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The Service Sector Earnings Determination Process Using Hierarchical Data Analysis*

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I. Issues of Income Determination Process in the Service Sector

It is argued that the growth of the service sector lowers the incomes of most workers but increases that of a small number of professional managerial workers in the service sector. This issue is very important because we are witnessing a significant growth of the service sector. The shift from a society dominated by the manufacturing sector to a society dominated by the service sector is dramatic. The U.S. Census (1990) showed that percentage of workers in the service industry to the total labor force has increased from 67% in 1980 to 71% in 1990. Other data from the Current Population Survey of 1991 also shows that the proportion employment in agriculture and mining, manufacturing, and service industries are 4%, 19% and 77% respectively.

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1There are various definitions of the service sector(Fuchs, 1968; Singelmann, 1978; Semyonov and Lewin-Epstein, 1986). These studies showed that service industries were very heterogeneous and hard to define. Based on this finding, this study defines the service sector residual sector of the manufacturing and extractive industries, such as agriculture and ining.

Current studies of income in the service sector discuss the impact of the growth of the service sector on income distribution based on the change in occupational composition (Fuchs, 1968; Stanback et al., 1981; Harrison & Bluestone, 1988) or change in the price of human capital (Murphy & Welch, 1992; Juhn et al., 1993). Among them, explanations based on the human capital theory are open to several criticisms. First of all, they lack a structural perspective. They assume that workers' incomes are determined by the workers' contribution to the product: workers in professional and managerial occupations have higher human capital, and contribute more to the production. As a result, they are highly paid. However, it still needs to be tested whether income polarization in the service sector is simply a result of the change of the occupational composition, or more specifically a result of the compositional change of workers' human capital endowments. Two explanations of income determinants, the structural approach of sociology (Bae and Form, 1986; Bibb and Form, 1977; Villemez and Bridges, 1988; Granovetter, 1984; Hodson, 1987; Kalleberg, 1989; Kalleberg and Lincoln ,1988; Kalleberg and Sorensen, 1979; Kalleberg et al., 1981; Lincoln and Kalleberg, 1985; Pfeffer, 1977; Stinchcombe, 1979; Stolzenberg, 1975; 1978; Wright and Perrone, 1977) and the new institutionalism in economics (Dunlop, 1957; Kerr, 1983; Krueger and Summers, 1987; Dickens and Katz, 1987) show that income is determined by factors other than human capital or occupational status. However, in the discussion of income in the service sector, structural variables such as effect of characteristics of industry, discrimination and the power of workers get less attention. There are also problems among some studies using the structural approach. For example, industry level variables are not utilized to explain income distribution. This is the heritage of the dual labor market explanation. The traditional dual labor market approach assumes that there are industry-level covariates. In their theoretical framework, industrial level effects are already explained as a form of dummy variable of dual labor market, "core" and "periphery" as was found in Tigges (1988). When she explains change of income determination, she simply shows the change of the effect of sectors, core and periphery. In doing so, she fails to identify what industrial level factors are important in explaining income of workers in each sector. A more serious problem is that both approaches assume that the effects of income determinants are same within the manufacturing and the service sector. However, this assumption is not plausible because there are many differences in

industrial characteristics between the manufacturing and service sectors. There is much evidence that the effect of sector on income could be different in each sector: firms in the service sector are usually small in size (Granovetter, 1984), and small size firms tend to pay low wages; the composition of workers in the service sector is also different from that of the manufacturing sector; there is a high proportion of professional and managerial workers (Bell, 1973) and a high proportion of low educated, minority and juvenile workers in the service sector (Singelmann, 1978; Stanback, 1981; Greenberger & Steinberg, 1986; Harrison and Bluestone, 1988); labor control mechanism is different in the service sector (Kroc, 1977; Leidner, 1988); the level of unionization in the service sector is low and unions in the service sector operate in smaller, more competitive product markets where the power of unions is believed to be weak (Granovetter, 1984; Freeman and Medoff, 1984; Tigges, 1988). In addition to the between-sector differences, there is significant variances among industries within service sector (Singelmann, 1978; Stanback et al., 1981; Semyonov and Lewin-Epstein, 1986). Traditionally, the service industry is identified with personal services, but these industries now employ only 2.3% of total workers, according to estimates from the Current Population Survey (CPS, 1991). In addition, major sub-sectors, such as social service, business service and the retail/wholesale industry are different in many ways: average firm size, percentage of part-time workers, level of unionization, etc. Therefore, we should assume that the effects of income determinants can be different across industries.

