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Running Title:
Wage differentials in Japan

Abstract

The purpose of this paper is to examine how much the geographical distribution of human capital affects the determinants of the interregional wage differentials in Japan. To measure the impact of them, the Gini coefficient was simulated in case where there was no difference in the distribution of human capital between prefectures and compared with the actual value. The result shows that more than half of the actual Gini coefficients can be explained by the geographical distribution of human capital.

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1. Introduction

The Japanese labour market has recently experienced substantial changes; human capital has risen in importance since the mid-1970s. As for labour demand, Japanese firms have regarded productive capacity as the most important thing and showed a tendency to make contracts with university graduates for good conditions, rather than high school or junior college graduates (see Figure 1). This trend still continues. In that period, Japanese firms took action to reorganize the former employment system in which firms characteristically gave no thought to the educational attainment of workers when recruiting.[1] For instance, in the new system, office workers were classified into special or technical positions, which require high productivity and play a central role in innovating firms, or administrative positions. And then the firms aggressively developed the capabilities of their employees, who were assigned to those special or technical positions (*Economic Planning Agency, 1985*). Of course, their wages were relatively high compared to those in administrative positions, and university graduates accounted for a large part of the special or technical positions because of their high-level productive capacity.[2] As a result of these circumstances, the wage differentials between university and junior college graduates have expanded remarkably in Japan.[3] As for labour supply, having observed these trends, Japanese

students would strongly aim at entering university rather than junior college. So, between 1985 and 2000, the numbers of Japanese university students dramatically increased (see Figure 2). Here, it should be remembered that a university education is a prerequisite for certain occupations or for obtaining a higher status or salary, in terms of accumulating human capital or enhancing their productivity.[4]

This type of change has an effect not only on income inequality all over Japan but also on the interregional wage differentials. Of course, the former problem is important to the designing of policy for income redistribution.[5] But, the latter problem is more important for designing the relationships between the central and local parts of the country and for maintaining the so-called national minimum. In the present paper, taking account of the above considerations, the impacts of the geographical distribution of human capital on the interregional wage differentials in Japan were investigated.[6] For instance, the difference between the wage level of Tokyo where many university graduates live and that of Akita, whose rate of university graduates is low, can be explained. As far as the authors know, this issue has not been analyzed by any empirical research or recognized precisely in Japan. It is thus important and indispensable to investigate the interregional wage differentials empirically from this perspective. Additionally, the results will be

informative and useful when considering the roles of the central and local governments in fiscal or economic policies under circumstances where most local governments tend to handle their own large fiscal deficits.

This paper is organized as follows. In the next section, a model and some features of using data are presented, and some econometric issues discussed. In the third section, the regression results are reported and examined. The conclusion with a summary and some remarks is given in the final section.

2. Model and Data

This section introduces the authors' assumptions on the model and data used in the estimation. The starting point for this analysis is that wages should be reflected by the characteristics, especially educational achievements, of the worker that influence the quality of labour services, along with the compensating differentials based on the nature of the work.

Firstly, the Cobb-Douglas production function of each prefecture and the structure of its explanatory variables were defined as follows:

$$Y = F(G, K^*, L^*) = AG^{\alpha}(K^*)^{\beta}(L^* e^{f(b)})^{\gamma} \quad (1)$$

$$K^* = \rho K \quad (2)$$

$$\rho = u^{\delta} \quad (3)$$

$$L^* = hL \quad (4)$$

$$f(b) = 1 + \eta_1 b_j + \eta_2 b_j^2 + \eta_3 b_u + \eta_4 b_u^2 \quad (5)$$

In equation (1), A is the total factor productivity, G is the public capital stock, K is private capital stock, L is labour force and $e^{f(b)}$ is an efficiency unit of labour. In equation (2), ρ is the capital utilization rate of private capital for each prefecture. In equation (3), *u* represents the unemployment rate of each prefecture. In equation (4), *h* is regular working hours without overtime and L denotes the numbers in the labour force for each prefecture. In equation (5), b_j and b_u are the ratio of junior college or technical college graduates and university or graduate school graduates to each prefectural population.[7] These variables represent the quality of human capital. To make a quadratic approximation, consideration was given to the quadratic terms, b_j^2 and b_u^2.

