this paper is as follows. The next section explains the empirical method. Chapter 3 describes the Japanese employer-employee matched panel data. In Chapter 4, we show the results of the estimation of the production function and wage equation. In Chapter 5, we display and discuss the features of tenure-productivity and tenure-wage profiles by gender and education. Chapter 6 provides our conclusions and some topics for future research.

II. Measuring the Gap between Productivity and Wages

This chapter develops a new empirical method to measure the gap between worker productivity and wages. First, we define the gap function between worker productivity and wages on the basis of the standard Mincer-type function. Next, we aggregate the labor service of workers employed in a firm. Then, we introduce the labor service input of a firm to the production function in a linear form.

(1) Defining the productivity-wage gap

We start with the standard Mincer-type wage equation. The wage per hour of a worker i with attribute type s is expressed as

$$\ln w_i = \varphi_0^s + \varphi_1^s ex_i + \varphi_2^s ex_i^2 + \varphi_3^s ten_i + \varphi_4^s ten_i^2 + \varepsilon_i \qquad (eq.1)$$

where w_i represents the hourly wage of worker i, ex_i experience years, ex^2_i the square of experience years, ten_i the tenure years, and ten^2_i the square of tenure years of worker i. The shape of the wage profiles should differ across the attributes of the workers. Therefore, we allow the five parameters－φ_0 to φ_4－to differ across s, the attribute types of the workers. In the next chapter, we divide the workers into nine groups, s = 1 to 9, eight for regular workers by gender and education and one for part-time workers[1].

Worker productivity is not necessarily equal to their wage rates. The productivity per hour of worker i of attribute s is expressed as

$$\ln l_i = \theta_0^s + \theta_1^s ex_i + \theta_2^s ex_i^2 + \theta_3^s ten_i + \theta_4^s ten_i^2 + \nu_i \qquad (eq.2)$$

where l_i is the labor service per hour－the productivity－of worker i. The shape of the productivity profiles also differs across the attributes of workers. Therefore, we allow the five parameters, θ_0 to θ_4, to differ across attributes s.

Now, we define the gap function as the difference between the log productivity and the log wage.

$$gap_i = \ln l_i - \ln w_i \qquad (eq.3)$$

This "gap" is the ratio by which productivity exceeds wage. In other words, this gap represents the exploitation rate with which the employers "squeeze" their workers. A negative gap means that the marginal product of workers is less than their wages.

Subtracting (eq. 1) from (eq. 2), the gap function can be expressed as

$$gap_i = \delta_0^s + \delta_1^s ex_i + \delta_2^s ex_i^2 + \delta_3^s ten_i + \delta_4^s ten_i^2 + \nu_i - \varepsilon_i \qquad (eq.4)$$

[1] We simplify the wage and productivity profile forms of part-time workers because of data availability and the diversity of the human capital of part-time workers.

where coefficients δ^{s}_{0} to δ^{s}_{4} are defined as

$$where \qquad \delta_j^s = \theta_j^s - \varphi_j^s \qquad (eq.5)$$

Using the gap function, the productivity of worker i is expressed as the sum of the wage and the gap function:

$$\ln l_i \quad = \ln w_i + gap_i \qquad (eq.6)$$

Because the gap_i is small in magnitude, (eq. 6) can be approximately rewritten as

$$l_j \quad = w_i(1 + gap_i) \qquad (eq.7)$$

It should be noted that both l_i and w_i, productivity and wages, are expressed in a non-logarithmic form in (eq. 7).

(2) Aggregating labor service input of a firm

In order to obtain the labor service input of a firm, the human capital function of various workers based on attributes, tenure, age, and gender should be summed up. In fact, aggregating the human capital function of workers has been a difficult task in empirical economics. If the hourly labor service supply of worker i with attribute s is expressed in the standard Mincer-type functional form (eq. 2), the labor service input of firm j will be

$$\begin{aligned} L_j \quad &= \sum_{i \in J} l_i h_i \\ &= \sum_{i \in J,S} h_i \exp(\theta_0^s + \theta_1^s ex_i + \theta_2^s ex_i^2 + \theta_3^s ten_i + \theta_4^s ten_i^2 + v_i) \end{aligned} \qquad (eq.8)$$

where L_j is the labor service input of firm j and h_i is the working hours of worker i. The right-hand side of (eq. 8) is the summation of the exponential terms across all workers in firm j. Because (eq. 8) contains many nonlinear terms, it is quite difficult to estimate the parameters empirically[2].

We already have the productivity of worker *i* (eq. 7) in the previous section. Because the left-hand side of (eq. 7) is in non-logarithmic form, we can easily aggregate the labor service input within a firm.

$$
\begin{aligned}
L_j &= \sum_{i \in J} l_i h_i \\
&= \sum_{i \in J} w_i h_i (1 + gap_i) \\
&= W_j (1 + \sum_{i \in J} \mu_i gap_i) \qquad (eq.9)
\end{aligned}
$$

$$
where \qquad W_j = \sum_{i \in J} w_i h_i, \qquad \mu_i = w_i h_i / W_j \qquad (eq.9.2)
$$

Here, $W_j = \Sigma w_i h_i$ is the total wages paid by firm *j*, and μ_{ij} ($= w_i h_i / W_j$) is the wage share of worker *i* in the total wages W_j.

The term $\Sigma \mu_i * gap_i$ is the weighted average of the individual worker's productivity-wage gap, so the magnitude of the term is close to zero. Therefore, taking the logarithm of both sides of (eq. 9) yields

$$
\begin{aligned}
\ln L_j &= \ln W_j (1 + \sum_{i \in J} \mu_i gap_i) \\
&= \ln W_j + \sum_{i \in J} \mu_i gap_i \qquad (eq.10)
\end{aligned}
$$

Equation (eq. 10) shows that the log of the total labor service input of a firm is the sum of the log of the total wages and the weighted average of the gap function of individual workers.

Inserting the Mincer-type expression of the individual gap function (eq. 4) in (eq. 10) yields

[2] Because of the difficulty in aggregating the labor service input, economists often use total man-hour or total wage as the labor input measurement.

$$\ln L_j = \ln W_j + \sum_S (\delta_0^s \sum_{i\in J,S} \mu_i + \delta_1^s \sum_{i\in J,S} \mu_i ex_i + \delta_2^s \sum_{i\in J,S} \mu_i ex_i^2 + \delta_3^s \sum_{i\in J,S} \mu_i ten_i + \delta_4^s \sum_{i\in J,S} \mu_i ten_i^2 + \sum_{i\in J,S} \mu_i (\nu_i - \varepsilon_i)) \qquad (eq.11)$$

Note that if the data of wage, tenure, and experience of each worker are available, (eq. 11) can provide a semi-log expression of the total labor service input of a firm with a linear combination of undetermined coefficients.

(3) Estimating gap coefficients by regressing production function

Economists often use the Cobb-Douglas and trans-log functions to analyze the production function. Labor inputs in these production functions take a logarithmic form. The left-hand side of (eq. 11) is the log of the total labor input, and the right-hand side is the sum of the log of total wages and a linear combination of undetermined coefficients δ_0^s to δ_4^s. Therefore, (eq. 11) can be easily introduced into the production function and estimated using standard econometric methods.

In this paper, we demonstrate the simplest application of (eq. 11) to the Cobb-Douglas production function:

$$\ln Y_{jt} = \ln A_{jt} + \beta_{Kjt} \ln K_{jt} + \beta_{Ljt} \ln L_{jt} + \beta_{Mjt} \ln M_{jt} + u_{jt} \qquad (eq.12)$$

where A_j, Y_{jt}, K_{jt}, $L_{jt,}$ and M_{jt} represent the total factor productivity, output, capital service, labor service, and intermediate materials, respectively, of firm j at time t, and β_{Kt}, β_{Lt}, and β_{Mt} are the output elasticities of three inputs. By applying (eq. 12) to firm-level panel data and introducing the firm-level fixed effect, (eq. 12) can be re-written as

$$\ln Y_{jt} = \beta_{Kjt} \ln K_{jt} + \beta_L jt \ln L_{jt} + \beta_{Mjt} \ln M_{jt} + FCT_j + u_{jt} \qquad (eq.13)$$

where *FCTj* represents the firm-level constant terms of firm *j*.

We allow the output elasticities of each inputs, β_{Kt}, β_{Lt}, and β_{Mt}, to differ across firms and over time. Because we assume that wages are not necessarily equal to the marginal product of labor service, the output elasticities of three inputs, β_{Kt}, β_{Lt}, and β_{Mt}, should be allowed to differ from factor shares. Therefore, we introduce three adjusting coefficients before each factor share, and the production function (eq. 13) can be expressed as

$$\begin{aligned}\ln Y_{jt} &= \eta_K S_{K\,jt} \ln K_{jt} + \eta_L S_{L\,jt} \ln W_{jt} + \eta_M S_{M\,jt} \ln M_{jt} \\ &+ \eta_L S_{L\,jt} \sum_S \{\delta_0^s \sum_{i \in J,S} \mu_{it} + \delta_1^s \sum_{i \in J,S} \mu_{it} ex_{it} + \delta_2^s \sum_{i \in J,S} \mu_{it} ex_{it}^2 \\ &+ \delta_3^s \sum_{i \in J,S} \mu_{it} ten_{it} + \delta_4^s \sum_{i \in J,S} \mu_{it} ten_{it}^2 + \sum_{i \in J,S} \mu_{it} (\nu_{it} - \varepsilon_{it})\} \\ &+ FCT_j + u_{jt} \qquad (eq.14)\end{aligned}$$

where S_{Kjt}, S_{Ljt}, and S_{Mjt} are the input cost shares of capital, labor, and intermediate materials, η_K, η_L, and η_M are adjusting coefficients between the input elasticities and the factor cost shares, respectively. Applying (eq. 14) to firm-level panel data, we estimate η_K, η_L, η_M, and $\eta_L \delta_0^s$ to $\eta_L \delta_4^s$.

The advantage of this empirical method is that it can control for firm-level productivity differences if applied to firm-level panel data. Another advantage is that this method can estimate the term δ_0^s even after controlling for firm-level productivity differences. The term δ_0^s is a vital term to pin the wage and productivity profiles on a single chart, although this term can never be measured in the existing literature.