Explanations of the income determination process in the service sector should consider the effects of these sectoral differences between the manufacturing and the service sector on income; different industrial characteristics(profit, unionization), labor composition (professionalization, female, juvenile and retired workers), and so on. Sometimes, the same factors have different effects on the income determination process due to sectoral or sub-sector differences. For example, in the manufacturing sector, most workers get more skilled as work experience increases, however, in the service sector, most workers do not gain skill even as their work experience increases (Harrison & Bluestone, 1988; Stanback et al., 1981; Leidner, 1988). In sum, we need individual level variables and structural level variables to explain income determination process in the service sector but current studies do not satisfy this need. To correct this problem this study incorporates individual level variables and structural level variables into models. This will

remedy the problem of individual level explanations lacking of contextual variables in the income determination process model, and structural explanations failing to incorporate individual level variables into their structural models.

II. Empirical findings among competing models

This chapter examines the income determination process in the service sector. It will compare and evaluate various models based on the fixed effects analysis. Other aspects of income determination process, polarization thesis will be discussed in the following chapter. For this chapter, the effects of the individual attributes and industrial effects are evaluated, using the mixed regression analysis routine in SAS. Because this study assumes that individual workers are influenced by the industry where they are employed (cluster effect of industry), it investigates the effects of industry and individual attributes together. This task can be met with the method that can measure individual and cluster effect simultaneous, such as mixed regression routine in SAS.

Individual level models include human capital variables and demographic variables, and industrial level models contain industry level variables, which are the characteristics of firm, industry and labor composition of industry. This chapter starts with examining a model with industry effect that contains no explanatory variables (Variance component model). This variance component model shows the mean income of industries and its significance. The existence of the significant (insignificant) intercept term can suggest that there is (not) the effect of the industries. The other base model used in this study is quasi-variance component model. This model includes intercept term and random effects for "noskill (whether low skilled simple service occupations or not)" and "prof (whether professional or managerial occupations or not)" in addition to the intercept term. The following models probe the source of different industry effects on income. One way to explain different industry effect is to examine the composition of workers in industries. The first individual level model incorporates human capital variables. If industry difference is purely due to the human capital difference among industries, industry effect will disappear. Following individual level model adds individual attributes, such as race, sex and marital status into the model. This model tests the effect of dis-

crimination based on individual attributes. Finally, if there is still different industry effect on income remained after controlling human capital variable and other individual level variables, it tries to identify the sources of the industry effect. To explain this part, various industry level variables are added to explain income difference among industries.

II. 1. Variance component model and quasi-variance component model

Variance component model contains only one variable, intercept. It assumes that industry is the only determinant of the income of worker: industries have different income levels and all workers are paid same wage in an industry. This model tests whether there is significant mean income differences among industries or not. The model can be summarized following equation;

$$income_{ij} = intercept_i + u_{ij}$$

where

i = industry $_{1 \cdots n}$

j = worker $_{1 \cdots n_i}$ in industry $_i$

$income_{ij}$ = income of worker $_j$ in industry $_i$

$intercept_i$ = mean income of industry $_i$

u_{ij} = residual

This model does not have any practical purpose other than to show whether there is a significant mean income difference among industries and to ascertain that there exists significant proportion of variance of mean incomes attributable to industry difference. Mean income of all industry is 399 dollar per week. This significant fixed effect and variance shows that mean income differs by industry. In other words, income of worker differs by industry. However, this model does not provide support either to human capital theory which argues that industrial difference of income is mainly results of the aggregate change of the individual attributes, or to structural theories that argue that the income difference comes from difference of industrial characteristics, yet. These competing arguments are tested in the following models. Quasi variance component model is an ex-

tension of base model, variance component model. The income polarization thesis is based on the assumption that incomes of workers are determined by their occupational status and industrial characteristics. Some workers with professional managerial occupations have higher income than workers in occupations with low skill requirement regardless of their human capital. There are many explanations why professionals make more money than low skilled in the service sector. Before, explain this polarization, it is needed to test whether income differs by occupational status and how much different they are. To test this argument, this study puts dummy variables of professional managerial occupation (prof) and low skilled occupation as random variables in the model. Table I shows that all fixed effects are significant. Mean income of industry is 365 dollars and the difference between professionals and low skilled service workers are 326 dollars. Significant variance of "prof" and "noskill" variables suggest that the effects of these variables differs by industry. However, this model shows additional information than variance component model but still it does not identify the source of industrial difference of mean income.