Secondly, worker's wages were assumed to be paid according to their marginal

productivities; the hypothesis of the firms' profit maximization supports this condition. It was supposed that the production function is homogeneous of degree one in L and K, so that $\beta+\gamma=1$.[8] Then, by differentiating equation (1) by L^* and by using the first order conditions for profit maximization, the wage equation can be written as follows:

$$w = F_{L^*} = A(1-\beta)e^{f(b)}G^{\alpha}\left(K^*\right)^{\beta}\left(L^* e^{f(b)}\right)^{-\beta} \tag{6}$$

To clarify the parameters to be estimated, equations (2), (3), (4) and (5) were substituted for (6) and equation (6) was reparameterized as follows:

$$w = F_{L^*} = A(1-\beta)\exp\left((1-\beta)f(b)\right)G^{\alpha}\left(K/hL\right)^{\beta}u^{\beta\delta}. \tag{7}$$

The present paper assumed that the wage level is indifferent among workers in the same prefecture. To estimate wage functions, equation (7) was transformed into logarithmic form and reparameterized as follows;

$$\log w = \theta_0 + \theta_1 b_j + \theta_2 b_j^2 + \theta_3 b_u + \theta_4 b_u^2 + \theta_5 \log G + \theta_6 \log\frac{K}{hL} + \theta_7 \log u + v \tag{8}$$

where

$$\theta_0 = \log A\gamma + (1-\beta)$$
$$\theta_i = (1-\beta)\eta_i, \qquad i = 1,\ldots, 4$$
$$\theta_5 = \alpha$$
$$\theta_6 = \beta$$
$$\theta_7 = \beta\delta$$

and v is an error term. Each set of coefficients in equation (8) was estimated by gender and age groups in 1980 and 1990 with prefectural data. Taking heteroscedasticity into account, this estimation was conducted using the weighted least squares method where the sample number of graduates was used as the weighted for each observation. Before explaining the data, it is necessary to clarify the assumption maintained when estimating the wage functions by gender and age groups with the same private and public capital levels (G and K^*). In this research, it is assumed that the total level of the private and public capital affects the productivity of each group.[9]

The data sources used in this paper are described in Table 1. The key data to categorize the gender and age groups are from the *National Census* by the *Management and Coordination Agency Statistic Bureau* and the *Basic Surveys on Wage Structure* by the *Ministry of Labor*. The former provides the prefectural population by gender and age groups: 20s, 30s, 40s, 50s, and over

60s, and their educational achievement: junior high school graduates (9 years of schooling), high school graduates (12 years of schooling), junior college or technical college graduates (14 years of schooling) and university or graduate school graduates (16 or more years of schooling). As the primary focus of this paper is to examine the interregional wage differentials caused by the distribution of human capital between prefectures, the categories of high school, junior college and university graduates were selected from this sample and the ratio of each category to the total prefectural population was calculated. The latter provides the monthly regular earnings and regular working hours without overtime that are classified into only three age categories, 25-29, 35-39 and 55-59. These two available data limited the estimation of the wage equations of the 20s, 30s and 50s by gender in 1980 and 1990.

Additionally, a distinction was made between the private sector and public sector for each prefecture's capital stock. The private capital stock researched by Doi (1998), and the public capital stock collected by the *Economic Planning Agency* were used.[10]

3. Empirical Results

The weighted OLS estimates of equation (8) are presented in Table 2 and Table 3.

Unfortunately, only the monthly regular earnings data that are classified into three age categories, 25-29, 35-39 and 55-59 could be obtained, and thus the wage equations of the 40s could not be estimated. In this estimation, *Akaike's Information Criterion* (AIC) was used for model selection (the results of the selected models are reported in the "selected" column). The levels of R-square are higher than 0.85 in every estimation. Almost all coefficients of the rate of university graduate variables are statistically significant at 1% for each year. Among these variables, θ_3 is positive and θ_4 is negative, so that the university graduate rate has generated a concave earnings profile. The coefficients of public capital stock and the ratio of private capital and labour are significant at 1% and positive as expected; however, the numerical values are extremely low. The coefficient of the unemployment rate is not significant even at 10% for each year.

How much impact does human capital have on interregional wage differentials in Japan? To check this issue, the Gini coefficients were calculated in three ways.[11] Firstly, the Gini coefficients were calculated by the actual wage. Secondly, they were calculated using the fitted values of equation (8). Thirdly, they were calculated with the simulated values when the values of b_j and b_u were set to the national averages respectively:

$$\log \overline{w} = \hat{\theta}_0 + \hat{\theta}_1 \overline{b}_j + \hat{\theta}_2 \overline{b}_j^2 + \hat{\theta}_3 \overline{b}_u + \hat{\theta}_4 \overline{b}_u^2 + \hat{\theta}_5 \log G + \hat{\theta}_6 \log \frac{K}{hL} + \hat{\theta}_7 \log u \qquad (9)$$

where,

$\overline{b}_j$: The national average rate of junior college graduates

$\overline{b}_u$: The national average rate of university graduates.

If the distribution of human capital had a large impact on interregional wage differentials, it was expected that the problems of interregional wage differentials could be redressed by substituting the average values of human capital for equation (9). Figure 3 shows the result of the calculated Gini coefficients by the three methods. From Figure 3, when the variables of the rate of human capital were substituted by the national average values, every differential was reduced to approximately half the scale.

