韓國人口學會誌，第十卷 第一號 (1987)
The Journal of The Population Association of Korea, Vol. 10, No. 1 (1987)

Effects of Cohort Size on Male Experience-Earnings Profiles in Korea*

Young-Soo Shin
(Department of Economics, Seoul Women's University)

〈Contents〉

Ⅰ. Introduction
Ⅱ. Theoretical Framework and Model Specification
Ⅲ. Data and Empirical Results
Ⅳ. Conclusion

Ⅰ. Introduction

The main purpose of this study is to analyze the effects of cohort size on male experience-earnings profiles by firm size (small,medium, and large-scale firms) in Korea within the framework of human capital theory.

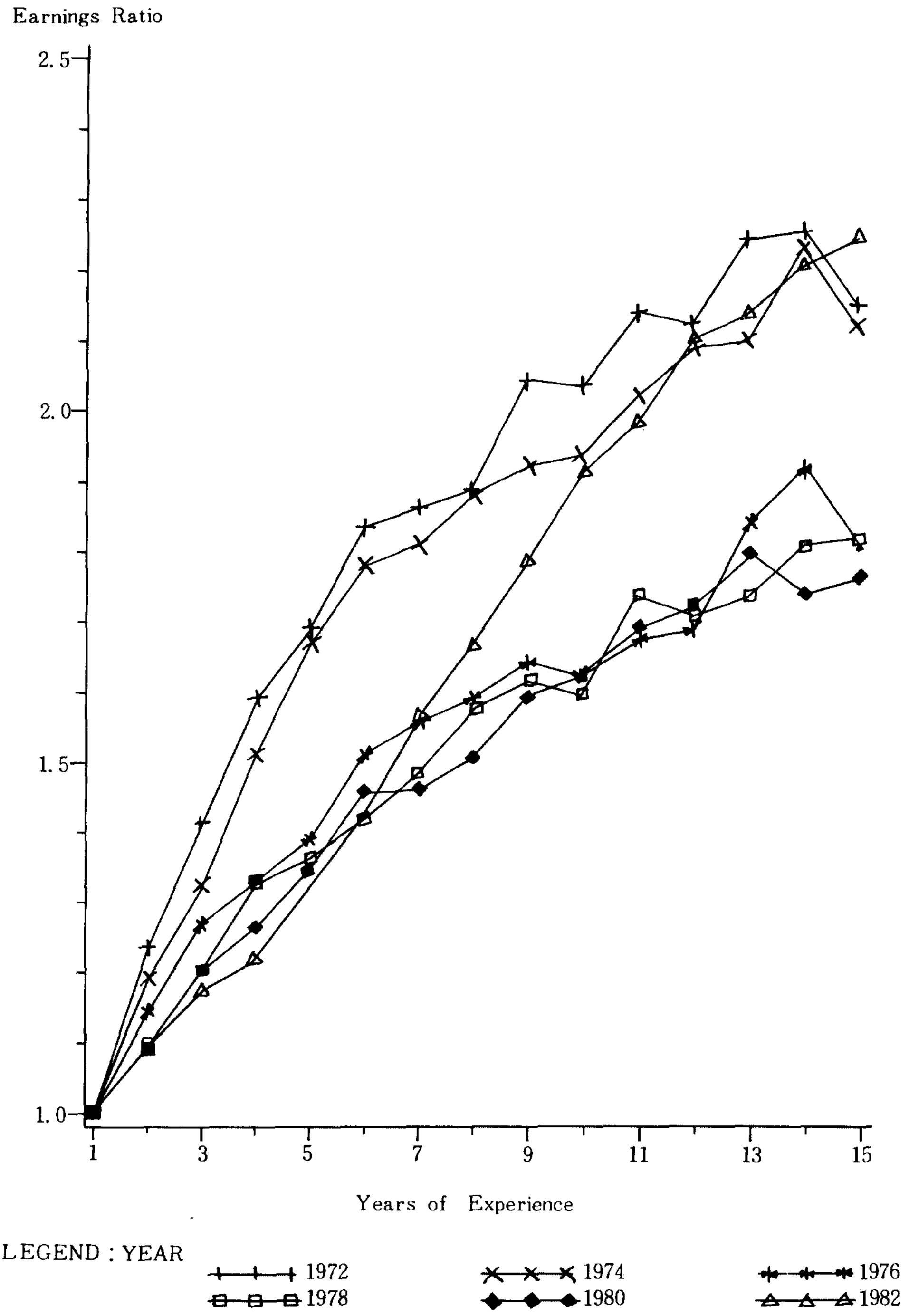
The characteristics of age—experience profiles of earnings have been analyzed extensively in many countries in order to explain the distribution of personal income with individual data and to gain a better understanding of the labor market, especially of earnings determination. There is also a third reason for this interest; the aggregate earnings profiles may be twisted over time when the age composition of the labor force changes, and workers of different ages are imperfectly substitutable in production.

During the 1970s and early 1980s, the structure of male earnings by educational groups in Korea changed noticeably, as shown in Figures 1, 2, and 3 for primary and middle school, high school, and college graduates, respectively. Much of the attention in the case of the group of primary and middle school graduates is focused on the fall of the earnings profiles from 1972 to 1980 and the expansion of the earnings profile in 1982. The earnings profiles of high school and college graduates are observed to expand from 1978, remarkably expand for college graduates in 1982. That is, the relative earnings of younger to older workers were low in the early 1970s for primary and middle school graduates, not clear-cut for high school graduates, and remarkably low in the early 1980s for college graduates. These changes coincided with the arrival of the peak-sized cohorts spawned by the post-Korean War baby boom. Thus, the changes in age composition of labor force are supposed to be a major factor in the explanations given for the earnings changes.

Theories and approaches which hinge on the supply of labor have been advanced and empi-