Table 1. Models of Income in the Service Sector, Random Regression Models (1991, Current Population Survey)

Fixed Effects	variance b	Quasi Variance b	Human capital b	Ascriptive b	Reduced 1 b	Reduced 2 b	Full b
Intercept	399.116	365.229	-466.589	-545.509	-563.336	-484.047	-508.118
Noskill (1)		-113.628	-53.903	-62.004	-56.092	-56.755	-53.285
Prof (2)		212.620	132.025	124.850	124.623	127.644	127.292
Hga (3)			18.983	17.922	17.162	18.236	17.489
Age (4)			12.083	12.728	12.517	12.095	11.964
Agesq (5)			-0.121	-0.131	-0.128	-0.124	-0.122
Uslhrs (6)			8.795	7.970	7.900	7.957	7.891
Metro (7)				51.520	46.987	49.474	45.550
S1 (8)				81.641	81.848	78.939	79.222
White (9)				25.093	28.690	25.652	28.838
Marry (10)				22.970	23.329	22.893	23.203
Profit** (11)					1.714		1.368
Empsize(12)					0.032		0.029
Apart (13)						-1.747	-1.459
U1 (14)						66.201	59.254
-2 log Like x^2	128329	126294	122842	122105	121917	121999	121838
x^2 difference		2035	3452	737	188*	107*	161*** 79****
degree of freedom		64	4	4	2*	2*	2**
p		〈 0.001	〈0.001	〈 0.001	〈0.001	〈0.001	〈0.001

* compared to "ascriptive model"

** compared to "reduced model 1, 2"

*** compared to "reduced model 1"

**** compared to "reduced model 2"

Table 1 (continued)

Random effects

intercept	13827	2953	4888	3524	2129	1563	939
noskill		5406	2138	1966	1355	1738	1377
prof		6836	3969	3421	3606	3464	3609

* all coefficients are significant at Greek alpha (α) = 0.05 level

** multiplied by 1000.

variable list

(1) dummy variable for occupational status, low skilled occupations
(2) dummy variable for occupational status, professional and managerial occupations
(3) highest grade attended
(4) age
(5) age squared
(6) hours worked per week
(7) dummy variable for the location of work, metropolitan area
(8) dummy variable for the sex, male
(9) dummy variable for race, white
(10) dummy variable for marital status, married
(11) profit of industry per person
(12) employment size of firms
(13) percentage of part-time workers in industries
(14) dummy variable for union membership, member of union.

II. 2. Human capital model

Human capital theory is based on the assumption that higher wages are allocated to workers with higher levels of productivity which is determined by human capital(Becker, 1975; Mincer, 1974). In this context, if we control variables related to human capital theory income difference among industries will disappear because some industries have more workers with higher (or lower) human capital than workers in other industries. In

other words, industry effects seen at the previous variance component model and "prof" and "noskill" in quasi variance model will disappear. For the test of this argument, human capital variables are added to the base models. Added variables are human capital related variables, such as years of education, age and age squared terms as proxies of skill and experience. A variable, "Hours of work per week (USLHRS)" is introduced as a control variable.

Results strongly back human capital argument. Adding these variables reduces the size of variance of the intercept term. Variance of industry (intercept) effect on income is reduced substantially in human capital model and variance of "noskill" and "prof" also reduced. Fixed effects of all human capital variables are also significant. Education effect is positive (19 dollars for one year of education) and age is positive but curvilinear as significant age squared term shows (estimated coefficients are 12 dollars and -0.1 dollars, for age and age squared term respectively), Therefore, one year of education difference is 19 dollars per week and one year of age difference is 12 dollars per week and these significant coefficients show that relationship between education and income is curve-linear. In addition, one hour of work per week makes 9 dollars difference.

However, industry variance part of the analysis clearly shows that there is still strong industry effect remaining after controlling human capital variables. Significant industry variance and residual variance suggest that mean income, the effects of occupational status variables, "prof" and "noskill" and income of individual workers are significantly different after controlling human capital variables. Existence of significant fixed effects of variables of low skilled workers and professional managerial workers after controlling human capital also indicate that there are other than human capital variables influencing income determination.

II. 3. Individual attributes model

Whereas human capital theory assumes that income is determined by individual capacity to produce in the market, many sociologists have argued the presence of the structural effects other than human capital on income. Most often cited variables to affect income determination processes are race (Kaufman, 1983; Stolzenberg, 1975; Wright, 1978) and sex (Corcoran et al., 1984; England & Norris, 1985; Halaby, 1979;

Hodson & England, 1986 ; Marini, 1989). Many studies show that workers with same education and experience are paid differently due to the different sex and race. However, there are two conflicting arguments about the effects of demographic variables in the service sector. Featherman and Hauser argue that the relationship of social background to earnings is loosening, especially in the service sector (Featherman and Hauser, 1978), therefore, we can expect that these social background variables, such as race and sex have a little or no effect in 1991. Lorence (1993) also argues that income difference of female workers and male workers are smaller in the service sector than in the manufacturing sector, even though this equality is not achieved by the increase of income of female workers but the decrease of income of male workers in the service sector. Pfeffer's argument (1977), however, is that when abilities and performance of workers are difficult to assess, socioeconomic status of workers is used as a proxy of productivity, therefore, socioeconomic status variable has a stronger effect on workers in the service industry where measuring productivity is difficult.