Comparing 1980 and 1990, wage differentials expanded in males of every age and females in their 30s and 50s. Especially in males in their 20s and 30s, the impact of human capital on the wage differentials expanded. Also, in females in their 30s and 50s, the same phenomenon could be found. To examine the contributions of the rates of university graduates to the wage differentials, the additional effects on the wages within the ranges of the rate of the university graduates in prefectures were determined for each age group (Figure 4). The shape of

these curves is concave. At each curve top, the rate of the university graduates is optimal. For example, Tokyo and Kanagawa are a higher rank, while Akita and Aomori are a lower rank in every age group in 1980 and 1990. However, among male group in their 20s in 1990, in prefectures whose rate of university graduates was more than about 34%, the wage level became lower.[12] In other words, in such prefectures, it is thought that male university graduates in their 20s exceeded the optimal level. Although the firm's need for university graduates and the intensity of advancement to university increased during 1980-1990, as a result, this phenomenon implies an excess labour supply of university graduates in such prefectures. From 1980 to 1990, in every age group, the curves shift upward and become steeper. This phenomenon means that the productivity of the university graduates had increased or at least their marginal productivity had increased, resulting from the changes in the Japanese employment system.

4. Summary and Conclusion

The following are the main conclusions of this paper. Firstly, the geographical distribution of human capital was a main factor of the interregional wage differentials in 1980 and 1990. Secondly, the increase in wage differentials between 1980 and 1990 was caused by the

increase in the contribution of human capital to the Gini coefficients, especially in males in their 20s and 30s, and females in their 30s and 50s. Thirdly, the increase in the productivity of university graduates caused the expansion of wage differentials between 1980 and 1990.

Finally, it is necessary to point out that some important research still remains. The first is that research is needed to estimate the university and junior college graduates' earnings profile with micro data in each prefecture. Because of the unavailability of data, such an approach cannot be taken. But, micro data will shed light on the interaction between human capital and firm size distribution or industrial structures in each prefecture. Then, the effect of human capital on prefectural wage differentials can be investigated more thoroughly. Second is to suggest some policies for reducing the inequality taking the distribution of human capital into consideration. While the recent large deficit of local governments narrows the way to improving income inequality, the prefectural wage differentials are becoming larger. Policy makers need some useful devices to deal with this difficulty.

Footnotes

[1] Koshiro and Kuwabara (1988) explain the problem of Japanese white-collar workers in the 1970s and 1980s, in detail.

[2] Genda (1997) analyzed the impacts of OJT on wage differentials between large and small Japanese firms. He pointed out that the impacts account for a large part of the wage differentials.

Rebick (1993), Okui and Ohtake (1997) and Suzuki (2001) also investigated the impacts of firm size on the wage differentials.

[3] Tanaka (1996) investigated changes in the Japanese wage structure and wage differentials, by considering tenure category and educational attainment level using data of the *Basic Survey on Wage Structure (Wage Census)*, i.e. 'average monthly scheduled cash earnings'. He found that the male wage differentials, especially between junior college and university graduates, strikingly widened between 1976-1991.

[4] Becker (1993) referred to investment in human capital in terms of theoretical and empirical analysis, in detail.

[5] Tachibanaki (1996) refers to Japanese wage determination in terms of theoretical and empirical analysis. Yue (1998) empirically analyzed the relation between difference in industrial structures and amounts of productive factors in each prefecture, using the Heckscher-Ohlin model, so as to investigate interregional income differentials.

[6] As for the regional wage differentials, Dickie and Gerking (1989) surveyed theoretical and empirical researches. Recently, Barrett, Callan and Nolan (1999) estimated standard human capital-type wage equations, based on educational attainments and a number of other relevant

characteristics, for both 1987 and 1994 in Ireland. They found large growth returns for university degrees. Johansen, Rigdal and Thøring (2001) also estimated a regional wage equation.

[7] The variable for high school graduates was removed from estimating the wage function because of multicollinearity.

[8] The production function of degree one homogeneity was assumed in two ways, $\alpha + \beta + \gamma = 1$ and $\beta + \gamma = 1$. After the specification of an equation, the assumption of $\beta + \gamma = 1$ was applied to the estimation.

[9] More exactly, the production function can be assumed to have a partially additive production function:

$$Y = \left(\sum_i A_i \left(L_i e^{fi(b)} \right) \right) G^{\alpha} \left(K^{*} \right)^{\beta},$$

where i represents the gender and age groups. It is similar to the production function that Grossman and Helpman (1991) proposed.

[10] The Economic Planning Agency, Planning Bureau (1998) conducted a detailed research on measuring social capital stock. The total aggregate of all the items was adopted for the wage equation.

[11] In the case of calculating the Gini coefficients, the exponential values were used in three ways.

[12] The rate of university graduates in Tokyo and Kanagawa is 39.4% and 35.2%, respectively.

Nara and Chiba are located at the top of the curve.