III. Japanese Employer-Employee Matched Panel Data

We create a novel employer-employee matched panel data from 1998 to 2003. Employer-side data is from the Basic Survey of Japanese Business Structure and Activities (BSJBSA), and employee data is from the Basic Survey on Wage Structure (BSWS), using the Establishment and Enterprise Census (EEC) as key.

The BSJBSA is a survey conducted annually by the Ministry of Economy, Trade, and Industry (METI), targeting about 40,000 firms in the manufacturing, commerce, and some service industries. The survey excludes some service industries such as finance, real estate, hospitals, and schools. In addition, as the survey targets only firms that have both a minimum of 50 or more employees and 30 million yen or more capital, small-sized firms are not included. The BSJBSA covers information on sales, total wages, depreciation, number of employees, and cost share of capital, labor, and intermediates.

The BSWS is an annual survey conducted by the Ministry of Health, Labour and Welfare, targeting establishments with five or more permanent employees. It extracts data on the establishments to be surveyed in two steps: first, it extracts data on the establishments themselves, and second, the employees in the targeted establishments. Each establishment is asked to pick employees randomly at a specified sampling rate, which varies from 1/1 to 1/90, depending on its size and industry. Each year, the number of establishments and employees surveyed are about 70,000 and 1,600,000, respectively. The employers provide individual employees' information on wages, age, gender, educational background, tenure, and hours worked as in June of the survey year and annual bonus amounts for the year prior to the survey.

The BSWS data is aggregated at the company level and merged with the BSJBSA data. We use the matching data set covering 24,000 firms, 15,800 firms in the manufacturing industry and 7,500 in the service industry. We estimate the wage function using the data of 1,260,000 employees. Table 1 shows the matching rate, number of matching firms, and number of employees for each year.

Table 2 gives the descriptive statistics. The average number of employees per company for our analysis is 811, and the average sales amount is 42,430 million yen. The average number of employees and sales of all companies in the BSJBSA are 394 employees and 21,720 million yen, respectively, thus our sample companies' size is larger than that of the representative pre-match sample. The ratios of female, male, and part-time workers are 22.1 percent, 77.9 percent, and 5.8 percent, respectively. The ratios of male high-school graduates, female high-school graduates, male 4-year college graduates, and female 4-year college graduates are 39.6 percent, 10.3 percent, 24.9 percent, and 2.3 percent, respectively. The average tenure (years of working in the current company) of workers is 14.4 years. The cost shares of capital, labor, and materials are 7.2 percent, 20.6 percent, and 72.1 percent, respectively. The ratio of companies in the manufacturing industry is 58.4 percent and that in the services industry is 39.1 percent.

IV. Empirical Results

Table 3 shows the estimation results of the production function and wage equation for all industries. Column 1 in Table 3 gives the estimation results of the production function (eq.14) in the previous section, and column 2 gives the estimation results of the wage equation (eq.1). η_K in (eq.14), the adjusting coefficient of $S_{K\,jt} \ln K_{jt}$, is 0.94. η_L and η_M are estimated to be 1.16 and 0.94, respectively. The output elasticity of labor is estimated to be slightly larger than the wage share, while output elasticities of capital and intermediate inputs are slightly smaller than their cost shares. We also confirm that the scale elasticity of the production function where the input cost shares to be equal to the average of our sample firms, $\eta_K \overline{S_{K\,jt}} + \eta_L \overline{S_{L\,jt}} + \eta_M \overline{S_{M\,jt}}$, is 1.04. This shows that the scale elasticity of the production function is almost unity. The coefficient for the part-time workers' dummy variable indicates that part-time workers receive higher wages compared to their productivity. Tables 4 and 5 report the results of the production function and wage equation for the manufacturing and service industries.

In the cross-sectional analysis, all explanatory variables are assumed to be exogenous. Since all high-performance companies tend to have many male college graduates, we may observe that male college graduates enhance firms' performance. We should argue this unobserved heterogeneity across firms. As a remedy for the endogeneity, the fixed-effects estimation is often suggested.

Tables 6 to 8 show the production function and wage equation estimation results using fixed-effect models. Table 6 shows the results for all industries, Table 7 for the manufacturing industry, and Table 8 for the service industry. η_K , η_L and η_M in (eq. 14) are equal to 1.07, 1.01, and 0.98, respectively; the scale coefficient is 0.99. We confirm that the scale coefficient is almost unity. The coefficient for the part-time workers' dummy variable indicates that part-time workers receive higher wages than their productivity.

In this paper, we call employees who have worked in the same company almost since graduation as "non-mid career." The "non-mid career" rates by gender and education background are presented in years in Table 9. Among the high-school educated males, the "non-mid career" rate for those with 10-year work experience is 80 percent, that for those with 20-year work experience is 64 percent, and that for those with 30-year work experience is 66 percent. As for high-school educated females, the "non-mid career" rate for those with 10-year work experience is 79 percent, that for those with 20-year work experience is 50 percent, and that for those with 30-year work experience is only 24 percent.

V. Discussion

There are examples of gap profiles (left column) and tenure-productivity and tenure-wage profiles (right column) in Figure 1-4. As shown in Figure 1, the productivity of workers in the manufacturing industries is lower than their wages throughout their working period. Figure 2 shows that the productivity of workers in service industries too is lower than wages almost throughout their working period.

This cross-sectional analysis may have a problem. In cross-sectional comparisons, firms with higher TFP often employ more capital and fewer workers. In this case, the cross-sectional analysis, which runs the regression of (eq.14) without the term *FCTj*, may have a bias that underestimates the gap coefficients. This bias could arise because these coefficients are on the variable *SLjt* that is negatively correlated with the omitted *FCTj*.

We show the tenure-productivity and tenure-wage profiles of male high school graduates in the manufacturing industries in row 1 of Figure 3. The ratio of male high school graduates to all workers is 45 percent, and the estimation is robust. The tenure-productivity and tenure-wage profiles of male high school graduates are convex shaped. In manufacturing industries, the value of a gap function as the difference between log productivity and log wage is -0.14 when both the working years in the current company and years of experience are zero. The value of the gap function changes from negative to positive when the number of working years is 13, peaks at 20, and reverts from positive to negative at 27. The hourly wage is 1,244 yen when the number of years worked is zero, and increases thereafter for 42 years: 1,931 yen for 10 years, 2,665 yen for 20 years, and 3,269 yen for 30 years. As a result, productivity is lower than wages at the beginning of their careers (from zero to 12 years). Wages surpass productivity from 13 to 26 years of job tenure, but after 27 years, productivity falls below wages again. In the initial stage of their careers, productivity grows faster and becomes higher than wages after training is completed. In the later stages of their careers, wages grow faster and become higher than productivity, as predicted by the deferred compensation model.

The tenure-productivity and tenure-wage profiles of female high school graduates in the manufacturing industries are shown in row 2, Figure 3. The ratio of female high school graduates to all workers is 10 percent, and productivity is almost as high as wages for their initial 20 years. Although their wage profiles are basically increasing and convex shaped, productivity starts to decrease after 20 years of tenure. In reality, there are only a few long-tenure female workers; for example, the survival rate of female high school graduates in the current company 30 years after graduation is 24 percent. The hourly wage of female high school graduates is 1,208 yen at zero years of tenure, 1,615 yen at 10 years, 2,052 yen at 20 years, and 2,319 yen at 30 years. The overlap of productivity and wages at the beginning of their careers and surplus wages when female high school graduates are near retirement age imply that they have neither invested in nor accumulated human resources.

Row 4 of Figure 3 shows the tenure-productivity and tenure-wage profiles of male 4-year college graduates in the manufacturing industries. The ratio of male 4-year college graduates to all workers is 22 percent. The value of the gap function is negative at zero years of job tenure, increases gradually, and turns positive at 24 years. The absolute gap function value is nearly zero. Productivity and wages overlap during their working period. The hourly wage of male 4-year college graduates is 1,244 yen at zero years of tenure, 2,380 yen at 10 years, 3,527 yen at 20 years, and 4,371 yen at 30 years. When their wages increase, productivity increases in parallel. This implies that male 4-year college graduates accumulate human resource investment neither from the company nor by deferred compensation.

The tenure-productivity and tenure-wage profiles of female 4-year college graduates in the manufacturing industries are shown in row 4, Figure 3. The ratio of female 4-year college graduates to all workers is only 2 percent, and most of them have less than a 10-year tenure. We need to note that the sample size of female 4-year college graduates is so small that the estimation is not robust, especially for workers with a long tenure. As for female 4-year college graduates, the value of the gap function is negative at zero years of tenure, turns positive at 7 years, and turns negative again after 15 years. After 25 years of tenure, there is a large difference between their tenure-productivity and tenure-wage profiles. This is because the ratio of female 4-year college graduates is only 2 percent, and, furthermore, the ratio of workers who continue to work in the current company for over 10 years is less than 20 percent. The expected period of investing in and harvesting from the human resources of female 4-year college graduates is shorter than that of male 4-year college graduates, because the average tenure of females is shorter than that of males. This finding matches the human resource investment model.

An empirical problem with regard to firm-level fixed-effect analysis is that the business cycle or demand shock may correlate with the explanatory variables. For example, it is often the case that firms in the service industry can adjust their labor service inputs more rapidly than manufacturing firms. Therefore, employment in the service industry fluctuates along with demand shocks. This means that *ujt* in (eq. 14) is positively correlated with *SLjt*. The gap coefficients, which are measured as the coefficients on *SLjt*, may therefore be upward biased particularly in the service industry.

VI. Concluding Remarks

The contribution of this paper is to formalize a simple empirical model to measure the gap between the value of a worker's marginal product and wage. The definition of our gap function is consistent with the Mincer-type standard semi-log equations for human capital and wages. Using the gap function, the firm-level aggregated labor input is easily expressed in the semi-log equation. Firm-level labor inputs can then be inserted in the standard production functions to yield an empirical model including the linear combination of gap coefficients. Because of this linearity, our empirical model can easily be applied to advanced econometric methods, especially those for panel data analysis.

This paper has shown that the gap between a worker's VMP and wage is not so large. The traditional empirical method, in which wages act as a proxy of the productivity of workers, could be a good approximation. The productivity of male high school graduates is lower than their wages during the early stages of their careers, higher during the mid-stage, and once again lower during the years prior to retirement. The productivity of male 4-year college graduates almost equals their wages throughout their careers. We also note that the wages of women correspond with their productivity. We find no evidence for gender discrimination. The wages of women almost equal their productivity in the early stages of their careers, but exceed productivity during the later stages. The wages of part-time workers equal their productivity in the manufacturing industries but are lower in the service industries.