"Individual attributes" Model includes individual attributes variables, such as dummy variables of race, gender and marital status with a control variable of "metropolitan area." Analysis shows that all variables have significant effects on the income. Even though the magnitudes of the coefficients of the human capital variables are diminished slightly, the directions of coefficients are remained same, that means human capital variables have significant effects on income even controlling individual attributes variables. Variable "metro" shows that workers living in the metropolitan area (therefore, probably working in the metropolitan area) are earning more than workers in non-metropolitan area. Male and white workers are earn more that female and non-white workers. In addition, married workers and professional workers are earning more than unmarried workers and non-professional workers. Among these dummy variables, sex and professional occupational status variables have bigger effects on income (82 dollars and 125 dollars, respectively) and race (white) and marital status variables have lesser effects on income (25 and 23 dollars, respectively). It suggests that discrimination is stronger against female than minority.

Even though, individual attributes are significant to determine income of workers, these variables do not explain why there are mean income differences among industries. Compared to the human capital model, which reduced the industry variance a lot, this

individual attributes model does not decrease industry variance much. This suggests that even though race, sex, region of work place and marital status are important, they are not explain as much of the income difference among industries as human capital variables.

II. 4. Structural models

Structural explanation considers how characteristics of the markets, not individual characteristics, influence income of workers (Akerloff & Yellin, 1986; Granovetter, 1981; Kalleberg et al., 1981; Krueger & Summers, 1987; Stolzenberg, 1975, 1978; Wallace & Kalleberg, 1981; Weakliem, 1990). Structural level variables affecting income consist of two groups: firm and industrial characteristics and characteristics of workers at the aggregated level. Using the first group variables, we can measure the capacity of industries to pay of employers that includes firm size, capital intensity and level of monopoly (Krueger and Summers, 1987) and using the second one, we measure the capacity of workers to demand higher income which includes union and labor composition variables (Kalleberg et al., 1981).

For the test of this structural argument, three models are tested: two reduced full models and one full model. First "reduced model 1" includes industry level variables, profit and employment size. "Reduced model 2" has added to an "individual attributes model" union membership of individual worker and percentage of part-time workers. Final model includes all variables mentioned in this chapter.

Coefficients in "Reduced model 1" are similar to those in individual attributes model. Income difference between "prof" and "noskill" is 181 dollars and all other coefficients are slightly different from previous model even though we added industry level variables. This suggests that added industry level variables are not much correlated to other individual level variables. It shows that profit level and employment is positively related to the income. The bigger and more profitable industries pay higher wage for their workers. Same pattern is found in "Reduced model 2." It shows that income difference between "prof" and "noskill" is 186 dollars and coefficients for other variables except "metro" variable are almost same. The variables related to the power of workers does not reduce the difference between these two occupational groups as was expected by

the study of Kalleberg et al.(1981) and Freeman and Medoff (1984). The change of coefficient for "metro" means that industries within metropolitan area is either more unionized or hiring less part-time workers.

Final model contains four industry level variables of market power and worker power. Comparing this model with human capital model reveals the explanatory power of industry level variables. The difference between "prof" and "noskill" in "human capital model" is 286 dollars but the difference in this model 180 dollars. So 106 dollars in 286 dollars difference between two occupational groups is attributable to industry difference.

Ⅲ. Test of the Polarization Argument

The polarization thesis argues that the development of the service sector is related to the growth of the income inequality because the labor market structure needs small number of professional and managerial occupation and a large number of low skilled service jobs (Harrison and Bluestone, 1988; Stanback et al. 1981). It suggests that income determination processes are different between two sectors. To test this hypothesis, workers in the manufacturing sector are included in the sample and interaction terms between major variables and industrial sector are added in the model to test whether there exist different income determination processes between these two sectors.

Table 2 shows that one of polarization argument is not supported. It assumes that income difference between professional and managerial occupation, and low skilled occupation is greater in the service sector. We expected different effects of occupational status in the manufacturing sector; for example, negative effect for professional and managerial occupation and positive effect for low skilled occupations. However, result shows that effects of the occupational status are not different in two sectors. The interaction effects of manufacturing sector and two occupational status are not significant.

Instead, ascriptive variables have interaction effects with the manufacturing sector. White, male workers are earning significantly more than workers with same attributes in the service sector. In addition, education effect (HGA) is greater in the manufacturing sector, not in the service sector as was suggested by Bell (1973). The other interesting

finding is that union effect and the percentage of part-time workers are negatively related to the manufacturing sector. Union effect is smaller in the manufacturing sector and the presence of part-time workers are more negative in the manufacturing sector.