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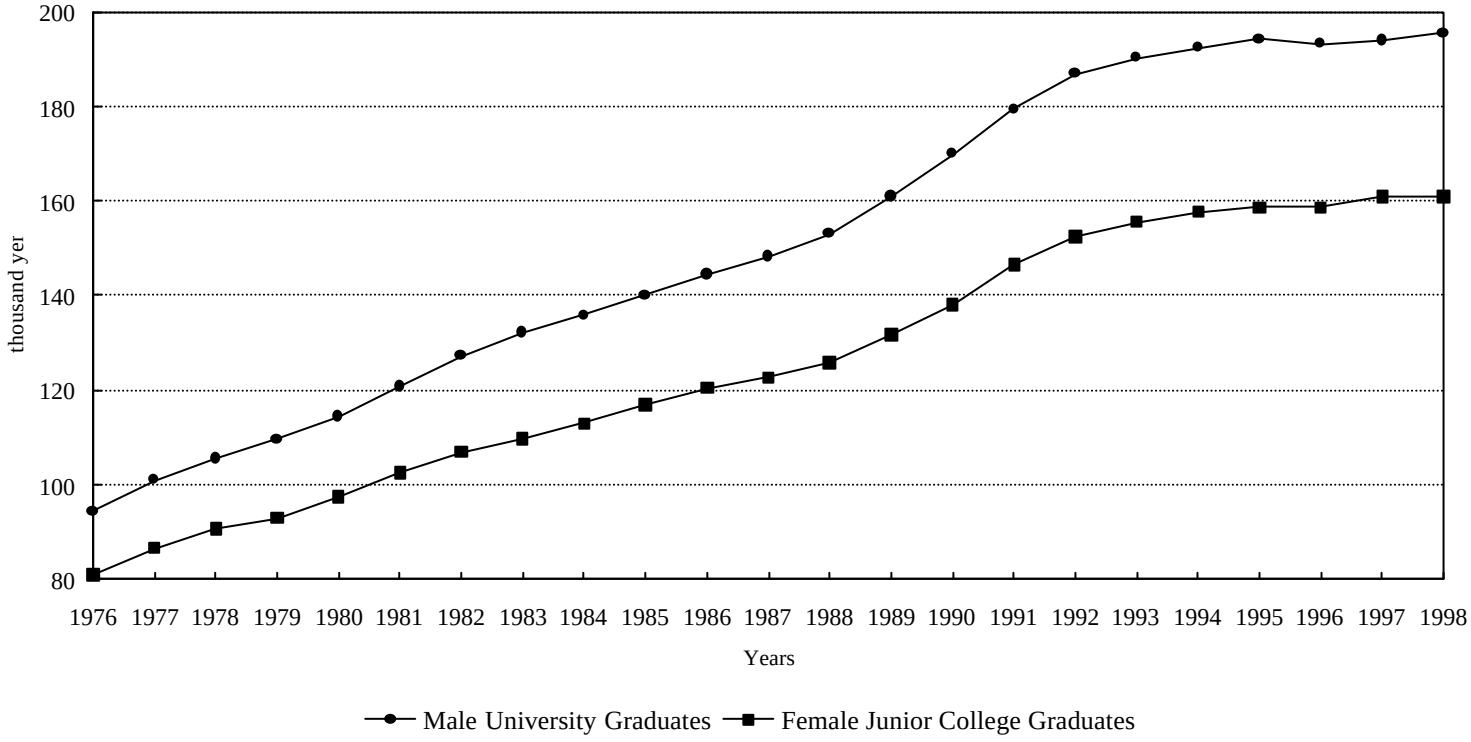
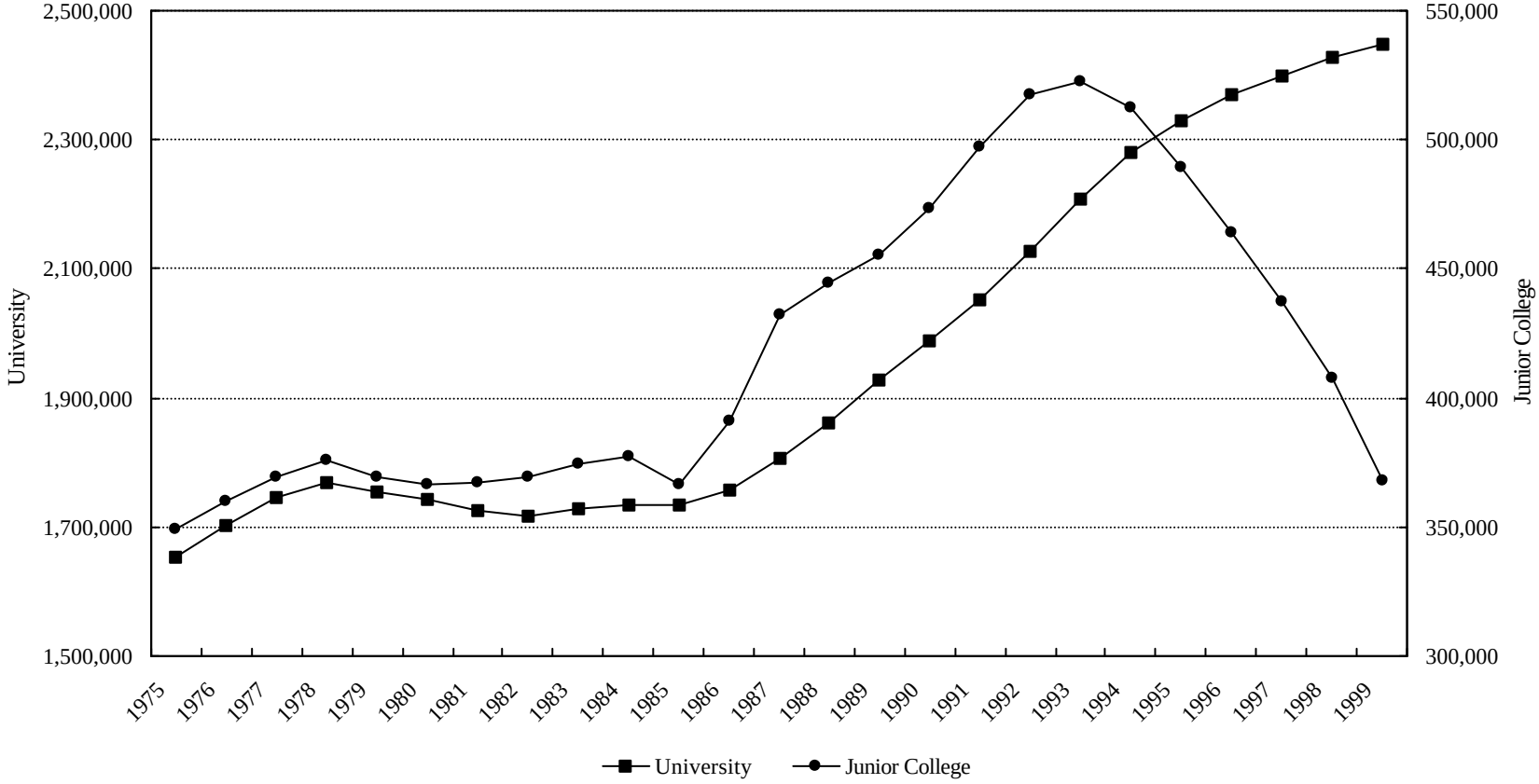
Figure 1. Starting Salaries, Classified by Gender,
Educational Attainment