One obvious limitation of cross-sectional analysis is that firms with higher TFP often employ more capital and fewer workers. In this case, our cross-sectional analysis may have a bias that underestimates gap coefficients. This is because the coefficient of labor share is negatively correlated with the omitted variable.

Fixed-effects estimation also has a limitation. It is often suggested as a remedy for endogeneity, but the variations of input tend to be small, and within-plant input variations tend to have a strong correlation with temporary productivity shocks. It is often the case that labor share becomes low when the demand for a firm is temporarily high. This means that the error term is negatively correlated with labor share. The gap coefficients, which are measured as the coefficients on labor share, may therefore be negatively biased. Olley and Pakes (1996) and Levinsohn and Petrin (2003) pointed out that fixed-effects estimation may even exacerbate the endogeneity bias. Also, although we already adjust the difference between the output elasticity of each input and its factor share in the Cobb-Douglas production function, the use of instrumental variables will improve the efficiency of the estimation. Therefore, the application of the method proposed by Olley and Pakes (1996) or Levinsohn and Petrin (2003) to our empirical model will be a next step to develop the econometric method to measure the gap between wages and productivity of human capital.

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Table 1.The Matching Rate of Employee Data and Employer Data						
	Number of firms in BSJBSA	Number of frims used for analysis	Number of frims used for analysis (Manufacturin	Number of frims used for analysis (Service	Number of employees used for analysis	Matching rate
Year	A	B	C	D	G	B/A
1998	26,270	3,702	2,603	968	189,127	0.14
1999	25,841	3,738	2,660	969	191,370	0.14
2000	27,655	3,846	2,544	1,198	208,750	0.14
2001	28,151	4,014	2,601	1,289	214,592	0.14
2002	27,545	4,275	2,675	1,493	226,984	0.16
2003	26,634	4,360	2,674	1,581	228,424	0.16
Total	162,096	23,935	15,757	7,498	1,259,247	0.15

Note: The number of colume "A" include firms who answered the total sales.
The number of colume "B" is counted when both BSJBSA and BSWS data are matched in the same year.

Table 2. Descriptive Statistics			
Variable	All Industry	Manufacturing	Service Industy
Number of Firms	23935	15757	7498
Total Sales	42912	42418	45554
Cost Share of Capital	0.07	0.08	0.07
Cost Share of Labor	0.21	0.22	0.20
Cost Share of Intermediate Materials	0.71	0.70	0.73
Total Employment	825	781	952
Number of Regular Workers	691	734	625
Number of Part-time Workers	151	53	370
Ratio of Manufacturing	0.66	1.00	0.00
Ratio of Service Industry	0.31	0.00	1.00
Number of Employees	1259247	819480	413570
Years of Tenure	14.9	15.7	13.3
Years of Working Experiment	21.7	22.7	19.4
Male Ratio	0.79	0.81	0.74
Female Ratio	0.21	0.19	0.26
Part-time Workers Ratio	0.05	0.03	0.17
Age -29	0.21	0.20	0.25
Age 30-39	0.24	0.24	0.26
Age 40-49	0.26	0.26	0.25
Age 50-	0.29	0.30	0.25
Junior High School Gaduates	0.09	0.11	0.05
High School Graduates	0.51	0.56	0.43
2-yr College Graduates	0.09	0.07	0.13
4-yr College Graduates	0.26	0.23	0.31
Male, Junior High School Gaduates	0.07	0.09	0.04
Male, High School Graduates	0.41	0.45	0.33
Male, 2-yr College Graduates	0.06	0.05	0.08
Male, 4-yr College Graduates	0.24	0.22	0.28
Female, Junior High School Gaduates	0.02	0.02	0.01
Female, High School Graduates	0.10	0.10	0.10
Female, 2-yr College Graduates	0.03	0.02	0.05
Female, 4-yr College Graduates	0.02	0.01	0.03

Note: 2-yr college graduates include special training school grads (*Koto Senmon Gakkou*).
4-yr college gradutes include those who graduatede from graduate school.

Table 3. Production Function and Wage Equation (All industries)

lnY	Coef.	Std. Err.	t	P>|t|	lnw	Coef.	Std. Err.	t	P>|t|
SKjt * lnKjt	0.964	0.014	68.060	0.000					
SMjt * lnMjt	0.944	0.002	387.420	0.000					
SLjt * lnLjt	1.157	0.013	89.710	0.000					
SLjt * Part-time worker	-1.015	0.140	-7.250	0.000	Part-time worker	0.08	0.02	3.57	0.00
SLjt * Male Junior High Grad.	-0.439	0.679	-0.650	0.518	Male Junior High Grad.				
SLjt * Female Junior High Grad.	-2.583	1.336	-1.930	0.053	Female Junior High Grad.	-0.02	0.03	-0.60	0.55
SLjt * Male High Grad.	-0.662	0.147	-4.490	0.000	Male High Grad.	0.34	0.02	15.46	0.00
SLjt * Female High Grad.	-1.160	0.210	-5.520	0.000	Female High Grad.	0.27	0.02	12.17	0.00
SLjt * Male 2-yr college Grad.	-1.119	0.298	-3.750	0.000	Male 2-yr college Grad.	0.35	0.03	13.81	0.00
SLjt * Female 2-yr college Grad.	-0.553	0.389	-1.420	0.155	Female 2-yr college Grad.	0.32	0.02	13.98	0.00
SLjt * Male 4-yr college Grad.	-1.073	0.206	-5.210	0.000	Male 4-yr college Grad.	0.46	0.02	20.34	0.00
SLjt * Female 4-yr college Grad.	-1.039	0.467	-2.230	0.026	Female 4-yr college Grad.	0.40	0.02	17.65	0.00
SLjt * Male Junior High Grad. * exp	-0.041	0.045	-0.910	0.364	Male Junior High Grad. * exp	0.05	0.00	28.80	0.00
SLjt * Male Junior High Grad. * exp^2	0.001	0.001	0.900	0.369	Male Junior High Grad. * exp^2	0.00	0.00	-28.42	0.00
SLjt * Female Junior High Grad. * exp	0.108	0.077	1.400	0.161	Female Junior High Grad. * exp	0.02	0.00	10.83	0.00
SLjt * Female Junior High Grad. * exp^2	-0.001	0.001	-1.260	0.207	Female Junior High Grad. * exp^2	0.00	0.00	-13.08	0.00
SLjt * Male High Grad. * exp	-0.011	0.012	-0.870	0.386	Male High Grad. * exp	0.03	0.00	46.66	0.00
SLjt * Male High Grad. * exp^2	0.000	0.000	0.140	0.892	Male High Grad. * exp^2	0.00	0.00	-39.34	0.00
SLjt * Female High Grad. * exp	0.010	0.024	0.430	0.669	Female High Grad. * exp	0.00	0.00	3.37	0.00
SLjt * Female High Grad. * exp^2	0.000	0.001	-0.350	0.725	Female High Grad. * exp^2	0.00	0.00	-10.75	0.00
SLjt * Male 2-yr college Grad. * exp	0.074	0.041	1.820	0.069	Male 2-yr college Grad. * exp	0.03	0.00	20.19	0.00
SLjt * Male 2-yr college Grad. * exp^2	-0.001	0.001	-1.430	0.152	Male 2-yr college Grad. * exp^2	0.00	0.00	-15.23	0.00
SLjt * Female 2-yr college Grad. * exp	0.003	0.064	0.050	0.963	Female 2-yr college Grad. * exp	0.01	0.00	3.28	0.00
SLjt * Female 2-yr college Grad. * exp^2	0.000	0.001	0.160	0.872	Female 2-yr college Grad. * exp^2	0.00	0.00	-5.31	0.00
SLjt * Male 4-yr college Grad. * exp	0.023	0.020	1.150	0.250	Male 4-yr college Grad. * exp	0.05	0.00	41.67	0.00
SLjt * Male 4-yr college Grad. * exp^2	0.000	0.000	-1.130	0.258	Male 4-yr college Grad. * exp^2	0.00	0.00	-28.02	0.00
SLjt * Female 4-yr college Grad. * exp	0.014	0.107	0.130	0.898	Female 4-yr college Grad. * exp	0.03	0.00	7.85	0.00
SLjt * Female 4-yr college Grad. * exp^2	0.000	0.003	-0.090	0.927	Female 4-yr college Grad. * exp^2	0.00	0.00	-7.52	0.00
SLjt * Male Junior High Grad. * ten	0.014	0.021	0.670	0.505	Male Junior High Grad. * ten	0.02	0.00	12.70	0.00
SLjt * Male Junior High Grad. * ten^2	0.000	0.000	-0.910	0.365	Male Junior High Grad. * ten^2	0.00	0.00	-0.70	0.49
SLjt * Female Junior High Grad. * ten	-0.051	0.044	-1.160	0.245	Female Junior High Grad. * ten	0.02	0.00	12.94	0.00
SLjt * Female Junior High Grad. * ten^2	0.001	0.001	1.240	0.215	Female Junior High Grad. * ten^2	0.00	0.00	0.88	0.38
SLjt * Male High Grad. * ten	-0.016	0.010	-1.640	0.101	Male High Grad. * ten	0.03	0.00	28.70	0.00
SLjt * Male High Grad. * ten^2	0.000	0.000	2.030	0.043	Male High Grad. * ten^2	0.00	0.00	-7.25	0.00
SLjt * Female High Grad. * ten	0.003	0.020	0.150	0.879	Female High Grad. * ten	0.04	0.00	31.06	0.00
SLjt * Female High Grad. * ten^2	0.000	0.001	0.040	0.971	Female High Grad. * ten^2	0.00	0.00	-6.79	0.00
SLjt * Male 2-yr college Grad. * ten	-0.123	0.035	-3.520	0.000	Male 2-yr college Grad. * ten	0.03	0.00	23.05	0.00
SLjt * Male 2-yr college Grad. * ten^2	0.003	0.001	3.140	0.002	Male 2-yr college Grad. * ten^2	0.00	0.00	-5.68	0.00
SLjt * Female 2-yr college Grad. * ten	-0.079	0.074	-1.070	0.286	Female 2-yr college Grad. * ten	0.05	0.00	21.13	0.00
SLjt * Female 2-yr college Grad. * ten^2	0.002	0.003	0.840	0.399	Female 2-yr college Grad. * ten^2	0.00	0.00	-5.96	0.00
SLjt * Male 4-yr college Grad. * ten	-0.001	0.021	-0.060	0.952	Male 4-yr college Grad. * ten	0.03	0.00	27.21	0.00
SLjt * Male 4-yr college Grad. * ten^2	0.000	0.001	-0.210	0.834	Male 4-yr college Grad. * ten^2	0.00	0.00	-10.35	0.00
SLjt * Female 4-yr college Grad. * ten	0.041	0.109	0.370	0.710	Female 4-yr college Grad. * ten	0.05	0.00	14.80	0.00
SLjt * Female 4-yr college Grad. * ten^2	-0.002	0.004	-0.700	0.483	Female 4-yr college Grad. * ten^2	0.00	0.00	-4.79	0.00
_cons	0.938	0.029	32.060	0.000	_cons	6.80	0.03	209.04	0.00
Number of obs	23935				Number of obs	1255748			
Prob > F	0.00				Prob > F	0.00			
R-squared	0.9955				R-squared	0.74			