Table 2. Regression Coefficient Matrix of Mixed Regression (all industries)*

Variables	Coefficients	significance
INTERCEPT	-509.649	0.000
NOSKILL (1)*	-53.198	0.000
PROF (2)	127.265	0.000
HGA (3)	17.505	0.000
AGE (4)	11.974	0.000
AGESQ (5)	-0.122	0.000
USLHRS (6)	7.892	0.000
METRO (7)	45.569	0.000
S1 (8)	79.168	0.000
WHITE (9)	28.885	0.000
MARRY (10)	23.249	0.000
PROFIT (11)	0.001	0.002
EMPSIZE (12)	0.030	0.000
APART (13)	-1.435	0.000
U1 (14)	59.410	0.000
MNOSKIL (15)	7.457	0.853
MPROF (16)	29.572	0.627
MHGA (17)	9.400	0.000
MAGE (18)	1.308	0.613
MAGESQ (19)	-0.002	0.936
MUSLHRS (20)	2.333	0.001
MMETRO (21)	28.005	0.008
MS1 (22)	35.617	0.001
MWHITE (23)	34.627	0.007
MMARRY (24)	14.793	0.151
MPROFIT (25)	0.003	0.825
MEMPSIZE (26)	0.031	0.000
MAPART (27)	-22.282	0.005
MU1 (28)	-40.514	0.002

Table 2(continued)

* Variable list
(1) dummy variable for occupational status, low skilled occupations
(2) dummy variable for occupational status, professional and managerial occupations
(3) highest grade attended
(4) age
(5) age squared
(6) hours worked per week
(7)dummy variable for the location of work, metropolian area
(8)dummy variable for the sez, male
(9)dummy variable for race, white
(10) dummy variable for marital status, married
(11) profit of industry per person
(12) employment size of firms
(13) percentage of part-time workers in industries
(14) dummy variable for union membership, member of union
(15) dummy variable for interaction between industry sector, manufacturing and occupational status, low skilled occupation
(16) dummy variable for interaction between industry sector, manufacturing and occupational status, professional and managerial occupation
(17) dummy variable for interaction between industry sector, manufacturing and education
(18) dummy variable for interaction between industry sector, manufacturing and age
(19) dummy variable for interaction between industry sector, manufacturing and age squared term
(20) dummy variable for interaction between industry sector, manufacturing and hours worked per week
(21) dummy variable for interaction between industry sector, manufacturing and the location of work, metropolitan area
(22) dummy variable for interaction between industry sector, manufacturing and sex
(23) dummy variable for interaction between industry sector, manufacturing and race, white
(24) dummy variable for interaction between industry sector, manufacturing and marital status, married
(25) dummy variable for interaction between industry sector, the manufacturing and profit of industry per person
(26) dummy variable for interaction between industry sector, manufacturing and employment size of firms
(27) dummy variable for interaction between industry sector, manufacturing and percentage of part-time workers in industries
(28) dummy variable for interaction between industry sector, manufacturing and dummy variable for union membership, member of union

Ⅳ. Concluding Remarks

Fixed effect part of the analysis showed that individual level variables and structural level variables explain income of workers in the service sector together. At the individual level, it turned out to be that education, work experience and marital status were all significant controlling industrial characteristics : more educated and more experienced workers were paid higher. This outcome generally supported human capital theory. However, sex and race variables were also significant controlling individual characteristics and industrial characteristics : male and white workers were paid higher than female and non-white workers. This suggested that the ascriptive variables, sex and race still affected income of workers. Another finding was the presence of significant effect of occupational status after controlling human capital : being a professional and managerial worker leads to higher pay and being a workers in a low skilled occupation leads to lower pay. It showed that the effect of occupational status on income is independent from the effect of human capital variables.

Structural level variables showed that they affected income of workers independent from the individual level variables. The size of profit and employment size had positive effect on income. It shows that workers in an industry with high profit and many workers per employer were paid higher. In addition to the effect of industrial characteristics, the effect of workers' power turned out to be positive on income. Unionization had positive effect but the proportion of part-time workers had negative effect on income of workers.

Industry effects are divided into two groups : industry characteristics itself facilitating to pay high income and workers' power to demand higher income. When we added these variables, variances of intercept and occupational status variables, "noskill" and "prof" started to decrease. Average firm size and profit level of industry decreased variance of intercept and occupational status variables significantly. The addition of unionization variable and percentage of part-time workers also reduced the variance of these variables. It meant that industry variation of income is explained by the industrial characteristics.

The general conclusion seems to be that observed differences in average wages

between industries do result from differences in labor quality but industry characteristics also played important role in explaining income difference in the service sector. This suggested that income determination process in the service sector looked similar to that of the manufacturing sector.

