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The Effect of Firm Pension and National Pension on the Retirement Behavior and Retirement Plans*

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< 目 次 >

국민연금제도가 1988년 이후 전국적으로 시행되고 있고, 최근에 와서는 기업연금제도의 도입필요성 논의가 조심스럽게 전개되고 있다. 남녀고용평등 문제가 쟁점화되고 있는 현재, 연령고용 평등문제도 조만간 제기될 것이 확실하고, 이는 결국에는 강제퇴직제도의 완화 내지는 철폐로 연결될 것이 예상된다.

강제퇴직제도라는 제도적 장치없이도 고용주는 적절한 기업연금제도의 운용으로 기업이 원하는 방향으로 퇴직정책을 수행할 수 있고, 노동자의 입장에서 보면 자율적인 의사결정에 의해서 퇴직시기를 결정할 수 있으므로 만족도를 높일 수 있다는 점을 강제퇴직제도가 이미 철폐된 미국의 자료를 이용하여 증명하고자 한다. 본 논문의 특징은 정상연금(stay pension benefit)과 조기퇴직연금(quit pension benefit) 및 연금기여라는 정책수단을 이용하여 퇴직행위뿐만 아니라 퇴직의사 결정까지도 분석한 데 있다.

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1. INTRODUCTION

Since Burkhauser(1976) introduced the notion of pension wealth in a life-cycle context into labor economics, a number of authors have attempted to examine the effects of pensions and Social Security on retirement and worker turnover. The literature on retirement behavior can be classified into three categories according to the method employed to analyze the effect of earnings and pensions on labor supply. These approaches are the nonlinear budget approach, the hazard model approach, and the dynamic programming approach. The outstanding feature of nonlinear budget approach is that it incorporates a lifetime budget constraint into the model analogous to the standard labor-leisure model with single period budget constraint. While this approach is, in many respects, preferable to the static utility maximization model in a life-cycle context, it has an important drawback. It implicitly assumes that individuals know with certainty the opportunities that will be available to them in the future. But the retirement decision is essentially a dynamic behavior based on uncertainty.

The hazard model approach is a reduced form technique designed to capture the impact on retirement behavior of variables such as Social Security wealth, pension wealth, and other economic and demographic variables. This approach does not include uncertainty in a dynamic sense which is characteristic of the dynamic programming approach. The hazard model approach is very flexible, but it does not have an apparent utility maximization interpretation or direct micro foundations.

What is needed is a model which has the dynamic (life-cycle) budget constraint, uncertainty characteristics, and an apparent utility maximization interpretation. The stochastic dynamic programming approach of Rust(1989) and Berkovec and Stern(1991) attempts to do this. Unfortunately, the estimation methodologies in the Rust and Berkovec and Stern models do not include information on private pension plans because of data and model limitations, and both procedures are econometrically burdensome.

In this paper, the retirement decision is modeled as a choice problem under uncertainty with a notion of option value of a pension. The option value of a pension at time t is the difference between what the worker expects to receive in pension wealth if he works until time t as compared with time t-1. The option value of the pension was first proposed by Lazear and Moore(1988). Stock and Wise(1988a, 1988b, 1990), Lumsdaine, Stock, and Wise(1992) developed the option value model of retirement with uncertainty.

The key idea of an option value model is the focus on the opportunity cost of retiring, or equivalently, on the value of keeping the option to retire at a later date. The person will continue to work at any age if the option value of continuing to work is greater than the value of retiring now, and the individual reevaluates the retirement decision as more information about the future becomes available with age.

The main purpose of this paper is to fill the gap that exists between the analysis of the effects of pension benefits on actual retirement and planned retirement. The option value model can clearly connect the probabilities of retirement to expected discounted pension benefits at the planned retirement age and current pension benefits as well as the expected discounted wage. Fortunately, the 1983 and 1986 Surveys of Consumer Finances include both planned retirement and actual retirement data as well as pension benefits information.

In chapter 2, I will derive the theoretical model. It is a reduced form option value and an age of retirement model. The probability of retiring and the retirement age are explicitly connected to the discounted value of lifetime income and pension benefits as well as socioeconomic variables which represent unmeasured utility of lifetime leisure. In chapter 3, descriptive statistics from the Survey of Consumer Finances data set are explained. The econometric specifications and estimation results follow. First, I investigate the effect of pension benefits and pension contributions on actual retirement behavior. Second, I analyze the effect of pension benefits and pension contributions on planned retirement age. Chapter 4 is a conclusion.