Table 4. Production Function and Wage Equation (Manufacturing industries)

lnY	Coef.	Std. Err.	t	P>|t|
SKjt * lnKjt	0.98	0.03	35.11	0.00
SMjt * lnMjt	0.94	0.00	277.38	0.00
SLjt * lnLjt	1.18	0.02	50.72	0.00
SLjt * Part-time worker	-1.14	0.22	-5.28	0.00
SLjt * Male Junior High Grad.	-0.54	0.61	-0.88	0.38
SLjt * Female Junior High Grad.	-3.35	1.53	-2.19	0.03
SLjt * Male High Grad.	-1.08	0.18	-5.93	0.00
SLjt * Female High Grad.	-1.00	0.32	-3.11	0.00
SLjt * Male 2-yr college Grad.	-0.86	0.29	-2.91	0.00
SLjt * Female 2-yr college Grad.	-1.64	0.45	-3.69	0.00
SLjt * Male 4-yr college Grad.	-1.20	0.25	-4.75	0.00
SLjt * Female 4-yr college Grad.	-0.93	0.45	-2.07	0.04
SLjt * Male Junior High Grad. * exp	-0.04	0.04	-1.12	0.26
SLjt * Male Junior High Grad. * exp^2	0.00	0.00	1.18	0.24
SLjt * Female Junior High Grad. * exp	0.16	0.09	1.79	0.07
SLjt * Female Junior High Grad. * exp^2	0.00	0.00	-1.77	0.08
SLjt * Male High Grad. * exp	0.00	0.01	-0.26	0.79
SLjt * Male High Grad. * exp^2	0.00	0.00	0.11	0.92
SLjt * Female High Grad. * exp	-0.01	0.03	-0.30	0.76
SLjt * Female High Grad. * exp^2	0.00	0.00	-0.04	0.97
SLjt * Male 2-yr college Grad. * exp	0.00	0.04	0.03	0.98
SLjt * Male 2-yr college Grad. * exp^2	0.00	0.00	-0.06	0.95
SLjt * Female 2-yr college Grad. * exp	0.02	0.06	0.33	0.75
SLjt * Female 2-yr college Grad. * exp^2	0.00	0.00	0.26	0.80
SLjt * Male 4-yr college Grad. * exp	0.00	0.02	0.22	0.82
SLjt * Male 4-yr college Grad. * exp^2	0.00	0.00	-0.31	0.76
SLjt * Female 4-yr college Grad. * exp	0.05	0.10	0.46	0.64
SLjt * Female 4-yr college Grad. * exp^2	0.00	0.00	0.02	0.98
SLjt * Male Junior High Grad. * ten	0.00	0.02	-0.08	0.93
SLjt * Male Junior High Grad. * ten^2	0.00	0.00	-0.20	0.84
SLjt * Female Junior High Grad. * ten	-0.07	0.05	-1.50	0.13
SLjt * Female Junior High Grad. * ten^2	0.00	0.00	1.54	0.12
SLjt * Male High Grad. * ten	-0.01	0.01	-0.85	0.40
SLjt * Male High Grad. * ten^2	0.00	0.00	0.79	0.43
SLjt * Female High Grad. * ten	0.01	0.02	0.50	0.62
SLjt * Female High Grad. * ten^2	0.00	0.00	-0.33	0.74
SLjt * Male 2-yr college Grad. * ten	-0.07	0.03	-2.24	0.03
SLjt * Male 2-yr college Grad. * ten^2	0.00	0.00	2.21	0.03
SLjt * Female 2-yr college Grad. * ten	-0.01	0.07	-0.21	0.83
SLjt * Female 2-yr college Grad. * ten^2	0.00	0.00	0.33	0.75
SLjt * Male 4-yr college Grad. * ten	0.01	0.02	0.46	0.65
SLjt * Male 4-yr college Grad. * ten^2	0.00	0.00	-0.58	0.56
SLjt * Female 4-yr college Grad. * ten	-0.06	0.12	-0.50	0.62
SLjt * Female 4-yr college Grad. * ten^2	0.00	0.00	-0.39	0.70
_cons	0.97	0.04	22.19	0.00
Number of obs	15757			
Prob > F	0.00			
R-squared	1.00			

lnw	Coef.	Std. Err.	t	P>|t|
Part-time worker	0.11	0.02	4.69	0.00
Male Junior High Grad.				
Female Junior High Grad.	-0.04	0.04	-1.02	0.31
Male High Grad.	0.34	0.02	15.37	0.00
Female High Grad.	0.28	0.02	12.17	0.00
Male 2-yr college Grad.	0.35	0.02	14.39	0.00
Female 2-yr college Grad.	0.32	0.02	13.45	0.00
Male 4-yr college Grad.	0.46	0.02	19.93	0.00
Female 4-yr college Grad.	0.41	0.02	17.00	0.00
Male Junior High Grad. * exp	0.04	0.00	29.50	0.00
Male Junior High Grad. * exp^2	0.00	0.00	-29.33	0.00
Female Junior High Grad. * exp	0.02	0.00	9.21	0.00
Female Junior High Grad. * exp^2	0.00	0.00	-10.95	0.00
Male High Grad. * exp	0.03	0.00	41.08	0.00
Male High Grad. * exp^2	0.00	0.00	-36.05	0.00
Female High Grad. * exp	0.00	0.00	1.00	0.32
Female High Grad. * exp^2	0.00	0.00	-13.29	0.00
Male 2-yr college Grad. * exp	0.03	0.00	25.95	0.00
Male 2-yr college Grad. * exp^2	0.00	0.00	-16.86	0.00
Female 2-yr college Grad. * exp	0.01	0.00	4.49	0.00
Female 2-yr college Grad. * exp^2	0.00	0.00	-9.90	0.00
Male 4-yr college Grad. * exp	0.04	0.00	38.91	0.00
Male 4-yr college Grad. * exp^2	0.00	0.00	-24.73	0.00
Female 4-yr college Grad. * exp	0.03	0.00	9.79	0.00
Female 4-yr college Grad. * exp^2	0.00	0.00	-9.73	0.00
Male Junior High Grad. * ten	0.02	0.00	18.13	0.00
Male Junior High Grad. * ten^2	0.00	0.00	-3.19	0.00
Female Junior High Grad. * ten	0.02	0.00	13.25	0.00
Female Junior High Grad. * ten^2	0.00	0.00	0.63	0.53
Male High Grad. * ten	0.03	0.00	28.59	0.00
Male High Grad. * ten^2	0.00	0.00	-5.97	0.00
Female High Grad. * ten	0.04	0.00	36.51	0.00
Female High Grad. * ten^2	0.00	0.00	-5.57	0.00
Male 2-yr college Grad. * ten	0.03	0.00	20.64	0.00
Male 2-yr college Grad. * ten^2	0.00	0.00	-5.65	0.00
Female 2-yr college Grad. * ten	0.05	0.00	22.81	0.00
Female 2-yr college Grad. * ten^2	0.00	0.00	-6.18	0.00
Male 4-yr college Grad. * ten	0.03	0.00	22.78	0.00
Male 4-yr college Grad. * ten^2	0.00	0.00	-9.62	0.00
Female 4-yr college Grad. * ten	0.04	0.00	11.17	0.00
Female 4-yr college Grad. * ten^2	0.00	0.00	-2.57	0.01
_cons	6.67	0.03	258.94	0.00
Number of obs	817648			
Prob > F	0.00			
R-squared	0.71			

Table 5. Production Function and Wage Equation (Service industries)