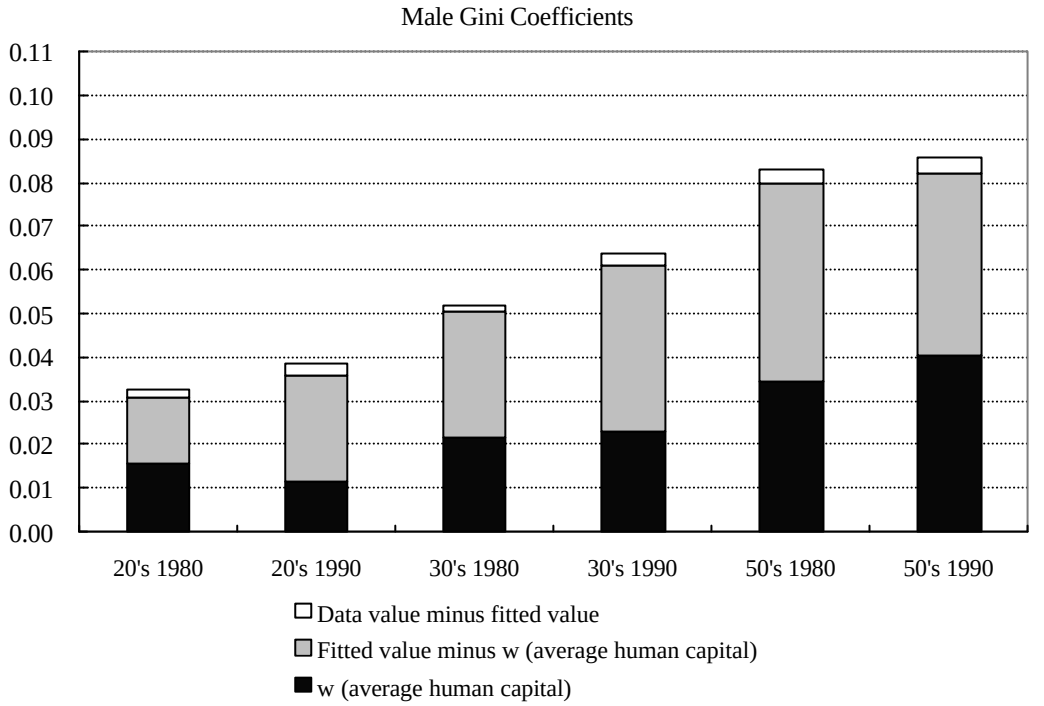
Source: Basic Survey of Wage Structure (Wage Census), 1998