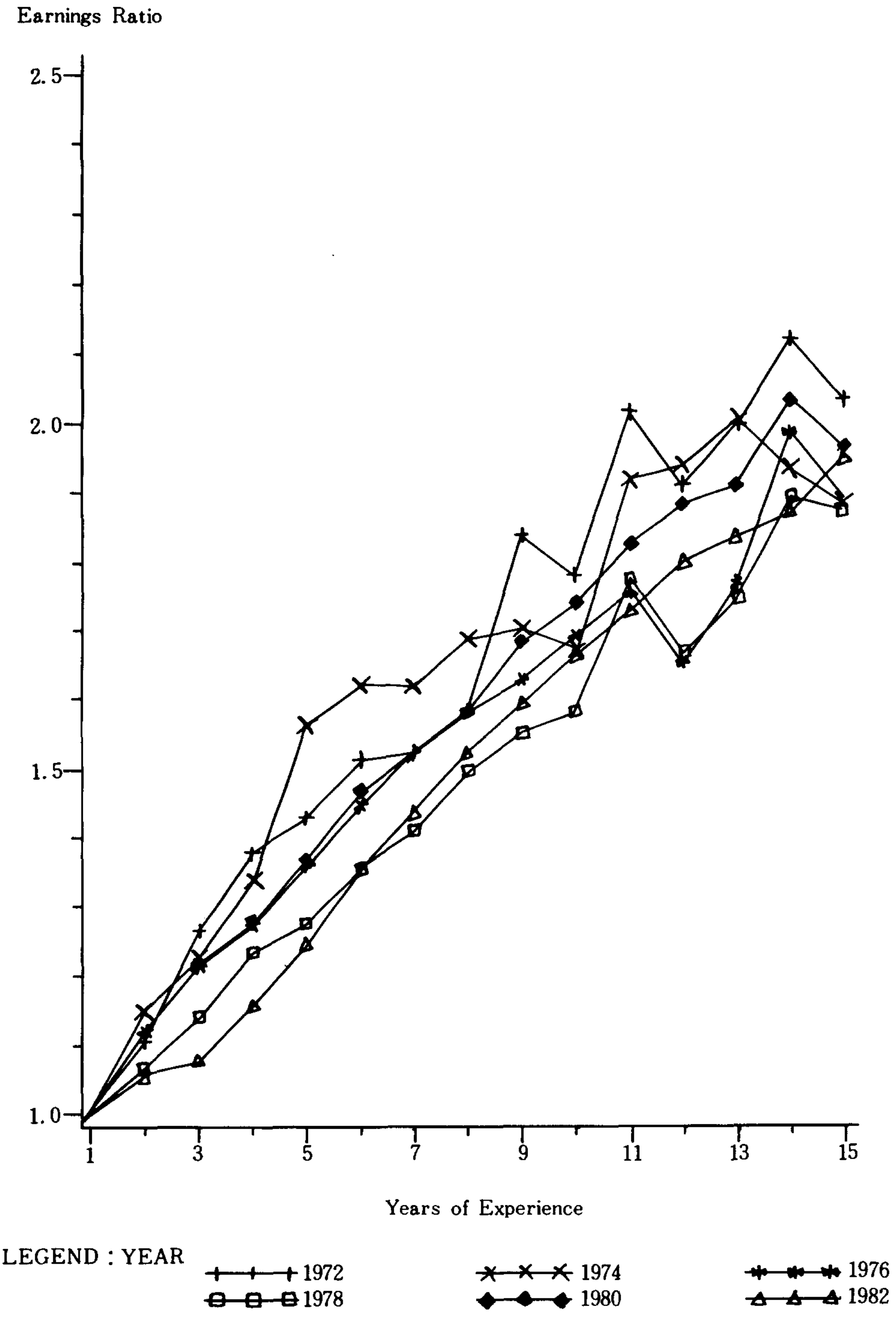
* This paper is a summary of my Ph.D. dissertation, presented to the university of Hawaii in 1986. I am very grateful to the East—West Population Institute, which provided me with a full four year scholarship for my studies.

Fig. 1. Experience–Earnings Profiles, 1972–1982 (Primary and Middle School Graduates)



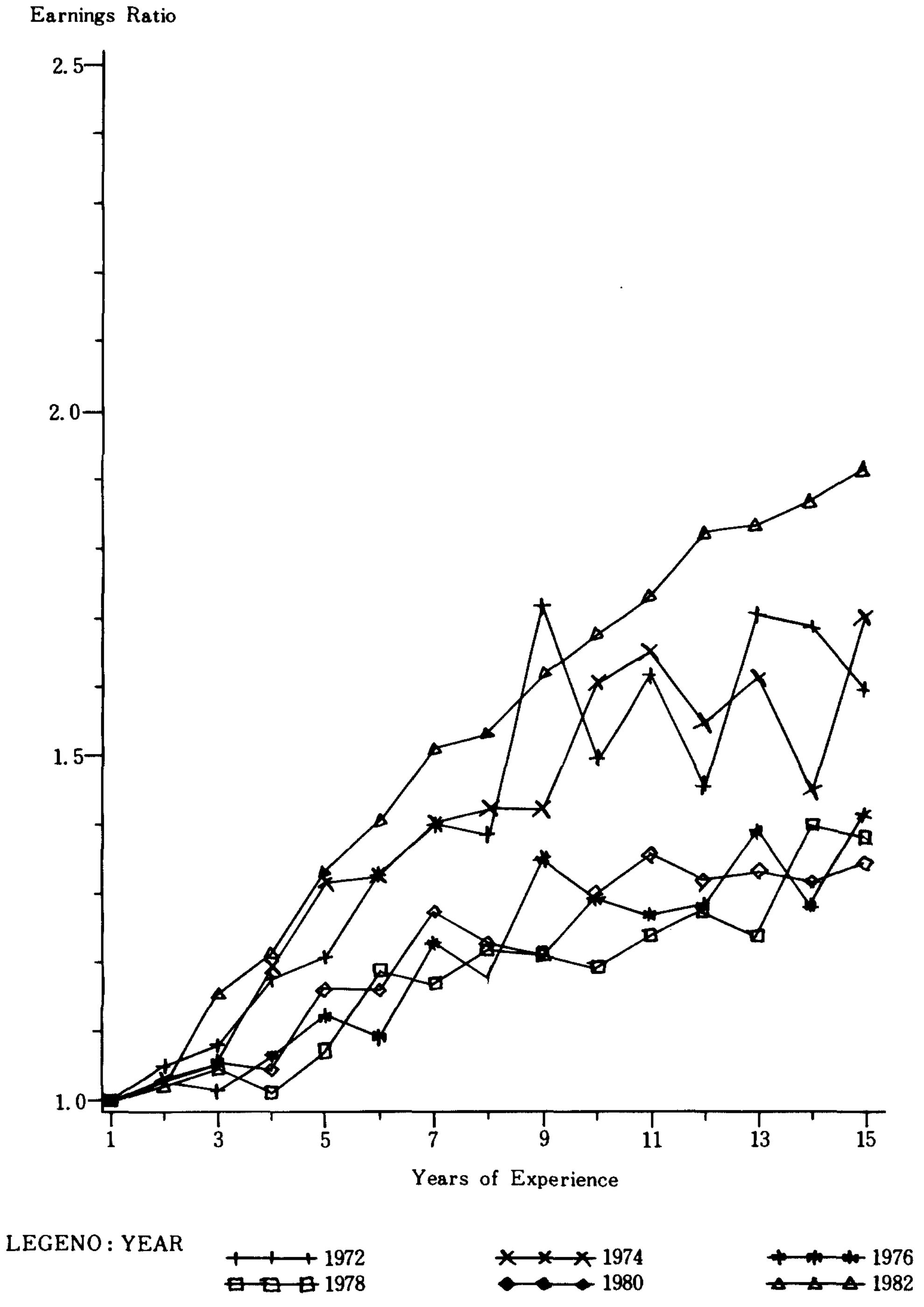
Note : The values for the graph are calculated from the Occupational Wage Survey of Korea for each year.

Fig. 2. Experience–Earnings Profiles, 1972–1982 (High School Graduates)



Note : The values for the graph are calculated from the Occupational Wage Survey of Korea for each year.

Fig. 3. Experience–Earnings Profiles, 1972–1982 (College graduates)



Note : The values for the graph are calculated from the Occupational Wage Survey of Korea for each year.

rically examined. The most compelling approaches are those advanced by Freeman (1979) and Welch (1979), and modified and broadened by scholars such as Grant and Hamermesh (1981) and Berger (1983b, 1984, 1985). Based on the assumption of imperfect substitutability between younger and older, more experienced workers (junior and senior), this line of analysis asserts that changes in the age (or experience) composition of labor force cause a tilt in the relationship between years of experience and earnings. That is to say, the entry of the largest postwar baby—boom birth cohorts into the labor force should increase the ratio of younger to older workers and reduce the relative earnings of junior to senior workers.

Keeping it in view that the substitutability between younger and older workers is different in large and smaller firms, the analysis will be done separately for the three types of firm size (small, medium, and large firms). In Korea's labor markets, capital intensity, specificity of training, wages, etc. are different in firms of different sizes. Large firms are relatively stable in terms of recruitment, permanent contracts with labor, promotion, etc., while the smaller firms operate more like an auction market with high turnover rates. Also, rapid industrialization experienced recently by the Korean economy has intensified interscale differences in capital intensity and market power. Both of them are likely to be positively related to the specificity of training, which would affect the earnings growth in a cohort with changes in costs of and returns on human capital investment through on—the—job training.