The analysis also presents quite contrasting result to the polarization thesis. Even though we expected negative effect of the professional managerial occupation in the manufacturing sector, it turned out to be positive. This suggests that controlling other factors, incomes of the professional managerial workers are higher in the manufacturing sector. On the other hand, the interaction effect of low skilled workers and the manufacturing sector is not significant. This suggests that income difference among between two sectors is not due to the sector, it is explained by industrial difference, such as unionization. Coefficients of all other variables in the two models have similar size of coefficients even though the polarization model includes two more interaction terms. This suggested that these variables were not related to these interaction terms. Therefore, the finding was contradictory to the expectation of the polarization thesis that there is the significant interaction term, occupational status, professional and managerial occupations and the manufacturing sector.

Ⅴ. Appendix : Data and Methods

Ⅴ. 1. Unit of analysis

The basic unit of data and statistical analysis is individual workers. These individuals are defined as those who work more than 20 or more hours per week, who were not self-employed, and who were 18 years or older as were defined in the Current Population Studies (CPS). Even though the unit of analysis is individual level, that is, individual worker's income in the service sector, this study resorts to explaining variables at both the individual level and the structural level. Variables at the individual level are education, work experience, marital status, age, race and sex, and variables at the structural level are the measures of capacity of industry to pay, such as level of profitability of industry and employment size, and capacity of

workers demand higher income, such as unionization and percentage of part-time workers. To investigate effects of these individual and structural level variables together, this study uses an analytical method that can manipulate the nature of the data, which is, workers belong to an industry that influence individual workers' income. We call this data hierarchical data because individual workers are clustered within a higher level, industry. Under this situation, individual outcome, income of individual workers, is the result of individual attributes and industrial characteristics[1].

This study uses industry as important structural variables affecting income of workers. Industries are appropriate units of analysis in studies of economic segmentation (Hodson, 1978). Firms must operate within certain constraints imposed by industrial structure. Many industries are accessible only to monopoly firms and state intervention in the economy is often industry specific (Hodson 1978 ; Kalleberg et al., 1981). However, as Baron and Bielby (1980) showed there is variation within industries. To offset the limitations of these industrial level variables, this study also uses a firm-level variable : the size of the establishment for which the individual works. Size effect of the establishment serves as a useful indicator of the firm's capacity and /or willingness to pay high wages.

Ⅴ. 2. Statistical Method

The hierarchical nature of data used in this study needs further consideration so that the researcher can choose a proper analytical method. This paper attempts to investigate jointly the effects of individual attributes and structural characteristics of worker*s position in the labor market on income of individual workers. In other words, worker characteristics and industry characteristics simultaneously affect income of workers. There have been several attempts to handle this nature of hierarchical data.

One way is to use individual level variables or industry level variables dismiss-

1) Before measuring the effect of labor markets, we should define level of labor market by geographic labor market or industry. This study use industry as most distinctive labor to influence income because industry is the most often used as a structure to influence income(Dunlop, 1957).

ing the effect of the other level. However, a method investigating only individual level underestimates standard error by ignoring dependence of observations in the cluster (that is industry in this study). This individual level only method creates too "liberal" decision on the statistical test and leads incorrect decision.

The other method, estimating industry effect at the aggregated level also has critical problems. If we apply this method to explain income difference, we use the mean income of workers as dependent variables and independent variables aggregated at industry level such as percentage of female, percentage of unionization for the analysis rather than female or individual union membership. Critical problem of assessing effect of industry only is that it cannot explain the effect of individual level variables, that is, it cannot control individual characteristics, such as human capital of individual workers. As a result, we cannot measure individual and industrial level effects properly. There is another statistical problem of this aggregated level analysis. The power of this statistical model can be low since the number of industries is relatively small. Thus, analysis at this level tends to increase Type II error (Hedeker et al., 1992). Therefore, when clusters have effects on individual worker's income, both methods of individual level analysis and aggregated level analysis create incorrect standard error of coefficients that lead to wrong conclusions (Hedeker et al., 1992).

More advanced than previous methods but still a problematic method is the mixed model analysis of variance (Dickens and Katz, 1987). This model puts individual level variables and industry level variables into the model specification at the same time. It seems to satisfy our goal, measuring effects of individual and industry together. When sample sizes within industries are same, proper use of this mixed-model analysis create correct results for the test regarding the effect of the industry level variables and individual level variables. However, this method often creates unstable coefficients due to the "unbalancedness" of data, which means number of individuals in each industry are not same (Dickens and Katz, 1987 ; Hedeker et al., 1992). Usually the number of individuals within the industries is not constant, but varies with each industry. The method to prevent this problem and to measure industry effect is discussed and applied by Dickens and Katz (1987). They used two-step method to remedy this problem. In the first step, individual worker's

wages are regressed on individual characteristics, geographic dummy variables and three-digit 1980 Census of Population code dummy variables. Then the coefficients of the three-digit industry dummies are regressed on the industrial characteristics in the second step. However, even though this method cured the problem of unbalancedness of data, this method also has a shortcoming. This method measures individual effect bigger than actual effect because joint explanation part by individual level variables and structural level variables goes to individual level variables at the first step. In addition, this method does not show the variance of each effect. Using Dickens and Katz's model, we can get the fixed effects of each variable but we do not know the variance of the effects.