Figure 2. The Number of University & Junior College Students in Japan, 1975-2000



Source: Basic School Survey, 2000

Figure 3. Male and Female Gini Coefficients



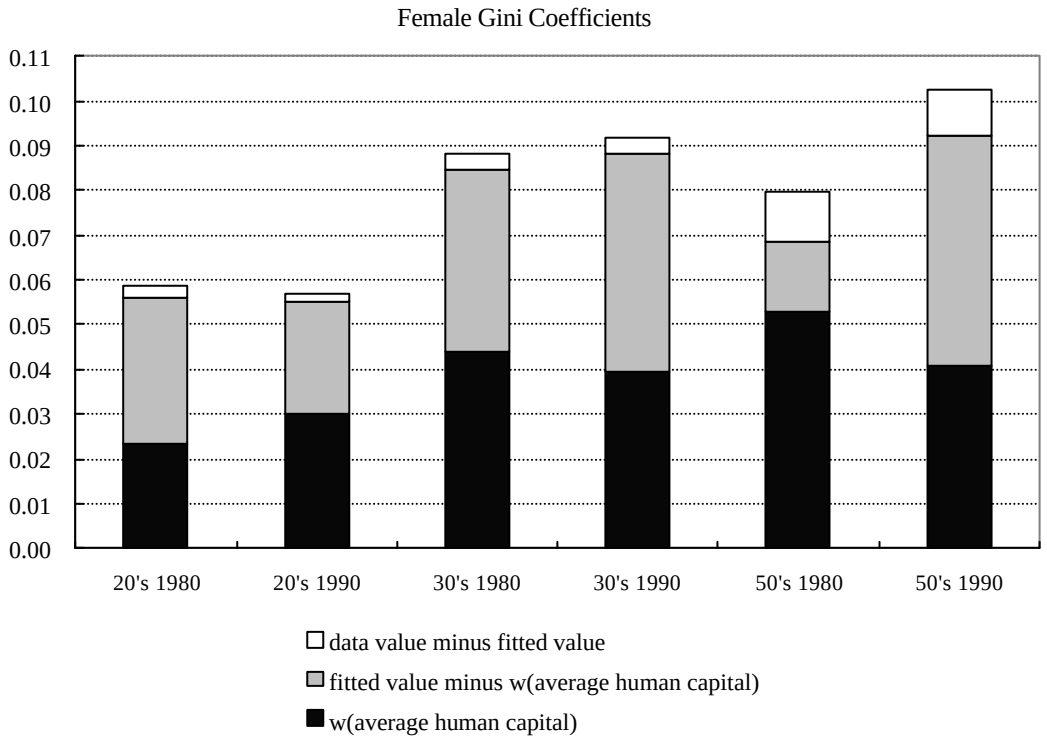


Figure 4. Quadratic approximation based on rate of university graduates in each prefecture