Ⅱ. Theoretical Framework and Model Specification

1. Negative Effect on Earnings

In this section, the human capital theory and the conventional production function will be linked in an effort to specify the relationship between cohort size and earnings, following Welch's (1979) model of career phases based on the optimal life—cycle configuration suggested by Rosen (1972).

The simplest view of the way cohort size affects earnings follows from the notion that work careers consist of a series of more or less distinct phases in production. A worker enters as a raw recruit or learner, first achieves junior membership, and somewhat later a senior membership in the profession. Only if all workers at different stages of the career substitute perfectly for each other, will the structure of earnings be independent of cohort size. However, if different types of workers with varying levels of experiences do different kinds of jobs or tasks, these jobs or tasks might not be perfect substitutes for one another. If so, then the value of each activity would reasonably depend on the number of people doing it, and cohort size would matter, Each activity is productive, and marginal productivities are determined by the number of workers engaged in all activities.

Consider an aggregate production function of the form :

$$Y=f(N, Z) \quad \cdots\cdots (1)$$

where N refers to the productive effort of persons in a given profession. Those things contained in Z are all other factors that are not included in N and are assumed to be weakly separable[1] from N in the production function, so that N is only illustrative in the following discussion.

The total effort, N, is itself a function of numbers of workers in each of several worker types.

$$N=G(N_1, N_2, \cdots\cdots) \quad \cdots\cdots (2)$$

where the number of workers of each type is the number of members of the profession devoting their effort to that type of activity. In the optimal life-cycle configuration suggested by Rosen (1972), a worker solves for an optimal sequence of position progress rates by recognizing that each position level corresponds to learning options that affect performance in sequential positon levels. Thus, a worker at any sequential career phase is involved in the process of transition from lower toward senior woker activites.

If n(X) refers to the number of members of the profession with X years of work experience, then the number of workers of type j is given by:

$$Nj = \int_{X_{j-1}}^{X_j} (1-p_{j-1}(X))n(X)dX + \int_{X_j}^{X_{j+1}} p_j(X)n(X)dX \quad \cdots\cdots (3)$$

$$0 \leq p_j(X) \leq 1, \quad X_j \leq X \leq X_{j+1},$$

where p_j denotes the part of their working time spent in activity j with X years of work experience. That is, as a worker enters the i^{th} career phase he initially devotes full time to the i^{th} activity and at that moment begins transition into the $i+1^{st}$ activity. As the i^{th} phase progresses the proportion of time spent in the i^{th} activity decreases until at the end of the phase all of his time is devoted to the next activity and a new phase begins.

In the competitive market, the wage a worker receives equals his marginal product. The wage of those with X years of experience is:

$$W(X) = \frac{\partial f}{\partial n(X)} = \frac{\partial f}{\partial g}\left(\frac{\partial g}{\partial N_i}\cdot\frac{\partial N_i}{\partial n(X)} + \frac{\partial g}{\partial N_{i+1}}\cdot\frac{\partial N_{i+1}}{\partial_n(X)}\right)$$

$$= f_1(g_i p_i + g_{i+1} p_{i+1}) \quad \cdots\cdots (4)$$

This assumes that changes in f_1 are neutral across experience groups and f_1 determines levels but not shapes of the experience–earnings profiles. In analyzing cohort size effect, f_1 can be ignored.

$$W(X) / f_1 = p_i g_i + (1-p_i) g_{i+1} \quad \cdots\cdots (5)$$

where $1-p_i = p_{j+1}$.

Effects of cohort size on (own) wages are given by the quadratic form:

$$\frac{\partial W(X) / f_1}{\partial n(X)} = (p_i \quad 1-p_i)\begin{bmatrix} g_{i,i} & g_{i,i+1} \\ g_{i,i+1} & g_{i+1,i+1} \end{bmatrix}\begin{bmatrix} p_i \\ 1-p_i \end{bmatrix}$$

$$= p \pm H_{ij} p < O \quad \cdots\cdots (6)$$

If the total effort, $N = g(N_1, N_2, \cdots\cdots)$, is (quasi-) concave, then the Hessian matrix H_{ij}, or the quadratic form $p' H_{ij} p$ of the equation (6) is negative definite, which means that the production function, $Y = f(N, Z)$, is (quasi-) concave, too. That is, larger cohorts in the labor force would result in relative wage reductions and vice versa if there are more than two factors in $g(\cdot)$. If positive cohort size effects on (own) wages are obtained, then the concavity of the production function no longer holds.

For simplicity consider the two–factor constant elasticity of substituion case (CES production function form),

$$g = (\delta_1 N_1^{-\beta} + \delta_2 N_2^{-\beta})^{\frac{-1}{\beta}} \quad \cdots\cdots (7)$$

where $S_{12} = 1/(1+\beta)$ is elasticity of substitution between N_1 and N_2. In this case there are only

1) The weak separability is the most popular assumption in a production function. When the groups N and Z in the function $Y=f(N, Z)$ are independent each other, it can be represented by sub-production functions for the groups of $N=g_1(n_1, n_2, \cdots\cdots)$ and $Z=g_2(z_1, z_2, \cdots)$. Under the assumption of strong separability or block additivity, the production function is also made up sub-production functions for each groups, but unlike weak separability, i.e., $Y=f(g_1(n_1, n_2, \cdots\cdots)+g_2(z_1, z_2, \cdots))$. The strong separability is the most popular assumption about preferences in a utility function (see Deaton and Muellbauer (1983), pp.127-142).

two activities, learner (N_1) and worker (N_2), and the life cycle can be viewed first as one of transition from learner to worker followed by a period as a fully vested worker. In this example,

$$\frac{\partial W(X)/f_1}{\partial n(X)} = -\frac{1}{S_{12}}\theta N_1 N_2 (p/N_1-(1-p)/N_2)^2 \quad \cdots\cdots (8)$$

where $\theta = g_1 g_2 / N$ and $p = p(X)$ is the function of time, at X, spent as a learner.

Several points deserve note in the equation(8). Effects of increased cohort size are inversely proportional to the elasticity of substitution. The substitution elasticity indexes worker–learner differences in the nature of jobs performed. Greater similarity of activities implies greater substitutability. It is likely that the substitution elasticity is related to the transition function, p(X). Rapid transition from learner to worker status implies that learners can easily adapt to worker tasks. It is expected that when transition occurs easily, worker–learner tasks are more similar, that is, workers and learners are better substitutes. This leads immediately to predictions across the types of firm size (small, medium, and large firms) of differences in worker–learner substitution elasticities. As technology of a firm becomes more capital-intensive, a higher degree of specialization, as well as independence of labor on performing a task, is required. It is a near tautology that those who are employed in large firms, whose techonology becomes more capital–intensive than small firms in Korea, transit less rapidly from learner to worker status after beginning work, and it is likely that worker–learner substitution elasticities are smaller than for those who are employed in small firms.

2. Indeterminate Effect on Earnings Growth

Human capital theory assumes that each individual maximizes his present value of earnings stream by allocating an optimal amount of resources to expenditure on human capital investments such as education and training on the job.