Recently, random-regression regression, or multi-level data analysis, has been developed for these unbalanced, clustered or hierarchical data[2](Goldstein, 1987 ; Prosser, Rosbash, Goldstein, 1991). Hedeker et al. (1992, p3) summarizes the utility of Random Regression Model (RRM) as follows ;

> *Random regression models are useful in the analysis of clustered data since outcomes at the individual level are modeled in terms of both individual and cluster level variables, while concurrently estimating and adjusting for the amount of intra-class correlation present in the data. Further, these models make no assumption regarding cluster sample size, allowing for a varying number of subjects within each other.*

The main advantage of this method over other methods discussed earlier is that RRM enables us to measure individual workers as being nested within industry. Using this analytical method, this study can measure effects of individual level variables and structural level variables properly based on the large micro data sets with detailed controls for workers' characteristics and industry characteristics. The merging of data on individuals with industry data also permits us to include both micro and macro features of other variables that may depend on his or her own attributes and the characteristics of

2) Multilevel data analysis is "any set of analytical procedures that involve data gathered fom individuals and from the social structure in which they are embedded and are analyzed in a manner that models the multilevel structure(Burstein, 1985).*

his or her establishment as well as on the attributes of the industry. The other advantage of this method is that it can assess amount of variability due to individual level and industry level. The fixed effect model only shows the effect of each variable, including each specific industry effect, but random regression model shows the variance of the variables. For example, by looking at the variance of education, we can tell how much of the effect of education is different and whether the effect of education is different among different industries.

In some circumstances fixed effect model can be appropriate. If there were only two industrial sectors and we were interested in whether the effect of occupational status of workers differed between them, then fixed effect model would be an appropriate model, and could be analyzed using any multiple regression or general linear model program. More generally, however, rather than consider the higher-level units (industries) as "fixed" levels of factor, we prefer to treat them as a random sample of all the schools in the population. This implies that the a_i are to be thought of as having a distribution over schools, and our interest will be mainly in the parameters of this distribution, mostly the mean and variance.

V. 3. Model

The model adapted in this research consists of two parts. First part deals with the effect of individual level and the other part measures the effects of industry level.

Within-industries model (individual level effects)

$$INCOME_{ij}=b_{0i} + b_{1i}(prof_{ij})+ b_{2i}(noskill_{ij})+ b_{k'}(Find_{ij})+ e_{ij}$$

Incom $Spnce_{ij}$ is a vector of income, and $prof_{ij}$ and $noskill_{ij}$ are occupational status, professional and managerial occupation and low skilled occupation respectively. $Find_{ij}$ are the vector of income and matrix of individual level independent variables: "Find" includes variables of education, age, hours of work, place of firms, sex, race and marital status. "b_{0i}" is random intercept of industries and b_{1i} and b_{2i} are random coefficients of occupational status, professional and managerial occupation and low skilled service occupations, respectively. In addition, $b_{k'}$ is a matrix of fixed effect for years of education,

age, age squared, hours work per week, sex, race, marital status and metropolitan area (k is number of fixed individual level variables). Notation i and j stand for, respectively, for worker i in industry j. e_{ij} is the residual.

i = 1..n industries

j = $1..n_i$ workers within industry i

Between-industries model (industry level variables)

$$b_{0i} = r_{00} + r_{0\ell}\ (ST_{i\ell})' + u_{01}$$
$$b_{1i} = r_{10} + r_{1\ell}\ (ST_{i\ell})' + u_{11}$$
$$b_{2i} = r_{20} + r_{2\ell}\ (ST_{i\ell})' + u_{21}$$

Where l is index of industry level variables.

St_{il} : structural level independent variables (profitability of the industry, employment size of firms, union membership and % of part-time workers)

r_{00} : mean income for average workers (Overall intercept).