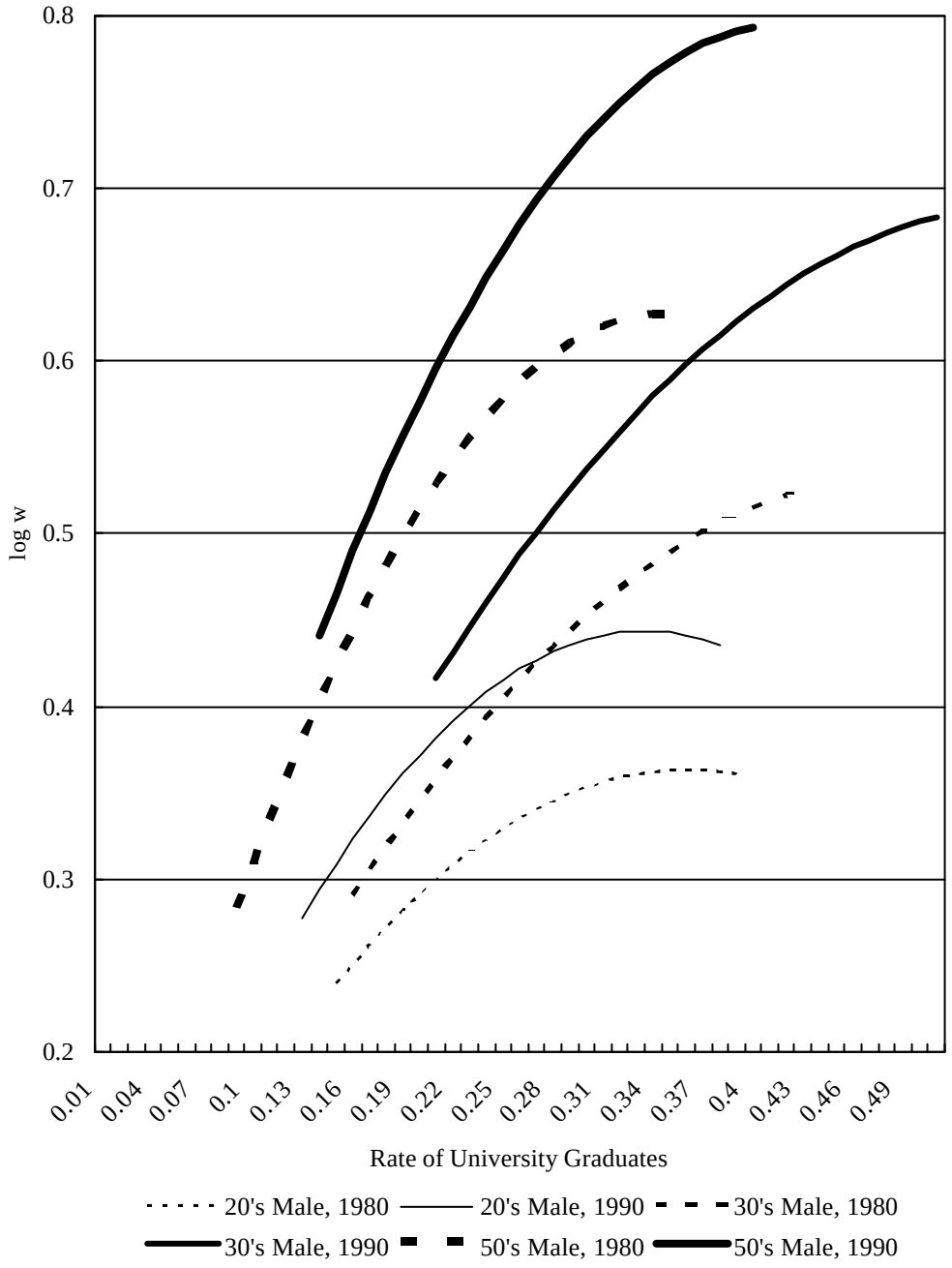


Table 1 Data and Data Sources

Data	Abbreviatio	Sources
Wage	w	Monthly Regular Earning :Basic Survey on Wage
Ratio of High School and University Graduates	b_j & b_u	National Census
Public Capital Stock	G	Economic Planning Agency, Planning Bureau (1998)
Private Capital Stock	K	Doi (1998)
Working Hours	h	Monthly Regular Working Hours : Basic Survey on Wage Structure
Labour Forces	L	National Census
Unemployment Rate	u	National Census

Table 2. Regression Results of Male Wage Function

	1980					
	20's		30's		50's	
	original	selected	original	selected	original	selected
$è_0$	3.895	3.816	4.541	4.957	6.199	6.039
	[17.090]	[19.801]	[11.799]	[20.861]	[6.442]	[36.357]
The ratio of junior college students						
$è_1$	9.504	9.028	10.054	-	-2.987	-1.174
	[2.235]	[2.179]	[1.289]		[0.266]	[-1.901]
$è_2$	-62.115	-59.242	-100.288	-	5.863	-
	[-2.157]	[2.016]	[-1.242]		[0.160]	
The ratio of university students						
$è_3$	1.937	2.016	2.440	2.169	3.620	3.614
	[4.400]	[4.575]	[3.972]	[3.995]	[5.966]	[6.670]
$è_4$	-2.724	-2.797	-2.716	-2.202	-5.204	-5.203
	[-3.497]	[-3.572]	[-2.794]	[-2.626]	[4.223]	[-4.505]
Public capital stock						
$è_5$	0.034	0.037	0.027	0.022	-0.001	-
	[4.184]	[4.902]	[2.061]	[1.986]	[-0.060]	
The ratio of private capital and labor						
$è_6$	0.029	-	0.110	0.101	0.253	0.250
	[1.177]		[3.255]	[3.495]	[6.175]	[7.242]
Unemployment rate						
$è_7$	-0.014	-	-0.024	-	0.036	0.037
	[-0.980]		[-1.162]		[1.299]	[1.146]
R-squared	0.868	0.859	0.903	0.897	0.921	0.921
Number of observations	47	47	47	47	47	47