The human capital theory attributes observed earnings growth to returns on investments in human capital that increase a worker's earnings. An individual chooses a level of investment over a given period of time by comparing the costs of investment, which consist of forgone current earnings and purchased goods and services, and the benefits in the form of higher expected future earnings. The effect of cohort size on earnings growth therefore ultimately depends on the influence it has on the costs and benefits of investment in human capital. If individuals in larger cohorts tend to invest in greater amounts of human capital, the observed earnings growth will be greater than that of individuals in smaller cohorts and so their experience–earnings profiles will be steeper than those of smaller cohorts. On the other hand, if larger cohorts invest less, then their earnings profiles will be flatter.

Welch (1979) assumes that the returns are greater than the costs in larger cohorts, emphasizing on the reduced costs of human capital investments because of depressed earnings levels. That is, if large entering cohorts depress ear nings, then the opportunity cost of on–the job training is depressd on entry and cost incentives are to speed learning. But, Beger(1984, 1985) assumes the opposite, emphasizing the increased cost per worker of a given level of investment activity in larger cohort because of the increased value of a trainer's time. If a large cohort of younger workers enters the labor market, the value of a trainer's time increases as total demand for training increases. Since trainers are likely to be senior workers, they also become more valuable in production activities and must be compensated for these forgone earnings.

But, the effect of cohort size on human capital investments can not be determined a priori.

Both costs and benefits may increase or decrease with cohort size, and workers in larger cohorts may therefore have higher or lower levels of human capital investment than workers in small cohorts. The uncertain effects of cohort of size on the costs and benefits of human capital investments are also apparent from the firm's point of view instead of an individual's. In some firm-specific training, workers and firms would share the cost of these investments. When a larger cohort of young workers appears, firms may react by reducing their investments in specific training per worker. This may imply a decrease in total amount of training workers receive or simply a decrease in the share of the cost borne by the firm. The latter case would raise the cost of training to the worker but also presumably increase the returns. Thus, the effects of cohort size on earnings growth is still indeterminate from a human capital perspective, depending on the relative magnitudes of the effects on the benefits and costs of investments. The relationship can be determined only by empirical examination.

The effects of cohort size on the costs and benefits of human capital investment through training may be different between large and smaller firms.

Becker (1962, 1975) has introduced the distinction between general and specific training into the analysis of investment in human capital. Completely general training, which raises the marginal productivity of worker by the same amount in the firm of employment as well as in other firms, does not allow the firm providing the training to collect returns and thus it is offered only if the firm does not have to pay any of the training costs. On the other hand, completely specific training, which is only useful in the firm providing training, is offered only if its costs and returns are shared between the trainee and the firm since quits by workers or layoffs by the firm inflict capital losses on the other side. In reality, most training received by each employee lies between those two extremes. However, in Korea, large firms are assumed to offer more firm-specificity of training and smaller firms to offer more general one. This is based on the comparison of differences in capital intensity and market power (product market as well as labor market) between the large and small firms.

As the technology of a firm becomes more capital–intensive, a higher degree of specialization, as well as independence of labor, is required. Thus, workers must be familiar with the particular process of production activity and must be able to work effectively with the given members of a team. The training to make workers familiar with the idiosyncratic process of production activity tends to be firm–specific. Also the ability to work with given co–workers with good team work is firm--specific human capital since it is not transferable to other firms (Doeringer and Piore, 1971, p.16).

In contrast to the workers in the firm with capital–intensive technology, workers in the firm with labor–intensive technology rely primarily on their manual skills to perform their jobs and they tend to be trained to perform various tasks in the production process. Thus, their skills may be easily marketable and almost as useful in other firms as in the firm which provides the training.

Finally, the specificity of training depends on the presence of transaction costs in labor markets (Rosen, 1977, p.19). Large transaction costs in labor markets prohibit workers from moving their workplace and raise incentives for investment in specific human capital.

The inputs for training include the trainee's time for learning, the trainer's time for teaching, other worker's wasted time due to the interruption of production process during training, and the equipment and materials used for training.

Large firms' specific training, during the continuous production processes with independent labor, requires more wasted time from other workers. Moreover, as labor is specialized and the training becomes more firm-specific, the number of trainees per trainer tends to decrease and thus economies of scale in training cannot be utilized (Doeringer and Piore, 1971, p.14).

> Skill specificity has two effects important in the generation of the internal labor market : (1) it increases the proportion of training costs borne by the employer, as opposed to the trainee, and (2) it increases the bsolute level of such costs. As skills become more specific, it becomes increasingly difficult for the worker to utillize elsewhere the enterprise-specific training he receives. This reduces the incentive for him to invest in such training, while simultaneously increasing the incentive for the employer to make the investment. Skill specificity tends to increase the absolute cost of training (regardless of who provides it) because the less prevalent a skill in the labor market, the less frequently training for that skill is provided, and economies of scale in training cannot be realized. Both of these effects encourage the employer to seek reduced labor turnover.

From the above perspective, the absolute cost of training increases with increased specificity of training, and the rate of increase in earnings from the additional years of firm service would be lower in large firms which require more firm-specific human capital investment.

In summary, it is argued that even though the effects of cohort size on earnings growth is indeterminate a priori, the earnings of large cohorts employed in smaller firms grow more rapidly than those of the cohorts employed in large firms, based on the human capital perspective.

3. Model Specification

In order to investigate cohort size effects on earnigs profiles, monthly earnings equations are estimated for full-time male workers with the data from Occupational Wage Surveys of Korea covering the period from 1972 to 1982 by two years intervals. Only male workers are considered in this study. Female workers whose working lives are characterized by frequent interruptions and short durations of employment related to child bearing and child rearing require longitudinal labor force participation data not available at this time.

In much of the work on age-experience profiles of earnings, it has been assumed that the shape of the profile does not change over time. But it might be useful to decompose the earnings (log of real earnings) of a cohort with a given level of schooling into an experience component, a period component and a cohort component in order to understand the dynamics of the earnings profiles.[2] The experience component could be interpreted as the return on net investments on the job ; the period component would result from investment in the machinery and equipment and from changes in the organization of work, which in turn changes the productivity of all age groups ; and the cohort component could, for instance, depend on the size of the cohort and on the quality of schooling. If the three components are additive, the experience component will explain the general profiles of earnings, rising with experience at a declining rate. The period component will not influence the shape of cross-sectional earnings profile but only induce parallel shifts. Excluding individual investments in on-the-job training, it has been common to regard investments in machinery, buildings and other activities that promote productivity and growth. They affect all age groups equally, and yield cross-sectional profiles that are stable in shape and exhibit parallel shifts depending on the growth of the economy.

2) Identification of the three components has been discussed in e.g. Mason et. al.(1973) and Hanoch (1982).

The cohort component will contribute to the shape of cross-sectional profiles. According to the theory, an increase in the quality of schooling will result in a relative increase in the earnings of young people and thus give a flatter cross-sectional profile.[3] If this quality increase is persistent, it will eventually include all active cohorts and the whole profile is shifted upward so that the shape it had before the first cohort with higher quality schooling entered the market will be regained. Similarly, if the size of new cohorts increase, their relative earnings will decrease. Suppose all active cohorts have achieved the new size. Then the whole profile would regain its old shape but at a relatively lower level. If the increase in cohorts size were a temporary phenomenon, it would first increase the cross-sectional slope and then decrease it. In summary, when there is limited substitution between workers of different experience groups, the cohort component of earnings becomes important. An increased supply of younger labor would lead to a relative decrease in earnings for these cohorts and the slope of the cross-sectional earnings profile would increase. An increase in demand for new graduates would have the opposite effect.