$r_{0\ell}$: average effects of structural variables (on the mean income for average worker).

r_{10} : average effect of occupational status, professional and managerial workers on adjusted cluster income

$r_{1\ell}$: interaction effect of structural variable and adjusted cluster income for the professional and managerial workers (p * 1)r_{20} : average effect of occupational status, low skilled service workers on adjusted cluster income

$r_{2\ell}$: interaction effect of structural variable and adjusted cluster income for low skilled service workers.

u_{01} : influences on B_{0i} unaccounted for by structural variables

u_{11} : influences on B_{1i} unaccounted for by structural variables

u_{21} : influences on B_{2i} unaccounted for by structural variables

i : 1..n industry

j : 1..ni workers in industry i

Amalgamated Model

$$INCOME_{ij} = r_{00} + r_{10}(prof_{ij}) + r_{20}(noskill_{ij}) + r_{01}(ST_{il})' + r_{11}(ST_{il})'(prof_{ij}) + r_{21}(ST_{il})'$$

$(noskill_{ij}) + b_k' find + u_{1j}(prof_{ij}) + u_{2j}(noskill_{ij}) + u_{0j} + e_{ij}$

This model shows that income is a function of overall individual mean (r_{00}) and random effect of occupational status (r_{10}, r_{20}), industry random effect ($r_{0j} * (st_{ij})'$), interaction effect between industry and individual occupational status ($r_{1j} * (st_{ij}) * (prof_{ij})'$ and $r_{2j} * (st_{ij}) * (noskill_{ij})'$) and fixed effects of individual characteristics (b_k'find).

V. 4. Data

The present study uses data collected from a nation wide labor force survey, *Current Population Survey (CPS), March 1992,* done by U.S. Department of Commerce, Bureau of the Census. This collection provides data on labor force activity for the week prior to the survey. Comprehensive data are available on the employment status, weekly earning, occupation, and industry of persons aged 14 and over. Also shown are personal characteristics and industrial characteristics such as age, sex, race, marital status, educational background, race, skills, on-the-job training, union membership and firm size.

For additional data on industry level characteristics, several data sets are used. *Economic Census of 1987, Enterprise Statistics,* U.S. Department of Commerce, Bureau of the Census are the prime data sources. Other sources of data are *Source Book : Statistics of Income, Corporate Income Tax Returns,* (Treasury Department) and *input/output Data,* (Bureau of Economic Analysis, 1984).

V. 5. Measures of Variables

The variables in the analytical framework of the present study are composed of four groups : 1) weekly earning as the dependent variable ; 2) human capital variables, 3) individual attributes variables, and 4) industry level variables, as the independent variables.

1. Dependent Variables : income

There are various ways to define income : hourly earning, annual income, log hourly earning, log annual income and adjusted income but this study uses weekly earnings

as income of workers.

2. Independent Variables

Independent variables are divided into two groups. One group includes individual related attributes, such as human capital and ascriptive variables and other group comprises industrial level variables. Human capital variables consist of education and work experience variables. These variables are measures of the level of human capital of workers. Another variable to measure the level of human capital is work experience. For the work experience variable, this study uses age as a proxy because there is no direct measure of this variable in current data utilized in this study.

Ascriptive variables consist of sex, race and marital status. Sex, race and marital status variables are easy to define. Sex is scored 0 as female and 1 as male. Race consists of four categories of White, Black, Asian and Others. Marital status is also coded 0 for the not married at the time of survey and 1 for the married.

Structural level variables are divided into two groups; one is industry's capacity to pay higher (or lower income) and another one is workers' capacity to demand for higher income. The data for these variables were collected on these variables from various sources for 68 major industry groups as did in Kalleberg et al.'s study (1981). Sixty-eight groups were constructed from the 1967 standard industrial classification (SIC) because SIC classifications are the basis for reporting corporate income tax returns and other data.

Capacity of industries to pay is measured in several ways: profitability, monopoly, and capital/labor ratio. Data on the profitability of company is collected at "average rate of return on capital"(*Source Book: Statistics of Income,* Corporate Income Tax Returns, Treasury Department). However, often reported profits do not reflect real profit of companies (Katz and Dickens, 1987).

Capacity to get more money is related to power of workers. This power comes from two sources. One is workers' direct collective action such as unionization and the other one are the organizational characteristics, which can be advantageous or disadvantageous.

Union members include workers in workplace covered by union contract. Union

membership variable is coded as a dummy variable of membership and non-membership.

Among industry variables, the effect of firm size is the most eminent. Bigger firms tend to pay higher income. Firm size data is available in CPS at individual level, but establishment size variable is measured by four dummy variables for 5 category (25, 25-99, 100-499, 500-999, over 1000). Categorized value of firm size is converted using mid point, then calculated to mean firm size in industry. Another way of measurement of firm size is dummy variable of values, "Big" and "Small." Granovetter (1984) argued that size 100 is a breakpoint of some sociological significance in the sense that it is easy in establishments of this size for all employees to know each other, and for supervisory personnel to know their workers in a fairly detailed and intimate way.

The other important aspect of industry is the level of routinization. This variable is not measured directly in this study but we can assume that industries with higher percentage of part-time workers indirectly reflect the level of routinization. So, this study uses the percentage of part-time workers to the total population as a proxy of routinization. Along with this measurement, this study also uses percentage of professional and other workers, percentage of female, minority and juvenile workers as variables decreasing worker's power.

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