lnY	Coef.	Std. Err.	t	P>|t|
SKjt * lnKjt	0.95	0.01	101.19	0.00
SMjt * lnMjt	0.95	0.00	221.56	0.00
SLjt * lnLjt	1.11	0.02	58.74	0.00
SLjt * Part-time worker	-0.66	0.22	-3.03	0.00
SLjt * Male Junior High Grad.	-0.22	1.33	-0.17	0.87
SLjt * Female Junior High Grad.	-2.40	2.28	-1.05	0.29
SLjt * Male High Grad.	0.12	0.29	0.40	0.69
SLjt * Female High Grad.	-1.21	0.25	-4.86	0.00
SLjt * Male 2-yr college Grad.	-1.13	0.57	-1.98	0.05
SLjt * Female 2-yr college Grad.	0.26	0.60	0.42	0.67
SLjt * Male 4-yr college Grad.	-0.57	0.34	-1.70	0.09
SLjt * Female 4-yr college Grad.	-0.41	0.71	-0.58	0.56
SLjt * Male Junior High Grad. * exp	-0.01	0.09	-0.08	0.94
SLjt * Male Junior High Grad. * exp^2	0.00	0.00	-0.19	0.85
SLjt * Female Junior High Grad. * exp	0.08	0.16	0.48	0.63
SLjt * Female Junior High Grad. * exp^2	0.00	0.00	-0.26	0.79
SLjt * Male High Grad. * exp	-0.04	0.03	-1.42	0.16
SLjt * Male High Grad. * exp^2	0.00	0.00	0.95	0.34
SLjt * Female High Grad. * exp	0.09	0.04	2.41	0.02
SLjt * Female High Grad. * exp^2	0.00	0.00	-1.85	0.06
SLjt * Male 2-yr college Grad. * exp	0.12	0.08	1.46	0.14
SLjt * Male 2-yr college Grad. * exp^2	0.00	0.00	-1.05	0.29
SLjt * Female 2-yr college Grad. * exp	-0.06	0.12	-0.50	0.62
SLjt * Female 2-yr college Grad. * exp^2	0.00	0.00	0.69	0.49
SLjt * Male 4-yr college Grad. * exp	0.03	0.04	0.71	0.48
SLjt * Male 4-yr college Grad. * exp^2	0.00	0.00	-0.71	0.48
SLjt * Female 4-yr college Grad. * exp	-0.09	0.18	-0.49	0.63
SLjt * Female 4-yr college Grad. * exp^2	0.00	0.00	0.40	0.69
SLjt * Male Junior High Grad. * ten	0.03	0.05	0.60	0.55
SLjt * Male Junior High Grad. * ten^2	0.00	0.00	-0.33	0.75
SLjt * Female Junior High Grad. * ten	0.02	0.11	0.19	0.85
SLjt * Female Junior High Grad. * ten^2	0.00	0.00	-0.18	0.86
SLjt * Male High Grad. * ten	-0.03	0.02	-1.45	0.15
SLjt * Male High Grad. * ten^2	0.00	0.00	1.84	0.07
SLjt * Female High Grad. * ten	-0.10	0.04	-2.38	0.02
SLjt * Female High Grad. * ten^2	0.00	0.00	2.64	0.01
SLjt * Male 2-yr college Grad. * ten	-0.13	0.06	-1.96	0.05
SLjt * Male 2-yr college Grad. * ten^2	0.00	0.00	1.48	0.14
SLjt * Female 2-yr college Grad. * ten	-0.07	0.13	-0.52	0.60
SLjt * Female 2-yr college Grad. * ten^2	0.00	0.00	0.28	0.78
SLjt * Male 4-yr college Grad. * ten	-0.02	0.05	-0.50	0.62
SLjt * Male 4-yr college Grad. * ten^2	0.00	0.00	0.31	0.75
SLjt * Female 4-yr college Grad. * ten	0.11	0.17	0.64	0.52
SLjt * Female 4-yr college Grad. * ten^2	0.00	0.01	-0.57	0.57
_cons	0.97	0.06	16.60	0.00
Number of obs	5917			
Prob > F	0.00			
R-squared	0.99			

lnw	Coef.	Std. Err.	t	P>|t|
Part-time worker	0.05	0.06	0.81	0.42
Male Junior High Grad.				
Female Junior High Grad.	-0.04	0.09	-0.43	0.67
Male High Grad.	0.29	0.07	4.32	0.00
Female High Grad.	0.21	0.06	3.29	0.00
Male 2-yr college Grad.	0.33	0.07	4.52	0.00
Female 2-yr college Grad.	0.29	0.06	4.59	0.00
Male 4-yr college Grad.	0.41	0.06	6.28	0.00
Female 4-yr college Grad.	0.37	0.06	5.79	0.00
Male Junior High Grad. * exp	0.05	0.00	10.74	0.00
Male Junior High Grad. * exp^2	0.00	0.00	-11.57	0.00
Female Junior High Grad. * exp	0.03	0.00	6.58	0.00
Female Junior High Grad. * exp^2	0.00	0.00	-8.34	0.00
Male High Grad. * exp	0.04	0.00	16.81	0.00
Male High Grad. * exp^2	0.00	0.00	-17.73	0.00
Female High Grad. * exp	0.01	0.00	3.10	0.00
Female High Grad. * exp^2	0.00	0.00	-5.35	0.00
Male 2-yr college Grad. * exp	0.04	0.00	8.47	0.00
Male 2-yr college Grad. * exp^2	0.00	0.00	-6.76	0.00
Female 2-yr college Grad. * exp	0.01	0.00	1.56	0.12
Female 2-yr college Grad. * exp^2	0.00	0.00	-2.57	0.01
Male 4-yr college Grad. * exp	0.05	0.00	22.41	0.00
Male 4-yr college Grad. * exp^2	0.00	0.00	-16.68	0.00
Female 4-yr college Grad. * exp	0.02	0.01	4.14	0.00
Female 4-yr college Grad. * exp^2	0.00	0.00	-3.99	0.00
Male Junior High Grad. * ten	0.02	0.00	5.05	0.00
Male Junior High Grad. * ten^2	0.00	0.00	0.18	0.86
Female Junior High Grad. * ten	0.02	0.00	4.54	0.00
Female Junior High Grad. * ten^2	0.00	0.00	0.12	0.90
Male High Grad. * ten	0.03	0.00	16.83	0.00
Male High Grad. * ten^2	0.00	0.00	-4.17	0.00
Female High Grad. * ten	0.05	0.00	10.47	0.00
Female High Grad. * ten^2	0.00	0.00	-3.63	0.00
Male 2-yr college Grad. * ten	0.02	0.00	10.61	0.00
Male 2-yr college Grad. * ten^2	0.00	0.00	-0.90	0.37
Female 2-yr college Grad. * ten	0.05	0.00	11.69	0.00
Female 2-yr college Grad. * ten^2	0.00	0.00	-3.75	0.00
Male 4-yr college Grad. * ten	0.03	0.00	13.77	0.00
Male 4-yr college Grad. * ten^2	0.00	0.00	-4.15	0.00
Female 4-yr college Grad. * ten	0.05	0.00	10.48	0.00
Female 4-yr college Grad. * ten^2	0.00	0.00	-4.33	0.00
_cons	6.77	0.08	87.95	0.00
Number of obs	411950			
Prob > F	0.00			
R-squared	0.79			

Table 6. Production Function and Wage Equation Using Fixed-Effects Model (All Industries)

lnY	Coef.	Std. Err.	t	P>|t|
SKjt * lnKjt	1.07	0.00	255.60	0.00
SMjt * lnMjt	0.98	0.00	354.12	0.00
SLjt * lnLjt	1.01	0.01	125.87	0.00
SLjt * Part-time worker	0.29	0.09	3.22	0.00
SLjt * Male Junior High Grad.	0.28	0.32	0.88	0.38
SLjt * Female Junior High Grad.	-1.23	0.62	-1.97	0.05
SLjt * Male High Grad.	0.16	0.10	1.56	0.12
SLjt * Female High Grad.	0.24	0.13	1.78	0.08
SLjt * Male 2-yr college Grad.	0.40	0.15	2.76	0.01
SLjt * Female 2-yr college Grad.	0.11	0.18	0.63	0.53
SLjt * Male 4-yr college Grad.	0.24	0.11	2.17	0.03
SLjt * Female 4-yr college Grad.	-0.08	0.21	-0.37	0.71
SLjt * Male Junior High Grad. * exp	0.00	0.02	-0.02	0.99
SLjt * Male Junior High Grad. * exp^2	0.00	0.00	-0.16	0.87
SLjt * Female Junior High Grad. * exp	0.09	0.04	2.23	0.03
SLjt * Female Junior High Grad. * exp^2	0.00	0.00	-1.87	0.06
SLjt * Male High Grad. * exp	0.02	0.01	2.64	0.01
SLjt * Male High Grad. * exp^2	0.00	0.00	-3.03	0.00
SLjt * Female High Grad. * exp	-0.01	0.01	-1.13	0.26
SLjt * Female High Grad. * exp^2	0.00	0.00	1.32	0.19
SLjt * Male 2-yr college Grad. * exp	0.01	0.02	0.74	0.46
SLjt * Male 2-yr college Grad. * exp^2	0.00	0.00	-1.29	0.20
SLjt * Female 2-yr college Grad. * exp	0.03	0.03	1.13	0.26
SLjt * Female 2-yr college Grad. * exp^2	0.00	0.00	-1.18	0.24
SLjt * Male 4-yr college Grad. * exp	0.01	0.01	0.51	0.61
SLjt * Male 4-yr college Grad. * exp^2	0.00	0.00	-0.47	0.64
SLjt * Female 4-yr college Grad. * exp	0.04	0.04	0.94	0.35
SLjt * Female 4-yr college Grad. * exp^2	0.00	0.00	-0.72	0.47
SLjt * Male Junior High Grad. * ten	0.00	0.01	0.24	0.81
SLjt * Male Junior High Grad. * ten^2	0.00	0.00	0.00	1.00
SLjt * Female Junior High Grad. * ten	0.00	0.02	-0.15	0.89
SLjt * Female Junior High Grad. * ten^2	0.00	0.00	-0.66	0.51
SLjt * Male High Grad. * ten	0.00	0.00	-0.20	0.84
SLjt * Male High Grad. * ten^2	0.00	0.00	0.28	0.78
SLjt * Female High Grad. * ten	0.02	0.01	1.69	0.09
SLjt * Female High Grad. * ten^2	0.00	0.00	-1.67	0.09
SLjt * Male 2-yr college Grad. * ten	-0.02	0.01	-1.48	0.14
SLjt * Male 2-yr college Grad. * ten^2	0.00	0.00	1.61	0.11
SLjt * Female 2-yr college Grad. * ten	-0.02	0.03	-0.71	0.48
SLjt * Female 2-yr college Grad. * ten^2	0.00	0.00	1.12	0.26
SLjt * Male 4-yr college Grad. * ten	-0.01	0.01	-0.56	0.58
SLjt * Male 4-yr college Grad. * ten^2	0.00	0.00	0.84	0.40
SLjt * Female 4-yr college Grad. * ten	0.05	0.04	1.20	0.23
SLjt * Female 4-yr college Grad. * ten^2	0.00	0.00	-2.24	0.03
_cons	0.59	0.03	21.31	0.00
Number of obs	23935			
Number of groups	9224			
Obs per group: min	1			
avg	2.6			
max	6			
R-sq: within	0.93			
between	0.99			
overall	0.99			
Prob > F	0.00			