To estimate the above three effects on real earnings, pooled cross-section and time-series data are used. Thus, the empirical model extends in both years of experience and time dimensions. The model estimated stems from the general model of the natural log of wage rates :

$$\ln W_{it} = X_i\alpha + Y_{it}\beta + Z_t\gamma + U_{it} \quad \cdots\cdots\cdots\cdots\cdots\cdots (9)$$

where W_{it}=real earnings of those who have i years of experience at time t. Here X_i is a vector of explanatory variables fixed for a cross-section over time ; Y_{it} is a vector of variables fixed that varies over both cross-section and time Z_t is a vector of variables fixed for a given time period. Under the assumption of an additive period effect (no allowance for an interaction between period and experience component) on real earnings, which will only induce parallel shifts of the earnings profiles, Z_t can be treated as variables of period component in earnings equations.

The period effect will be eliminated to emphasize the experience and cohort effects on earnings in the model. If there is a misspecification of variables, in other words, omission of some relevant variables of period component of Z_t from the regression equation, it could yield biased and inconsistent parameter estimates of other variables, unless the correlation coefficients between included and omitted variables are zero (see Pindyck and Rubinfeld (1981), pp.128-129). In reality, we can never be sure that the correlation coefficients are zero, or some variables specified for the period effects are correct and capture the parallel shifts of earnings profiles over time, completely.

To eliminate the period effects on real earnings, the log of real earnings with s years of experience is specified from equation (9) as follows :

$$W_{st} = X_s\alpha + Y_{st}\beta + Z_t\gamma + U_{st} \quad \cdots\cdots\cdots\cdots\cdots (10)$$

By subtracting (10) from (9), the earnings equation is that :

$$\ln(W_{it} / W_{st}) = (X_i - X_s)\alpha + (Y_{it} - X_{st})\beta + (U_{it} - U_{st}) \quad \cdots\cdots\cdots\cdots\cdots (11)$$

The regressors for the period effects (Z_t) on real

3) It is assumed that demand for the services produced by new cohorts is elastic.

earnings are eliminated.

The specific from that equation (11) takes for estimating for each of the education groups of male workers by firm size is :

$$\begin{aligned}\ln(W_{it}/W_{st}) = & b_1(EXPER_i - EXPER_s) \\ & + b_2(EXPER_i^2 - EXPER_s^2) \\ & + b_3(COHORT_{it} - COHORT_{st}) \\ & + b_4(EXPER_i * COHORT_{it} - EXPER_s * COHORT_{st}) \\ & + b_5(POPW_{it} - POPW_{st}) \\ & + e_{it} \cdots\cdots (12)\end{aligned}$$

where W_i=monthly labor earnings for those who have i years of experience,

W_s=monthly labor earnings for those who have s years of experience (s=1 in this study),

EXPER=years of experience,

COHORT=weighted cohort size of workers,

POPW=proportion of production workers,

and the subscripts of i and t represent years of experience and time, respectively. The intercept term, say, b_0 is forced to be zero. If i=s the expectation of right hand side (RHS) of the equation (12) is equal to b_0, i.e., $E(b_0+e_{st})=b_0+E(e_{st})=b_0$. The left hand side (LHS) is also equal to zero, i.e., $E(\ln(W_{st}/W_{st}))=0$. Thus, the intercept term should be zero based on E(LHS)= E(RHS).

The empirical model used here is different from others in this human capital approach in terms of the period effects which are eliminated to avoid specification error. The period effects, which induce parallel shifts of cross-sectional earnings profiles, are captured only by the aggregate unemployment rate for white males and a time trend in the case of Welch's (1979) and Berger's (1985), and the business cycle indicator and a time trend in the case of Lin's (1982). But, we can never be sure that these two variables would completely capture the parallel shifts of earnings profiles over time.

$EXPER_i$ and $EXPER_i^2$ are the variables of experience component (X_i), $COHORT_{it}$ is the variable of cohort size in cohort component (Y_{it}), and the interaction between experience and cohort components are allowed by introducing the variable of $EXPER_i * COHORT_{it}$ in the equation (12).[4] $POPW_{it}$ is introduced to control for the different patterns of demand for human capital investment between production and non production workers, which will be stated later in this section.

Total monthly earnings, which include regular payments, overtime payments and monthly average bonus, are used instead of the hourly wage rate as a numerator of dependent variable in the estimation of the earnings equations, since the concept of hourly wage is vague in Korea. Total monthly earnings for those who have one year of experience are used, without any specific reason, as a denominator of the dependent variable, which changs over time, but not in cross-section.[5]

Thus, the wage ratio (W_{it}/W_{1t}) is used as a dependent variable for the earnings equations to emphasize the cohort size effect, which inf-

4) Welch's annual earnings equation allows for separate cohort size, experience and period effects while also controlling for other factors. Period effects are captured by the aggregate unemployment rate for white males, a time trend, and the proportion of each experience-sample year cell not working, which also controls for selectivity bias, as does a variable measuring the proportion of each cell having its income imputed by the Census Bureau.

5) I regressed the equations by using the earnings of those who have other years of experience than one year of experience as a base, but the coefficients of explanatory variables in the regressions were almost same as the results reported.

lucences the shape of cross–sectional profiles, among the three components (experience, cohort, and period components) included in the dynamics of experience–earnings profiles over time.

Variation in earnings growth due to differences in cohort size is likely to be important only among workers still pursuing training activities, because older workers who have completed their human capital investments have already adjusted the amount of their training in response to cohort size. Any remaining differences in earnings growth among these workers are likely to be the result of the influence of other variables , since most human capital investments take place early in a worker's career. Also, the likely presence of uncontrolled cohort effects other than cohort size effects makes it inadvisable to project the future experiences of the baby–boom cohorts. The uncontrolled cohort effects would be the effects from shifts of demand side, for example, gradual increases in quality of schooling or capital. The former would increase demand for younger workers and so increase their wages, but the latter for older (or skilled) workers if older labor is relatively more complementary to capital than younger workers. This is less likely to be a problem within the relatively narrow band of birth cohorts covered in the younger worker subsamples.[6)]

Thus, the best test of the effect of cohort size on earnings growth can be obtained by restricting the estimation to younger workers, who have less than 15 years of work experience in this study and are still pursuing training.

In order to address questions of differences in the effects of cohort size on experience–earnings profiles for each firm size and education level, the earnings equations are regressed for three types of firm size : small, medium, and large firms ; and three schooling groups : primary and middle school, ; high school, and college graduates. The experience–earnings profiles are captured by experience ($EXPER_i$) and experience squared ($EXPER_i^2$). In conventional human capital semi-logarithmic wage equations, $EXPER_i$ and $EXPER_i^2$ are both used to approximate the concavity of the profiles. Because the optimal pattern of human capital investments in on–the–job training for individuals suggests that later investments are less profitable than earlier ones, human capital investments would be expected at the early stage of life. The investments would then decline after this stage. Corresponding to changes in human capital investments over the life cycle, the observed earnings of the individual workers rise initially with experience, peak, and then fall thereafter. Thus, the coefficient of $EXPER_i(b_1)$ is expected to be positive and the coefficient of $EXPER_i^2$ (b_2) negative.