	1990					
	20's		30's		50's	
	original	selected	original	selected	original	selected
$è_0$	4.533	4.683	4.162	4.147	5.378	5.902
	[17.900]	[28.656]	[10.306]	[10.599]	[12.251]	[41.193]
The ratio of junior college students						
$è_1$	5.143	6.220	21.170	20.740	7.414	-
	[1.780]	[2.278]	[2.695]	[2.799]	[0.748]	
$è_2$	-15.488	-19.429	-128.972	-126.373	-98.179	-
	[-1.276]	[-1.669]	[-2.524]	[-2.604]	[-0.931]	
The ratio of university students						
$è_3$	2.796	2.652	2.439	2.433	2.661	3.784
	[4.563]	[4.446]	[3.911]	[3.955]	[2.505]	[4.535]
$è_4$	-4.292	-3.963	-2.155	-2.141	-2.830	-4.502
	[-3.696]	[-3.530]	[-2.515]	[-2.539]	[-1.556]	[-3.047]
Public capital stock						
$è_5$	0.012	-	0.027	0.028	0.032	-
	[1.094]		[2.155]	[2.347]	[1.547]	
The ratio of private capital and labor						
$è_6$	0.059	0.067	0.115	0.114	0.228	0.278
	[2.680]	[3.245]	[3.807]	[3.903]	[4.987]	[7.779]
Unemployment rate						
$è_7$	0.001	-	0.005	-	0.029	-
	[0.054]		[0.185]		[0.703]	
R-squared	0.884	0.879	0.921	0.921	0.907	0.897
Number of observations	47	47	47	47	47	47

Note: The t-values are shown in brackets.

Table 3. Regression Results of Female Wage Function

	1980					
	20's		30's		50's	
	original	selected	original	selected	original	selected
$\hat{e}_0$	2.776	2.944	3.914	4.191	4.593	4.312
	[7.538]	[10.82]	[5.040]	[10.021]	[7.627]	[9.115]
The ratio of junior college students						
$\hat{e}_1$	6.220	5.799	4.299	-	-5.647	-
	[2.838]	[2.686]	[0.421]		[-0.770]	
$\hat{e}_2$	-11.858	-10.983	-16.160	-	50.496	18.551
	[-2.360]	[-2.214]	[-0.402]		[1.171]	[3.237]
The ratio of university students						
$\hat{e}_3$	3.875	3.962	6.510	7.547	6.523	-
	[3.532]	[3.661]	[2.026]	[3.449]	[0.670]	
$\hat{e}_4$	-13.102	-13.744	-18.763	-27.134	-289.558	-99.963
	[-2.317]	[-2.465]	[-0.788]	[-2.009]	[-1.165]	[-1.404]
Public capital stock						
$\hat{e}_5$	0.059	0.057	0.065	0.065	0.079	0.083
	[5.245]	[5.692]	[3.447]	[3.649]	[3.711]	[4.049]
The ratio of private capital and labor						
$\hat{e}_6$	0.002	-	0.154	0.154	0.133	0.119
	[0.044]		[2.855]	[3.021]	[2.128]	[2.018]
Unemployment rate						
$\hat{e}_7$	-0.027	-	0.050	0.058	0.129	0.132
	[-1.300]		[1.304]	[1.752]	[3.183]	[3.347]
R-squared	0.907	0.903	0.878	0.877	0.772	0.768
Number of observations	47	47	47	47	47	47

	1990					
	20's		30's		50's	
	original	selected	original	selected	original	selected
$\hat{e}_0$	2.892	2.708	2.282	2.345	3.998	3.792
	[8.075]	[8.843]	[3.833]	[4.603]	[6.376]	[7.727]
The ratio of junior college students						
$\hat{e}_1$	4.047	4.304	11.090	12.059	7.294	10.136
	[2.826]	[3.057]	[2.982]	[3.699]	[0.985]	[2.294]
$\hat{e}_2$	-5.737	-6.164	-22.061	-24.039	-44.204	-61.576
	[-2.374]	[-2.592]	[-2.680]	[-3.248]	[-1.021]	[-2.423]
The ratio of university students						
$\hat{e}_3$	3.805	3.857	3.060	2.119	11.157	8.925
	[3.544]	[3.599]	[2.541]	[4.702]	[2.057]	[4.489]
$\hat{e}_4$	-12.753	-12.483	-3.661	-	-29.836	-
	[-2.914]	[-2.858]	[-0.845]		[-0.474]	
Public capital stock						
$\hat{e}_5$	0.076	0.079	0.090	0.085	0.065	0.068
	[6.455]	[7.007]	[5.463]	[5.441]	[2.347]	[2.626]
The ratio of private capital and labor						
$\hat{e}_6$	0.029	-	0.067	0.063	0.149	0.139
	[0.989]		[1.471]	[1.428]	[2.352]	[2.336]
Unemployment rate						
$\hat{e}_7$	-0.055	-0.057	-0.018	-	0.019	-
	[-2.283]	[-2.348]	[-0.531]		[0.394]	
R-squared	0.908	0.906	0.917	0.915	0.833	0.831
Number of observations	47	47	47	47	47	47

Note: The t-values are shown in brackets.