lnw	Coef.	Std. Err.	t	P>|t|
Part-time worker	0.02	0.01	1.76	0.08
Male Junior High Grad.				
Female Junior High Grad.	0.04	0.03	1.57	0.12
Male High Grad.	0.22	0.01	17.60	0.00
Female High Grad.	0.20	0.01	16.14	0.00
Male 2-yr college Grad.	0.25	0.01	20.22	0.00
Female 2-yr college Grad.	0.20	0.01	16.58	0.00
Male 4-yr college Grad.	0.30	0.01	23.65	0.00
Female 4-yr college Grad.	0.27	0.01	20.88	0.00
Male Junior High Grad. * exp	0.04	0.00	45.26	0.00
Male Junior High Grad. * exp^2	0.00	0.00	-41.99	0.00
Female Junior High Grad. * exp	0.02	0.00	11.79	0.00
Female Junior High Grad. * exp^2	0.00	0.00	-14.28	0.00
Male High Grad. * exp	0.04	0.00	51.47	0.00
Male High Grad. * exp^2	0.00	0.00	-42.08	0.00
Female High Grad. * exp	0.01	0.00	4.21	0.00
Female High Grad. * exp^2	0.00	0.00	-7.99	0.00
Male 2-yr college Grad. * exp	0.04	0.00	44.86	0.00
Male 2-yr college Grad. * exp^2	0.00	0.00	-25.27	0.00
Female 2-yr college Grad. * exp	0.01	0.00	3.45	0.00
Female 2-yr college Grad. * exp^2	0.00	0.00	-4.46	0.00
Male 4-yr college Grad. * exp	0.05	0.00	50.56	0.00
Male 4-yr college Grad. * exp^2	0.00	0.00	-30.01	0.00
Female 4-yr college Grad. * exp	0.02	0.00	7.93	0.00
Female 4-yr college Grad. * exp^2	0.00	0.00	-6.70	0.00
Male Junior High Grad. * ten	0.02	0.00	20.23	0.00
Male Junior High Grad. * ten^2	0.00	0.00	-3.56	0.00
Female Junior High Grad. * ten	0.02	0.00	18.20	0.00
Female Junior High Grad. * ten^2	0.00	0.00	-1.60	0.11
Male High Grad. * ten	0.02	0.00	29.55	0.00
Male High Grad. * ten^2	0.00	0.00	-3.71	0.00
Female High Grad. * ten	0.03	0.00	15.46	0.00
Female High Grad. * ten^2	0.00	0.00	-6.05	0.00
Male 2-yr college Grad. * ten	0.02	0.00	24.03	0.00
Male 2-yr college Grad. * ten^2	0.00	0.00	-6.73	0.00
Female 2-yr college Grad. * ten	0.04	0.00	14.61	0.00
Female 2-yr college Grad. * ten^2	0.00	0.00	-6.85	0.00
Male 4-yr college Grad. * ten	0.02	0.00	30.82	0.00
Male 4-yr college Grad. * ten^2	0.00	0.00	-12.85	0.00
Female 4-yr college Grad. * ten	0.04	0.00	16.86	0.00
Female 4-yr college Grad. * ten^2	0.00	0.00	-7.37	0.00
_cons	6.95	0.02	374.27	0.00
Number of obs	1255748			
Number of groups	8605			
Obs per group: min	5			
avg	145.9			
max	25663			
R-sq: within	0.74			
between	0.64			
overall	0.71			
Prob > F	0.00			

Table 7. Production Function and Wage Equation Using Fixed-Effects Model (Manufacturing Industries)

lnY	Coef.	Std. Err.	t	P>|t|	lnw	Coef.	Std. Err.	t	P>|t|
SKjt * lnKjt	1.11	0.01	209.13	0.00					
SMjt * lnMjt	0.98	0.00	287.36	0.00					
SLjt * lnLjt	1.06	0.01	108.83	0.00					
SLjt * Part-time worker	0.02	0.11	0.19	0.85	Part-time worker	0.03	0.01	2.45	0.01
SLjt * Male Junior High Grad.	-0.23	0.39	-0.58	0.57	Male Junior High Grad.				
SLjt * Female Junior High Grad.	-1.64	0.68	-2.42	0.02	Female Junior High Grad.	0.05	0.02	2.75	0.01
SLjt * Male High Grad.	-0.15	0.12	-1.24	0.22	Male High Grad.	0.23	0.01	19.05	0.00
SLjt * Female High Grad.	-0.06	0.16	-0.39	0.70	Female High Grad.	0.20	0.01	16.00	0.00
SLjt * Male 2-yr college Grad.	0.32	0.19	1.73	0.08	Male 2-yr college Grad.	0.25	0.01	18.88	0.00
SLjt * Female 2-yr college Grad.	-0.59	0.26	-2.23	0.03	Female 2-yr college Grad.	0.20	0.01	15.39	0.00
SLjt * Male 4-yr college Grad.	-0.04	0.14	-0.25	0.80	Male 4-yr college Grad.	0.30	0.01	22.84	0.00
SLjt * Female 4-yr college Grad.	-0.29	0.32	-0.92	0.36	Female 4-yr college Grad.	0.27	0.01	19.07	0.00
SLjt * Male Junior High Grad. * exp	0.02	0.02	0.71	0.48	Male Junior High Grad. * exp	0.04	0.00	41.77	0.00
SLjt * Male Junior High Grad. * exp^2	0.00	0.00	-0.93	0.35	Male Junior High Grad. * exp^2	0.00	0.00	-38.68	0.00
SLjt * Female Junior High Grad. * exp	0.09	0.04	2.21	0.03	Female Junior High Grad. * exp	0.02	0.00	12.98	0.00
SLjt * Female Junior High Grad. * exp^2	0.00	0.00	-1.76	0.08	Female Junior High Grad. * exp^2	0.00	0.00	-15.51	0.00
SLjt * Male High Grad. * exp	0.01	0.01	1.78	0.08	Male High Grad. * exp	0.03	0.00	62.32	0.00
SLjt * Male High Grad. * exp^2	0.00	0.00	-2.16	0.03	Male High Grad. * exp^2	0.00	0.00	-50.95	0.00
SLjt * Female High Grad. * exp	-0.02	0.01	-1.34	0.18	Female High Grad. * exp	0.01	0.00	10.57	0.00
SLjt * Female High Grad. * exp^2	0.00	0.00	1.54	0.13	Female High Grad. * exp^2	0.00	0.00	-18.19	0.00
SLjt * Male 2-yr college Grad. * exp	-0.01	0.02	-0.66	0.51	Male 2-yr college Grad. * exp	0.04	0.00	38.28	0.00
SLjt * Male 2-yr college Grad. * exp^2	0.00	0.00	0.04	0.97	Male 2-yr college Grad. * exp^2	0.00	0.00	-19.76	0.00
SLjt * Female 2-yr college Grad. * exp	0.03	0.04	0.71	0.48	Female 2-yr college Grad. * exp	0.01	0.00	9.96	0.00
SLjt * Female 2-yr college Grad. * exp^2	0.00	0.00	-0.32	0.75	Female 2-yr college Grad. * exp^2	0.00	0.00	-10.82	0.00
SLjt * Male 4-yr college Grad. * exp	0.01	0.01	0.54	0.59	Male 4-yr college Grad. * exp	0.04	0.00	55.04	0.00
SLjt * Male 4-yr college Grad. * exp^2	0.00	0.00	-0.49	0.62	Male 4-yr college Grad. * exp^2	0.00	0.00	-30.73	0.00
SLjt * Female 4-yr college Grad. * exp	0.03	0.06	0.49	0.63	Female 4-yr college Grad. * exp	0.02	0.00	9.36	0.00
SLjt * Female 4-yr college Grad. * exp^2	0.00	0.00	0.09	0.93	Female 4-yr college Grad. * exp^2	0.00	0.00	-7.34	0.00
SLjt * Male Junior High Grad. * ten	-0.01	0.01	-0.60	0.55	Male Junior High Grad. * ten	0.02	0.00	20.85	0.00
SLjt * Male Junior High Grad. * ten^2	0.00	0.00	0.91	0.36	Male Junior High Grad. * ten^2	0.00	0.00	-5.43	0.00
SLjt * Female Junior High Grad. * ten	-0.02	0.03	-0.60	0.55	Female Junior High Grad. * ten	0.02	0.00	19.35	0.00
SLjt * Female Junior High Grad. * ten^2	0.00	0.00	-0.24	0.81	Female Junior High Grad. * ten^2	0.00	0.00	-1.88	0.06
SLjt * Male High Grad. * ten	0.00	0.01	0.74	0.46	Male High Grad. * ten	0.02	0.00	27.55	0.00
SLjt * Male High Grad. * ten^2	0.00	0.00	-0.82	0.41	Male High Grad. * ten^2	0.00	0.00	-6.22	0.00
SLjt * Female High Grad. * ten	0.03	0.01	2.43	0.02	Female High Grad. * ten	0.03	0.00	44.46	0.00
SLjt * Female High Grad. * ten^2	0.00	0.00	-2.56	0.01	Female High Grad. * ten^2	0.00	0.00	-12.04	0.00
SLjt * Male 2-yr college Grad. * ten	-0.01	0.02	-0.80	0.42	Male 2-yr college Grad. * ten	0.02	0.00	22.91	0.00
SLjt * Male 2-yr college Grad. * ten^2	0.00	0.00	0.96	0.34	Male 2-yr college Grad. * ten^2	0.00	0.00	-5.95	0.00
SLjt * Female 2-yr college Grad. * ten	0.00	0.04	0.11	0.92	Female 2-yr college Grad. * ten	0.03	0.00	20.79	0.00
SLjt * Female 2-yr college Grad. * ten^2	0.00	0.00	-0.14	0.89	Female 2-yr college Grad. * ten^2	0.00	0.00	-6.50	0.00
SLjt * Male 4-yr college Grad. * ten	-0.01	0.01	-0.96	0.34	Male 4-yr college Grad. * ten	0.02	0.00	26.07	0.00
SLjt * Male 4-yr college Grad. * ten^2	0.00	0.00	1.12	0.26	Male 4-yr college Grad. * ten^2	0.00	0.00	-11.46	0.00
SLjt * Female 4-yr college Grad. * ten	0.04	0.06	0.57	0.57	Female 4-yr college Grad. * ten	0.03	0.00	10.36	0.00
SLjt * Female 4-yr college Grad. * ten^2	0.00	0.00	-1.52	0.13	Female 4-yr college Grad. * ten^2	0.00	0.00	-2.77	0.01
_cons	0.54	0.03	15.74	0.00	_cons	6.90	0.01	474.45	0.00
Number of obs	15757				Number of obs	817648			
Number of groups	5905				Number of groups	5574			
Obs per group: min	1				Obs per group: min	5			
avg	2.7				avg	146.7			
max	6				max	6885			
R-sq: within	0.932				R-sq: within	0.75			
between	0.995				between	0.60			
overall	0.995				overall	0.69			
Prob > F	0.000				Prob > F	0.00			