The measure of cohort size used incorporates not only workers with a particular experience, but also the set of workers with surrounding experiences. It seems likely that wages of a particular cohort are affected both by its own size and by the size of surrounding cohorts as well. In particular, the measure is :

$$COHORT_{it}=\sum_{k=-2}^{2} w_k(N_{i+k,t}/N_t), \quad \cdots\cdots\cdots\cdots (13)$$

where $w_k=(1/9,\ 2/9,\ 3/9,\ 2/9,\ 1/9)$, except for recent entrants in which succeeding co-

6) Recall that the key identifying assumption is that the only cohort effects on earnings are cohort size effects. While this may be plausible across narrow bands of entry year cohorts, it may not be across wide bands. Any number of factors such as school quality not otherwise controlled for in the model may vary across wide bands of entry year cohorts. If so, one way to control for cohort effects other than cohort size is to estimate earnings equations for relatively narrow bands of entry cohorts.

hort fractions are not defined. In this case, the weights are scaled so as to sum to one. Individuals of adjacent experiences are included in the numerator since these workers are probably very close substitutes and essentially in the same cohort. Each of the five experience groups in the measure is given "V" rated weights. The denominator is the total number of individuals at time t.

This measure attempts to deal with the fact that workers with different amounts of schooling and in different firm size are substitutable to some degree. For example, if the number of workers at a particular schooling level increases, the cohort size for workers at the remaining schooling levels decreases, and is likely to experience a wage increase.

The experience-cohort size interaction variable ($EXPER_i * COHORT_{it}$) in the earnings equation provides a test of relationship between early career earnings and cohort size : that is,

$$\partial \ln W_{it} / \partial EXPER_i = b_1 + 2b_2 EXPER_i + b_4 COHORT_{it} \quad \cdots\cdots (14)$$

If earnings grow at faster rates in larger cohorts, then the estimated coefficient (b_4) on the interaction variable should be positive. On the other hand, if this coefficient is negative, then cohort size effects on earnings increase as workers age.

The characteristics of jobs in different market, characterized by occupation in this study, may lead to different patterns of demand for human capital investment and therefore of experience earnings profiles If each job offers investment opportunity in different types of human capital and each individual's humnan capital productivity varies with the type of human capital, an individual's earnings profile would change according to the job he chooses, thereby changing the aggregate earnings profiles. Furthermore, if we divide workers into production workers and non-production workers, the proportion of either worker types in a cohort with the same experience may affect the aggregate earnings, because of their earnings differentials. Since it is possible that differences attributable to occupational class might be added to differences due to cohort size when all occupational groups are lumped together in the estimation of within-sector aggregate earnings equations, the sample is divided into two broad occupational categories : production and non-production workers, and the proportion of production workers within and experince-year cell is introduced into the earnings equations. Also, this variable controls for selectivity bias in computing average earnings. This effect is expected to be negative in Korea, because non-production workers' wages are generally higher than production workers' with the same experi ence and education.

Ⅲ. DATA AND EMPIRICAL RESULTS

1. Data

In this study, raw data from the 1972, 1974, 1976, 1978, 1980, and 1982 Occupational Wage Surveys of Korea, conducted under the sponsorship of the Ministry of Labor Affiars, have been used for the pooled time-series analysis of the effect of cohort size on earnings for the non-agricultural sector in Korea. The surveys are the systematic and stratified samples of full-time workers with a sample error of less than 5 percent. Each survey has a sample size of approximately 300,000 individuals employed by firms with more than 10 workers and collected various kinds of information on the full-time workers.

Firms are categorized into three groups as usual with consistency over time. Lage firms are defined to be the firms with more than 500 employees, medium firms to be those with 100-499 employees, and small firms to be those with 10

Table 1. Regression Results for Primary and Middle School Graduates

Explanatory Variables	Small Firms	Medium Firms	Large Firms
$EXPER_i$	0.0794 (8.404)	0.0945 (10.51)	0.0988 (15.83)
$EXPER_i^2$	-0.0023 (3.605)	-0.0022 (3.262)	-0.0028 (6.747)
$COHORT_{it}$	-18.131 (2.376)	-8.5437 (2.346)	-1.8256 (2.402)
$EXPER_i * COHORT_{it}$	1.5885 (2.351)	0.8656 (2.571)	0.3369 (3.101)
$POPW_{it}$	-0.2733 (2.255)	1.1434 (6.346)	-0.2868 (1.918)
Buse R^2	0.9370	0.9414	0.9576
S.E.E.	0.9692	0.9751	0.9678
N	90	90	90

Note : The absolute values of t-statistics are in parentheses. The Buse R^2 is the goodness of fit in GLS estimation (see Buse (1973))

Table 2. Regression Results for High School Graduates

Explanatory Variables	Small Firms	Medium Firms	Large Firms
$EXPER_i$	0.0831 (24.92)	0.0844 (19.87)	0.0573 (9.374)
$EXPER_i^2$	-0.0026 (11.48)	-0.0022 (7.940)	-0.0010 (2.271)
$COHORT_{it}$	0.5046 (0.067)	-5.7002 (1.867)	-5.6105 (4.883)
$EXPER_i * COHORT_{it}$	0.9279 (1.413)	0.8479 (3.064)	0.2940 (2.593)
$POPW_{it}$	-0.6830 (9.437)	-0.1920 (1.957)	-0.5939 (5.659)
Buse R^2	0.9719	0.9595	0.9692
S.E.E.	0.9891	0.9633	0.9698
N	90	90	90

Note : The absolute values of t-statistics are in parentheses

—99 employees.

Table 3. Regression Results for College Graduates

Explanatory Variables	Small Firms	Medium Firms	Large Firms
$EXPER_i$	0.0615 (10.97)	0.0732 (14.69)	0.0695 (15.52)
$EXPER_i^2$	-0.0009 (2.198)	-0.0010 (2.632)	-0.0004 (1.059)
$COHORT_{it}$	70.047 (1.946)	31.607 (2.648)	-6.7142 (1.961)
$EXPER_i * COHORT_{it}$	10.145 (3.031)	3.4194 (3.080)	2.0591 (5.220)
$POPW_{it}$	-2.0798 (5.681)	-1.4593 (3.890)	-0.2572 (1.664)
Buse R^2	0.8873	0.9534	0.9424
S.E.E.	0.9809	0.9569	0.9736
N	90	90	90

Note : The absolute values of t-statistics are in parentheses

The surveys report two type of work experience : years of experience within current type of occupation and years of service with current employer in current occupation. The former is used as a definition of years of experience in this analysis, because a worker's past experience in the same occupation is supposed to affect productivity and his wage in a firm currently employed.

2. Empirical Results

The regression results for the earnings equations are shown in Table 1, 2, and 3, for primary and middle school, high school, and college graduates, respectively. The results are presented by firm size and education level, since we are interested in comparing the effects of cohort size on earnings profiles in large firms with those in small and medium firms with a given level of schooling.

7) Welch (1979) and Berger (1985) weighted the observations in their regression analyses by cell frequencies of earners to aviod the heteroscedasticity problems inherent in grouped data (see Maddala (1977), pp. 268-274.), ignoring the possibilities of autocorrelation and contemporaneous correlation across equations.

With the data arrayed across experience levels and across years, that is, pooled cross—section and time—series data, there may be cross—sectionally heteroscedasticities and time—wise autocorrelations.7) Furthermore, residuals are probably correlatd across equations by firm size and schooling groups so that estimates should not be viewed as independent. A generalized lleast squares (GLS) procedure is used on the estimation of the earnings equations following the cross—sectionally heteroscedsatic and time—wise autoregressive model discussed in Kmenta (1971, pp. 509-512), ignoring the possibility of contemporaneous correlation across equations. As is always true in such cases, estimates may be unbiased but are inefficient, and so computed standard errors are biased.

The coefficients of experience ($EXPER_l$) are all positive and significantly different from zero at the 5% significance level and the coefficients of experience squared ($EXPER_l^2$) are all negative. It means that concave earnings profiles are found in all regressions, and diminishing returns to experience prevail in production.