2. THEORY

2.1 Basic Model

The retirement decision is essentially life-cycle behavior under uncertainty. Thus stochastic dynamic programming is one of the appropriate tools to analyze retirement behavior and the effects of pensions on retirement. Consider an individual who is working at the beginning of year t and plans to retire in year s ($s \geq t$). Let R be the first year of the individual's retirement and T be his life span. He will receive earnings Y_S when he works in year s; otherwise he will receive retirement pension benefits, B_S. Earnings are decomposed into net wage(W_S) and private pension and Social Security contributions(C_S). The pension benefits function, $B_S(R)$, explicitly depends on the age of retirement, which reflects the typical characteristics of real world pension formulae.

Suppose the individual derives indirect lifetime utility from the discounted value of earnings and pension benefits which change with the choice of retirement age R given earnings and pension benefits.[1] Let β be the discount factor. The individual's value function is:

$$V_t(R) = \sum_{s=t}^{R-1} \beta^{s-t} U^0(Y_s) + \sum_{s=R}^{T} \beta^{s-t} U^1(B_s(R)). \tag{1}$$

Suppose that the indirect utility derived from annual income and pension benefits has a unit relative risk aversion with additive individual disturbance terms. The specific form of the earnings equation is:

$$U^0(Y_s) = W_s - C_s + e_s^0 \tag{2a}$$

The pension benefits equation has the same form as the earnings equation:

$$B_s(R) = \{P_s(R)\} + \kappa + e_s^1. \tag{2b}$$

e_s^0 and e_s^1 are individual specific random effects changing across time and distributed identically and independently of income, pension benefits and age. κ represent unmeasured lifetime leisure (or determinants of nonmonetary differences) in the pension benefits function.

There are several ways to solve the above dynamic problem, depending on the individual's decision rule. The dynamic programming model uses the "Principle of Optimality and Bellman's Equation". The "Option Value Model" uses the option value decision rule. This decision rule compares the maximum of the expected present discounted value of future utilities at retirement now versus retirement of each of the potential future ages.

The individual who is working at the beginning of year t must decide either to work during year t or retire. If he decides to work during year t, then the retirement age R is greater than t. If he decides to retire during year t, then the retirement age R equals t.

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[1] For a review and the general comparison of retirement models under utility maximization and income maximization, see Mitchell and Fields(1982).

The expected gain, at time t, from postponing retirement to age R(option value of retirement) is then given by

$$G_t(R) = E_t\, V_t(R) - E_t\, V_t(t). \tag{3}$$

The decision rule in the Option Value Model is that the individual retires at age t (now) if there is no expected gain from continued work; otherwise he postpones retirement.

He retires in year t,

$$\text{if } G_t(R) = E_t\, V_t\,(R) - E_t\, V_t(t) \le 0 \ \text{ for all } R \in \{t+1, t+2, \ldots, T\}. \tag{4a}$$

He works in year t,

$$\text{if } G_t(R) = E_t\, V_t\,(R) - E_t\, V_t(t) > 0 \text{ for at least one } R \in \{t+1, t+2, \ldots, T\}. \tag{4b}$$

By substituting equation (2a) and (2b) into equation (1), and assuming that the probability of being alive up to T is 1 and statistically independent of his earnings streams (W_s, C_s and $P_s(R)$) and the individual random terms(e_s^0 and e_s^1), then the expectation operator becomes linear. Thus, we can get

$$G_t(R, \kappa) = \sum_{s=t}^{R-1} \beta^{s-t} E_t W_s - \sum_{s=t}^{R-1} \beta^{s-t} E_t C_s + \sum_{s=R}^{T} \beta^{s-t} E_t[P_s(R)\,]$$
$$- \sum_{s=t}^{T} \beta^{s-t} E_t[P_s(t)\,] - \sum_{s=t}^{R-1} \beta^{s-t} \kappa + (e_t^0 - e_t^1\,). \tag{5}$$

The last term in equation (5) results from the fact that e_t^0 and e_t^1 are i.i.d. So $E_t\, e_s^0 = E_t\, e_s^1 = 0$ for $s > t$ and $\sum_{s=t} \beta^{s-t} E_t\,(e_s^0 - e_s^1\,) = (e_t^0 - e_t^1)$.