Table 8. Production Function and Wage Equation Using Fixed-Effects Model (Service Industries)

lnY	Coef.	Std. Err.	t	P>|t|
SKjt * lnKjt	0.99	0.01	148.61	0.00
SMjt * lnMjt	0.95	0.00	202.01	0.00
SLjt * lnLjt	0.91	0.01	62.70	0.00
SLjt * Part-time worker	1.03	0.16	6.32	0.00
SLjt * Male Junior High Grad.	0.54	0.60	0.91	0.36
SLjt * Female Junior High Grad.	1.37	1.53	0.90	0.37
SLjt * Male High Grad.	0.87	0.20	4.41	0.00
SLjt * Female High Grad.	1.10	0.23	4.69	0.00
SLjt * Male 2-yr college Grad.	0.85	0.23	3.68	0.00
SLjt * Female 2-yr college Grad.	1.09	0.26	4.26	0.00
SLjt * Male 4-yr college Grad.	1.01	0.18	5.55	0.00
SLjt * Female 4-yr college Grad.	0.56	0.28	2.00	0.05
SLjt * Male Junior High Grad. * exp	0.01	0.03	0.26	0.80
SLjt * Male Junior High Grad. * exp^2	0.00	0.00	-0.24	0.81
SLjt * Female Junior High Grad. * exp	-0.01	0.10	-0.07	0.94
SLjt * Female Junior High Grad. * exp^2	0.00	0.00	-0.20	0.84
SLjt * Male High Grad. * exp	0.02	0.01	1.42	0.16
SLjt * Male High Grad. * exp^2	0.00	0.00	-1.63	0.10
SLjt * Female High Grad. * exp	0.00	0.02	0.02	0.98
SLjt * Female High Grad. * exp^2	0.00	0.00	0.01	1.00
SLjt * Male 2-yr college Grad. * exp	0.06	0.03	2.27	0.02
SLjt * Male 2-yr college Grad. * exp^2	0.00	0.00	-2.22	0.03
SLjt * Female 2-yr college Grad. * exp	0.05	0.04	1.38	0.17
SLjt * Female 2-yr college Grad. * exp^2	0.00	0.00	-1.83	0.07
SLjt * Male 4-yr college Grad. * exp	0.00	0.02	0.05	0.96
SLjt * Male 4-yr college Grad. * exp^2	0.00	0.00	-0.04	0.97
SLjt * Female 4-yr college Grad. * exp	0.07	0.06	1.31	0.19
SLjt * Female 4-yr college Grad. * exp^2	0.00	0.00	-1.46	0.15
SLjt * Male Junior High Grad. * ten	0.05	0.02	2.30	0.02
SLjt * Male Junior High Grad. * ten^2	0.00	0.00	-2.42	0.02
SLjt * Female Junior High Grad. * ten	0.07	0.06	1.09	0.27
SLjt * Female Junior High Grad. * ten^2	0.00	0.00	-1.67	0.10
SLjt * Male High Grad. * ten	0.00	0.01	0.05	0.96
SLjt * Male High Grad. * ten^2	0.00	0.00	0.67	0.51
SLjt * Female High Grad. * ten	-0.03	0.02	-1.68	0.09
SLjt * Female High Grad. * ten^2	0.00	0.00	1.72	0.09
SLjt * Male 2-yr college Grad. * ten	-0.04	0.02	-1.90	0.06
SLjt * Male 2-yr college Grad. * ten^2	0.00	0.00	1.85	0.07
SLjt * Female 2-yr college Grad. * ten	-0.06	0.04	-1.60	0.11
SLjt * Female 2-yr college Grad. * ten^2	0.00	0.00	2.16	0.03
SLjt * Male 4-yr college Grad. * ten	0.00	0.01	-0.14	0.89
SLjt * Male 4-yr college Grad. * ten^2	0.00	0.00	0.30	0.76
SLjt * Female 4-yr college Grad. * ten	0.03	0.06	0.53	0.60
SLjt * Female 4-yr college Grad. * ten^2	0.00	0.00	-1.40	0.16
_cons	0.68	0.09	7.61	0.00
Number of obs	7498			
Number of groups	3322			
Obs per group: min	1			
avg	2.3			
max	6			
R-sq: within	0.93			
between	0.99			
overall	0.99			
Prob > F	0.00			

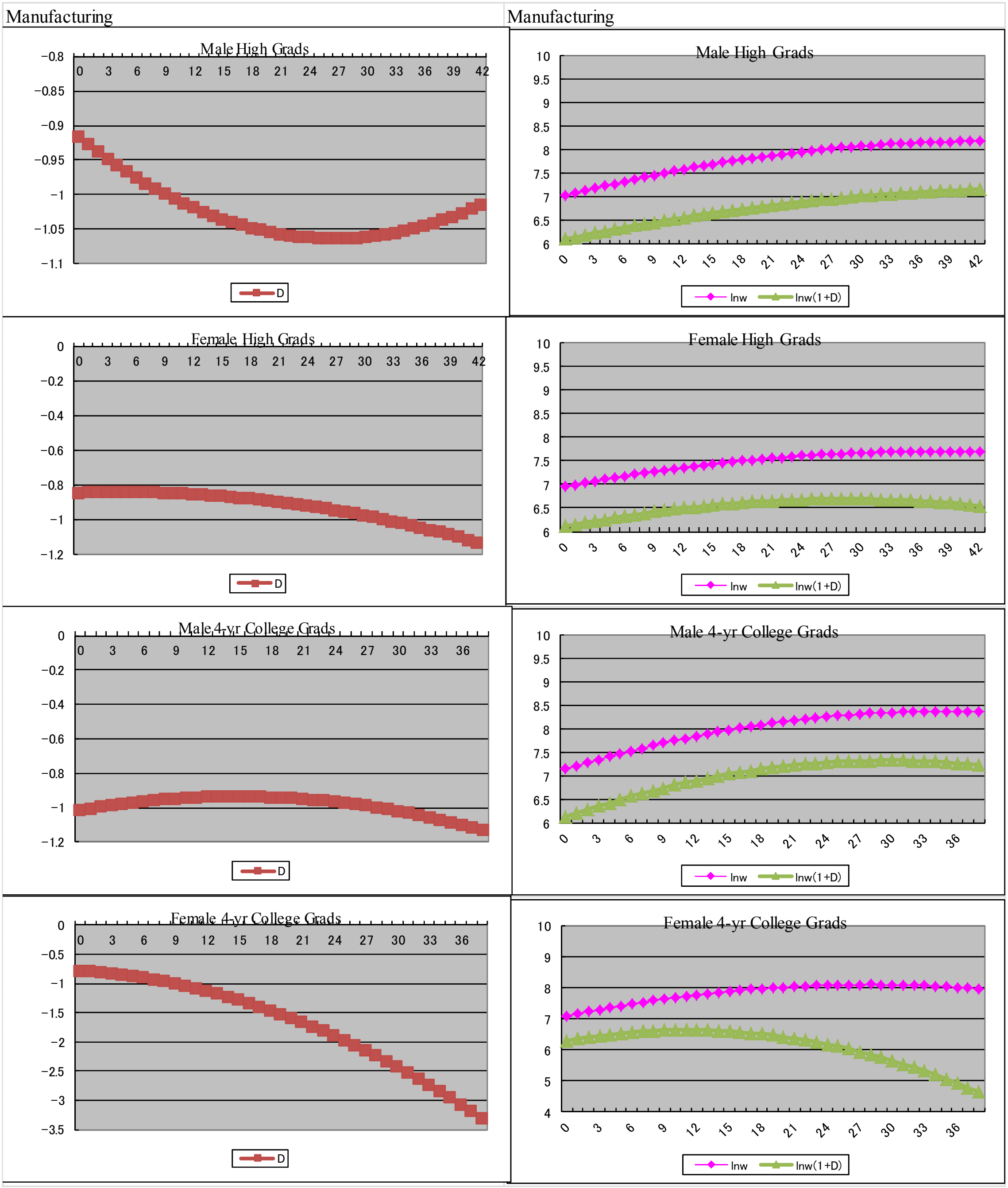
lnw	Coef.	Std. Err.	t	P>|t|
Part-time worker	0.05	0.04	1.36	0.18
Male Junior High Grad.				
Female Junior High Grad.	0.00	0.09	-0.03	0.97
Male High Grad.	0.21	0.04	5.26	0.00
Female High Grad.	0.21	0.04	6.06	0.00
Male 2-yr college Grad.	0.29	0.04	7.88	0.00
Female 2-yr college Grad.	0.25	0.03	7.27	0.00
Male 4-yr college Grad.	0.33	0.04	9.49	0.00
Female 4-yr college Grad.	0.31	0.03	9.03	0.00
Male Junior High Grad. * exp	0.05	0.00	17.36	0.00
Male Junior High Grad. * exp^2	0.00	0.00	-16.64	0.00
Female Junior High Grad. * exp	0.03	0.00	6.16	0.00
Female Junior High Grad. * exp^2	0.00	0.00	-7.93	0.00
Male High Grad. * exp	0.04	0.00	24.11	0.00
Male High Grad. * exp^2	0.00	0.00	-20.91	0.00
Female High Grad. * exp	0.01	0.00	2.11	0.04
Female High Grad. * exp^2	0.00	0.00	-3.91	0.00
Male 2-yr college Grad. * exp	0.04	0.00	19.08	0.00
Male 2-yr college Grad. * exp^2	0.00	0.00	-12.79	0.00
Female 2-yr college Grad. * exp	0.00	0.00	0.96	0.34
Female 2-yr college Grad. * exp^2	0.00	0.00	-1.51	0.13
Male 4-yr college Grad. * exp	0.05	0.00	24.29	0.00
Male 4-yr college Grad. * exp^2	0.00	0.00	-16.97	0.00
Female 4-yr college Grad. * exp	0.01	0.00	3.14	0.00
Female 4-yr college Grad. * exp^2	0.00	0.00	-2.76	0.01
Male Junior High Grad. * ten	0.02	0.00	7.80	0.00
Male Junior High Grad. * ten^2	0.00	0.00	-0.68	0.50
Female Junior High Grad. * ten	0.02	0.00	5.71	0.00
Female Junior High Grad. * ten^2	0.00	0.00	-0.50	0.62
Male High Grad. * ten	0.02	0.00	13.47	0.00
Male High Grad. * ten^2	0.00	0.00	0.57	0.57
Female High Grad. * ten	0.04	0.01	7.47	0.00
Female High Grad. * ten^2	0.00	0.00	-3.43	0.00
Male 2-yr college Grad. * ten	0.02	0.00	12.46	0.00
Male 2-yr college Grad. * ten^2	0.00	0.00	-3.16	0.00
Female 2-yr college Grad. * ten	0.05	0.00	11.17	0.00
Female 2-yr college Grad. * ten^2	0.00	0.00	-6.11	0.00
Male 4-yr college Grad. * ten	0.03	0.00	16.98	0.00
Male 4-yr college Grad. * ten^2	0.00	0.00	-7.03	0.00
Female 4-yr college Grad. * ten	0.05	0.00	14.19	0.00
Female 4-yr college Grad. * ten^2	0.00	0.00	-8.63	0.00
_cons	6.91	0.05	131.86	0.00
Number of obs	411950			
Number of groups	3024			
Obs per group: min	5			
avg	136.2			
max	25663			
R-sq: within	0.75			
between	0.70			
overall	0.75			
Prob > F	0.00			