The main purpose of this study is to examine the changes in the magnitude of cohort size effects on earnings over the life cycle, by estimating the effects different for each level of experience. By partially differentiating the estimated equations in respect to $COHORT_{lt}$, we have following equation;

$$\partial \ln W_{lt}/\partial COHORT_{lt}=b_3+b_4EXPER_l \cdots\cdots(15)$$

The coefficient of b_3 represents the effect of unit change in cohort size of new entrants (those who have less than one year of experience) on the percentage change in their (own) earnings. It is negative under the assumption of imperfect substitution between new entrants and more experienced workers. On the other hand, the absolute size of b_4 represents the speed of decline or increase of depressed earnings at entry of large cohort into labor market for each positive or negative signs, respectively, as the entrants gain additional labor market experience.

The cohort size effects on earnings are significantly negative upon entry ($b_3<0$) except for high school graduates in small firms and college graduates in small and medium firms. On the other hand, the coefficients of experience-cohort size interaction terms ($EXPER_l * COHORT_{lt}$) are all significantly positive. Thus, the evidence generally suggests that even though large cohorts experience depressed earnings at the entry level, they experience faster rate of early career earnings growth and steeper earnings profiles than do smaller cohorts. This is consistent with Welch's (1979) but contrary to Berger's (1985) results in the case of the U.S.. This finding suggests that when large cohorts enter the labor market, they face depressed earnings levels and low opportunity costs of investment activities. Therefore, they undertake larger amounts of investment than do individuals in small cohorts and experience faster rates of earnings growth in the early stages of the career, at least in Korea's labor market. Also, the structure of Korean industry had changed dramatically during the 1970s, which is the period of high growth in Korean economy. It seems reasonable that given changes in technology, firm—specific training would be provided to younger rather than older workers, i.e., the younger, larger cohorts during the 1970_s had more chances to increase their humman capital investments and productivities than older workers.

The coefficient of $COHORT_{lt}$ of the high school graduates in small firms is positive but insignificant, and so it can not be rejected the null hypothesis that the coefficient is equal to zero. The regressions for college educated in small and medium firms have the significantly positive signs of $COHORT_{lt}$, which are inconsistent with a priori expectations. One interpretation of this finding is that there is relatively strong complementarity between work activities performed at different phases of the career in professional and managerial capacities where the highly educated tend to be concentrated, especially in small and medium firms. The second possible explanation could be specification error in the earnings equation for the college graduates. For example, our earnings equations do not control for the qualitative changes in human capital embodied in different cohorts of the labor force. If the quality of a college education, which is one of the cohort components stated earlier, and post—college on—the—job training improved over time, there would be a positive correlation between qualitative changes in human capital and cohort size the college group. Therefore, an overestimated coefficient of the cohort size effect would be obtained.

The estimates of cohort size effects on earnings in terms of both $COHORT_{It}$ and $EXPER*COHORT_{It}$ have all expected signs and are significant for all education levels in large firms, for primary and middle, and high school graduates in medium firms, and only for primary and middle school graduates in small firms. In other words, the bigger the firm size, the more significant the effects of negative cohort size on earning in all education levels. This is consistent with the idea that in large firms whose technology becomes more capital—intensive, the substitutability between junior and established workers is smallest, but in small firms whose techbology becomes more labor—intensive, the substitutability is greatest. The negative cohort size effects exist with imperfect substitution between junior and established employees, with neither perfect substitution nor complementarity between them in a production.

One of the interesting findings is that the coefficients of $COHORT_{It}$ are decreased in absolute value with eductional levels in small and medium firms, and increased with educational levels in large firms.[8] In other words, the biggest initial cohort size effects are estimated for college graduates in large firms, and for primary and middle school graduates in small and medium firms.

Another interesting finding is that the absolute size of the coefficients of experience—cohort size interaction decreases with firm size in all education levels, so negative cohort size effects decrease more rapidly in small firms than in lagre fims. This point would be interpreted in terms of the difference in specificity of training among three types of firm size. These findings of decreases in the absolute size of $EXPER_I*COHORT_{It}$ with firm size support the argument that the specificity of training increases with firm size. As has been discussed earlier, capital intensity and market power are positively related to the specificity of training. Large firms are more likely to be caoital—intensive and have strong market power than small firms. Training in large Korean firms is more specific than that in small firms, during the 1970s.

Using this logic, we can say the estimates are consistent with the view that substitutability between junior and established employees is greatest in small firms and smallest in large firms, because the career—phase model predicts that the coefficients are inversely proportional to junior —senior worker substitution elasticities (see equation(8)).Thus, the finding of the effects of $EXPER_I*COHOR_{It}$ decreasing with firm size suggests that the negative cohort size effect

8) From now on, I will exclude the small firms in the group of high school graduates, and the small and medium firms in the college graduates, which have the positive and unexpected cohort size effects, for the statements of results.

decreases more rapidly in small firms than in large firms with worker's additional year of experience in current firms, and the substitutability between junior and established workers is smallest in large firms, which offer more firm-specific training and / or require more firm-specific than capital than small firms. Also, it is consistent with the idea that the absolute cost of training increases with increased specificity of training, and the rate of increase in earnings from the additional years of firm service should be lower in large firms than that in smaller firms. Thus, the new entrants of large cohorts employed in small firms catch up the level of earnings of "normal" cohorts more rapidly than those employed in larger firms.

The coefficients of $POPW_{it}$ are significantly negative in all regressions except the case of medium firms for primary and middle school graduates. These results may suggest that there are significant differences in earnings between the two groups, production and non-production workers in favor of production workers only for primary and middle school graduates in medium firms, but in favor of non-production workers for all others. This result favoring non-production workers in terms of wages is consistent with the past research about wage differentials between them in Korea.

Ⅳ. CONCLUSIONS

1. Summary of Major Findings

Baesd on the human capital theory, changes in the age-experience profiles of male earnings in Korea have been analyzed with the data from 1972 to 1982. On the supply side, demographic changes--specifically the entrance of the post-Korean War baby-boom cohorts into the labor market--had a profound impact on earnings profiles, especially for those male workers who have not received college education. In discussing the firm size differences in demand for labor, the earnings equations are estimated by firm size and education level. It is argued that the substitutability between junior and senior workers is less in large firms than in smaller firms.

The empirical results presented here are generally consistent with the idea that the effects of cohort size on earnings would be negative and the effects of cohort size on earnings growth be indeterminate from a human capital perspective, but those effects should be different between large firms and smaller firms.

It is found that while cohort size depresses earnings at entry, these negative effects of cohort size diminish and wages reach "normal" levels at relatively young ages, except for college graduates in small and medium-size firms. Thus cohort size generally has a negative effect on earnings levels but a positive effect on early career earnings growth. This implies that the costs of human capital investments are reduced in larger cohorts and the expected returns to investments by larger cohorts are larger than those by small cohorts. Therefore, the individuals in larger cohorts tend to invest in greater amounts of human capital and experience faster rates of earnings growth in the early stages of the career. Moreover, the greatest positive effect on earnings growth is found in small firms for all education levels, which is consistent with the idea that the substitutability between younger and older, more experienced workers is the greatest in small firms, and the smallest in large firms, and so the negative cohort size effect of entry cohort diminishes more rapidly in small firms than in larger firms. Also, it is consistent with the idea that the cost of training as a human capital investment increases with increased specificity of training, which is more relevant in the case of large firms than smaller firms.