Table 9. Existence Rate in the Same Company

Rate of those who join a company right after a high school or college				
		Exp is 10yrs	Exp is 20yrs	Exp is 30yrs
Male High Grads	All Industry	0.80	0.64	0.66
	Manufacturing	0.80	0.60	0.65
	Service Industry	0.80	0.75	0.71
Female High Grads	All Industry	0.79	0.50	0.24
	Manufacturing	0.81	0.50	0.23
	Service Industry	0.75	0.50	0.27
Male 4-yr college Grads	All Industry	0.84	0.70	0.73
	Manufacturing	0.84	0.69	0.72
	Service Industry	0.83	0.73	0.74
Female 4-yr college Grads	All Industry	0.84	0.57	0.45
	Manufacturing	0.82	0.53	0.43
	Service Industry	0.86	0.61	0.48

Note: We show rate of those who join a company right after a high school or college.
Tenure(year of working in the current company) almost equals experience year. (Experience year−3<=Tenure<=Expe
Exp is experience year after graduating a high school or college.

Figure 1. Gap Profile and Tenure-Productivity, Tenure-Wage Profile (Manufacturing Industries)



Note: "D" in left column is gap function profile. "lnw" and "lnw(1+D)" in right column are tenure-wage profile and tenure-productivity profile, respectively. The horizontal axis is tenure (the years of working in the current company).

Figure 2. Gap Profile and Tenure-Productivity, Tenure-Wage Profile (Service Industries)

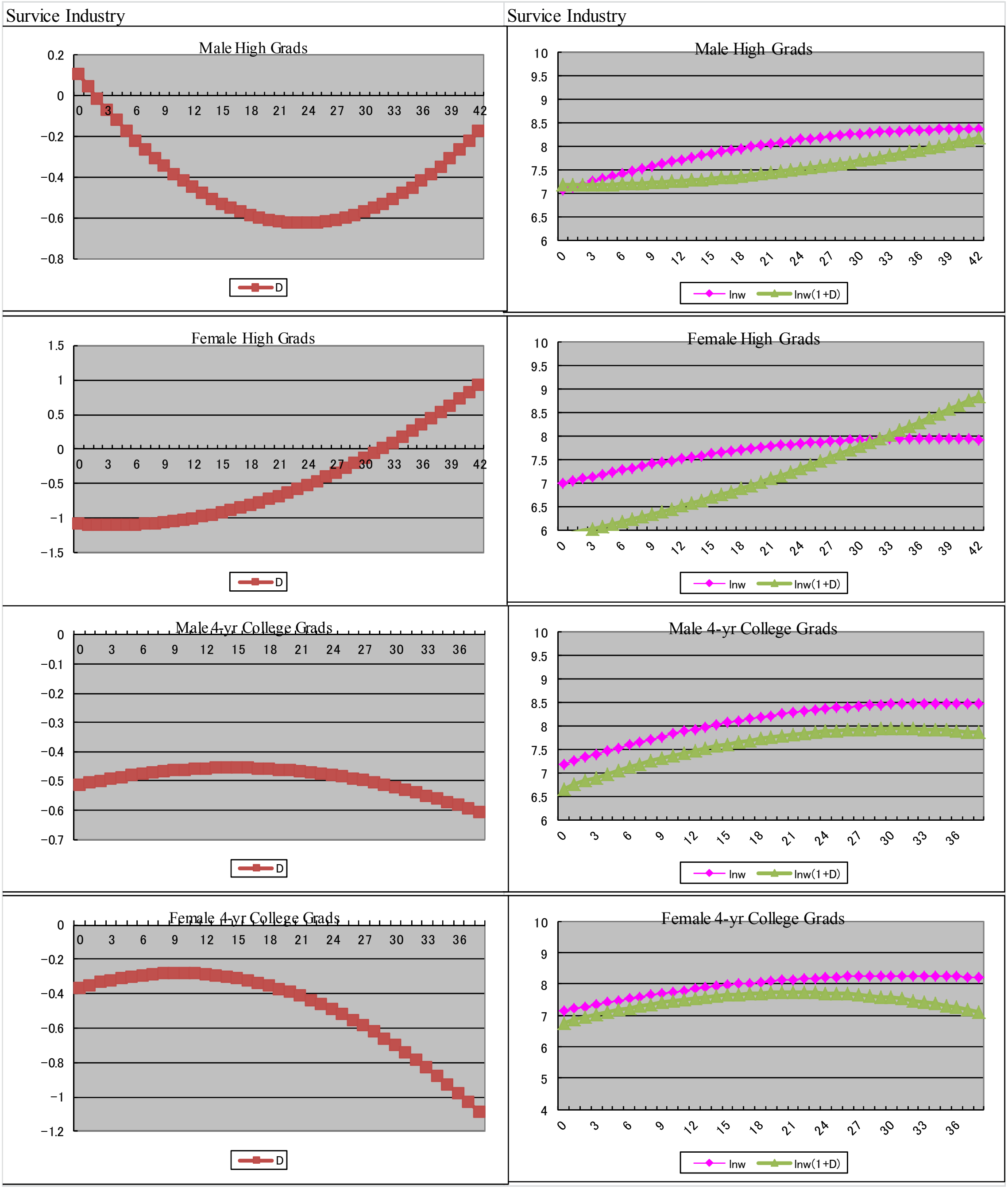


Figure 3. Gap Profile and Tenure-Productivity, Tenure-Wage Profile Using Fixed-Effects Model (Manufacturing Industries)

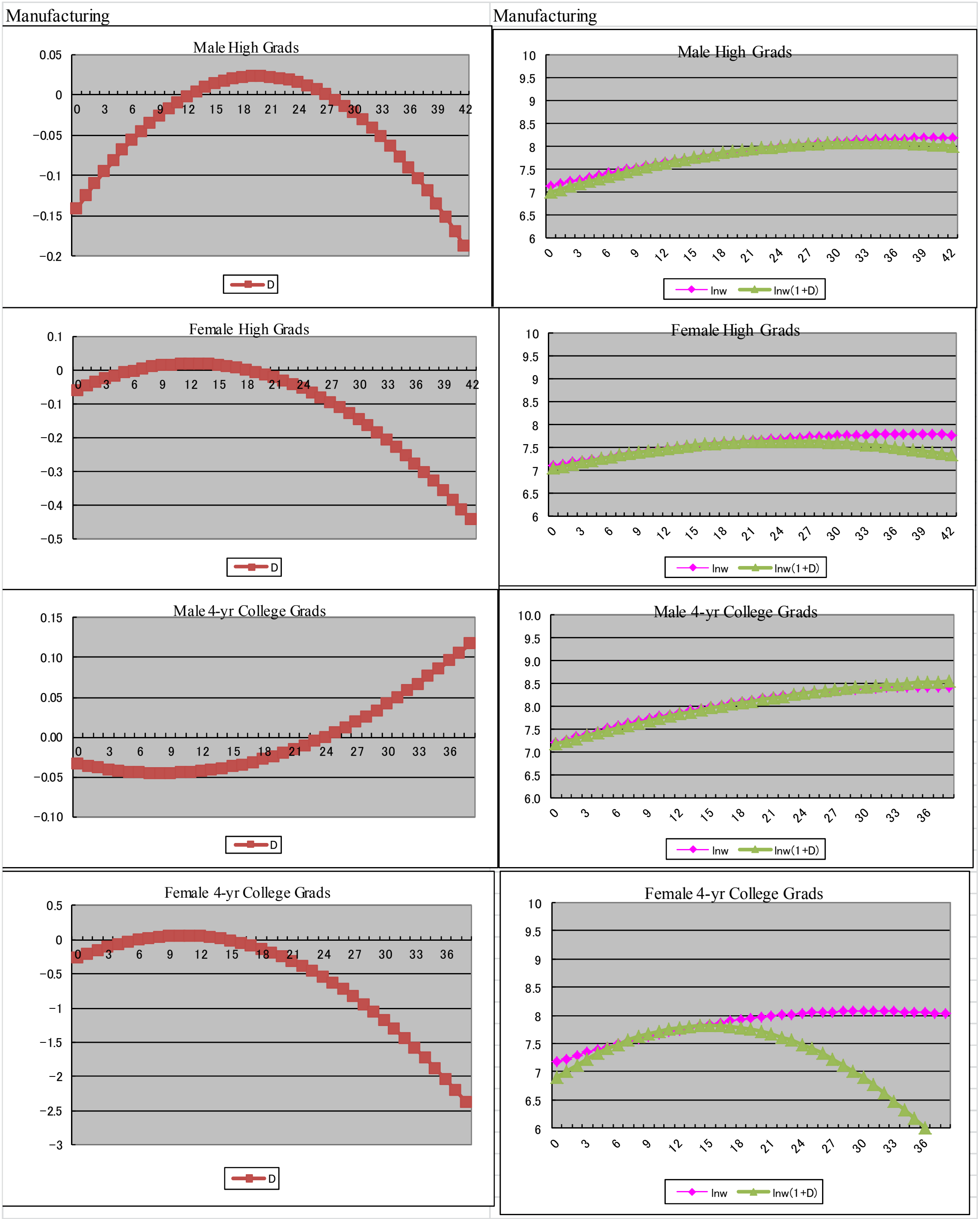


Figure 4. Gap Profile and Tenure-Productivity, Tenure-Wage Profile Using Fixed-Effects Model (Service Industries)