The regressions for the college graduates in small and medium firms indicate a positive effect of cohort size on earnings even in the early career phase. One interpretation of this finding is that there would be relatively strong complementarity between work activities performed at different phases of the career in professional and managerial capacities where the highly educated tend to be concentrated. The other possible interpretation is that there could be a specification error in the earnings equations estimated, which do not completely control for changes in the quality of schooling in different cohorts.

2. Limitations of the Study and Suggestions for Further Research

This study is of interest in understanding the dynamics of age-experience profiles of earnings over time, emphasizing the supply side of labor within the demand side approach (human capital approach in my study). There still remain several possible avenues of further research. Even though the structural change in Korea's labor market, where there are firm size differences in specificity of training, wages, etc., is considered by estimating the earnings equations for each type of firm size, this study would hopefully stimulate further research about labor market segmentation in Korea.

A major portion of the analysis in this study deals with male workers, and more research needs to be done to sort out cohort size effects for female workers. This inquiry could possibly supplement ongoing research on female labor supply through the addition of cohort size variables.

The empirical results we have discussed so far do not take into account shifts in demand except insofar as narrow bands of entry cohort (15 years of experience) reflect this shift. In other words, the effect of gradual improvements in quality of education might influence the productivities and the demand for younger workers as opposed to older workers, and hence the relative earnings. Also, increases in capital might shift demand from younger towards older workers, which will give the earnings profile a steeper tilt, if skilled labor (or experienced workers) is relatively more complementary to capital than unskilled labor (or younger workers). The effects of changes in quality of schooling and in capital are partially considered only by estimating the earnings equations for relatively narrow bands of entry cohort in this study. Ideally it would be useful in this context to introduce some exogenous variables which would be proxies for demand shift. Unfortunately, the accomplishment of this task is not feasible with the data as well as the methodology used in this study. However, the failure to account for the demand shift indicates the need for the careful consideration of labor demand in future studies.

This study has assumed the formal education choice and sectorial (large, medium, and small firms) self-selection to be exogenous. However, there are probably demographic effects on the choice of level of education as training just like on-the-job training. Also, heterogeneity of workers in human capital productivities, and of firms in providing learning opportunities, implies that each worker is choosing a firm according to his comparative advantage in learning activity to maximize the present value of his life-time earnings stream by obtaining an optimal life-time accumulation path of human capital. An investigation of these effects should also be undertaken in future research.

References

Becker, G. S., "Investment in Human Capital: A Theoretical Analysis," *Journal of Political Economy*, Vol. 70, No. 5, Oct. 1962, Suppl. pp. 9-49.

———, *Human Capital*, New York: Columbia

Univ. Press, 1964.

Berger, Mark C.,"Changes in Labor Force Composition and Male Earnings : A Production Approach," *The Journal of Human Resources*, Spring 1983b, pp. 177-196.

______, " Cohort Size and The Earnings Growth of Young Workers,"*Industrial & Labor Relations Review*, Vol. 37, No. 4, July 1984, pp. 582-591.

______' "The Effect of Cohort Size on Earnings Growth : A Re-examination of the Evidence,"*Journal of Political Economy*, Vol. 93, No. 3, 1985, pp. 561-573.

Buse, A., "Goodness of Fit in Generalized Least Squares Estimation," *The American Statistician*, Vol. 27, No. 3, June 1973, pp. 106-108.

Deaton A. and J. Muellbauer, *Economics and Consumer Behavior*, Cambridge University Press, New York, 1983.

Doeringer, Peter B. and Michael J. Piore, *Internal Labor Markets and Manpower Analysis*, Health Lexington Books, Lexington, Massachusetts, 1971.

Freeman, Richard B., "Overinvestment in College Training?," *The Journal of Human Resources*, Vol. 10, Summer 1975, pp. 287-311.

______' "The Effect of Demographic Factors on Age-Earnings Profiles," *The Journal of Human Resources*, Vol. 14, No.3, Summer 1979, pp. 289-318.

Grant, J. and D. Hamermesh, "Labor Market Competition Among Youths, White Women, and Others," *Review of Economics and Statistics*, August 1981, pp. 354-360.

Hanoch, G., "A General Strategy for Estimating Period, Cohort and Age Effects," In (ed. H. H. Winsborough and O. D. Duncan) *Analysing Longitudinal Data : Age, Period and Cohort Effects*, Academic Press, 1982.

Hicks, John, R., "Elasticity of Substitution Once Again : Substitutes and Complements," *Oxford Economic Papers* 22(November 1970) pp. 289-296.

Johnson, William R., "Vintage Effects in The Earnings of White American Men," *Review of Economics and Statistics* 62(August 1980), pp. 399-407.

Kmenta J., *Elements of Econometrics*, New York : The Macmillan Company, 1971.

Lin, Chung-Cheng. *Labor Force Age Composition and the Age-Earnings Profile in Developing Countries : The Case of Taiwan*, Ph. D. Dissertation, Department of Economics, University of Hawaii, May 1982.

Maddala, G. S., *Econometrics*, 1977.

Martin, Linda G., "Japanese Response to an Aging Labor Force, "*Population Research and Policy Review*, Vol. 1, No. 1, 1982, pp. 19-41.

Mason, K. O., W. M. Mason, H. H. Winsborough, and W. K. Pool, "Some Methodological Issues in Cohort Analysis of Archival Data," *American Sociological Review*, Vol. 38, No. 2, April 1973, pp. 242-258.)

Mincer, Jacob, "Investment in Human Capital and Personal Income Distribution," *Journal of Political Economy*, Vol. 66, No. 4, August 1985.

______, "On-the-job Training : Costs, Returns and Some Implications" *Journal of Political Economy*, Vol. 30, No. 5, Oct. 1962, Suppl. pp. S50-S79.

______, " The Distribution of Labor Incomes : A Survey with Special Reference to the Human Capital Approach," *Journal of Economic Literature*, Vol. 8, No. 1, March 1970, pp. 1-26.

______; *Schooling, Experience, And Earnings*, NBER New York, 1974.

Mosk, Carl and Yoshi-Fumi Nakata, "The Age-Wage Profile and Structural Change in the Japanese Labor Market for Males, 1964-1982," *The Journal of Human Resources*, Vol.

20. No. 1, Winter 1985, pp. 100-116.

of Substitution & Complementarity," *Oxford Economic Papers*, March 1973, pp. 44-56.

Shin, Young-Soo, *Effects of Cohort Size on Male Experience-Earnings Profiles in Korea*, Ph. D. Dissertation, Department of Economics University of Hawaii, May 1986.

Welch, Finis, "Effect of Cohort Size on Earnings : The Baby Boom Babies' Financial Bust," *Journal of Political Economy*, Vol. 87, No. 5, October 1979, pp. S65-S97.

Zellner, Arnold, "An Efficient Method of Estimating Seemingly Unrelated Regressions and Tests for Aggregation Bias, " *Journal of American Statistical Association* 57 (June 1962), pp. 348-368.

Pindyck, R. S. and D. L. Rubinfeld, ***Econometric Models & Economic Forecasts***, 2nd ed. ; New York : McGraw-Hill, 1981.

Rosen, Sherwin, "Learning, Experience and the Labor Market," ***The Journal of Human Resources***, Summer 1972, pp. 326-342.

,"Human Capital : A Survey of Empirical Research," in Ehrenberg, R. G. (ed.), ***Research in Labor Econimics***, Vol. 1, Greenwich : Jai Press, 1977.

——, and Paul Taubman, "Changes in Life-Cycle Earnings : What do Social Security Data Show ?," ***The Journal of Human Resources***, Summer 1982, pp. 321-338.

Sato R. and T. Koizumi, "On The Elasticities