2.2 The Probability of Retiring

In our dynamic model, the retirement year R is a random variable. The probability that an individual in the sample at the beginning of year t retires in year t is Pr[R = t]. This probability directly depends on the value of $G_t(R)$. The $G_t(R)$ in equation (5) is composed of a deterministic part and a random part. The deterministic part is the monetary difference between retiring at age R and at age t. The random part is the difference in the error terms in the earnings and pension benefits equations at age t only. From equation (4a), a worker will retire in year t if $G_t(R,\kappa) \le 0$ for all $R \in \{t+1, t+2, \ldots, T\}$.

$$\Pr[\,R = t] = \Pr[G_t(R,\kappa) \leq 0 \text{ for all } R \quad \{t+1, t+2, \ldots\ldots, T\}] \equiv \Pr[G_t(R^*,\kappa) \leq 0]$$
$$\equiv \Pr[\{WAGE_t(R^*) - CONT_t(R^*) + STAY_t(R^*) - QUIT_t(t) - LEIS(R^*)$$
$$+ (e_t^0 - e_t^1)\} \leq 0\,]$$
$$= \Pr[(\,e_t^1 - e_t^0) \geq \{WAGE_t(R^*) - CONT_t(R^*) + STAY_t(R^*) - QUIT_t(t)$$
$$- LEIS(R^*)\}]$$
$$= \Pr[(\,e_t^1 - e_t^0) \leq \{-WAGE_t(R^*) + CONT_t(R^*) - STAY_t(R^*) + QUIT_t(t)$$
$$+ LEIS(R^*)\}]$$
$$\equiv \Pr[e_t \leq Z_t'\alpha + X'\lambda], \tag{6}$$

where $e_t = e_t^0 - e_t^1$, Z=[WAGE, CONT, STAY, QUIT], X=[LEIS], and R* is the value that maximizes the deterministic parts of $G_t(R, \kappa)$.

R* is the future retirement year that gives the maximum option value of retirement. R* could be derived by the dynamic programming method.[2] $WAGE_t(R^*)$ is the expected wages from now to the expected retirement age. $CONT_t(R^*)$ is the expected contributions to pension and Social Security from now to the expected retirement age. $STAY_t(R^*)$ is the expected pension and Social Security benefits from expected retirement to T, when he works up to expected retirement age R*. $QUIT_t$ is the expected pension and Social Security value which he can take out at any time from now to T when he retires at age t.[3] LEIS(R*) is the monetary equivalent of forgone leisure time(or the disutility from working) from t to R*. Z_t is a vector of time variant monetary variables and X is a vector of time invariant exogenous covariates. α and λ are the associated coefficient vectors.

I assumed that the individual acts rationally as a dynamic stochastic maximizer of the option value of retirement. This assumption is embedded in equations (1), (4) and (6). Thus, I interpret the expected planned retirement age, reported by the individual at time t, as the optimal retirement age R* in equation (6). This is a valid interpretation since the subjective probability equals the objective probability under rational expectation. Thus,

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[2] For an excellent survey of dynamic stochastic discrete choice models, see Eckstein and Wolpin(1989).

[3] Note the arguments in the pension benefit function. The argument in the third term is R* whereas the fourth is t. This results from the pension and Social Security functions which are dependent on the retirement date.

we can avoid direct calculation of R* in the model and use the planned retirement age as an R* reported in our data set. We can estimate equation (6) with latent variable estimation methods by assuming an appropriate distributional functional form for e_t.

2.3 The Age of Retirement

Under the certainty case we can solve for R* that maximizes $G_t(R,\kappa)$ in equation (6) implicitly. To simplify the calculation I will use the continuous version of $G_t(R,\kappa)$.

$$\max_{R} \; G_t(R,\kappa) = \int_{s=t}^{R} e^{-\beta(s-t)} W_s \, ds - \int_{s=t}^{R} e^{-\beta(s-t)} C_s \, ds + \int_{s=R}^{T} e^{-\beta(s-t)} P_s(R) \, ds$$

$$- \int_{s=t}^{T} e^{-\beta(s-t)} P_s(t) \, ds - \int_{s=t}^{R} e^{-\beta(s-t)} \kappa \, ds \qquad (7)$$

The first order condition for maximization is equation (8).

$$\frac{\partial G_t(R,\kappa)}{\partial R} = e^{-\beta(R-t)} W_R - e^{-\beta(R-t)} C_R$$

$$- e^{-\beta(R-t)} P_R(R) + \int_{s=R}^{T} e^{-\beta(s-t)} \frac{\partial P_s(R)}{\partial R} ds - e^{-\beta(R-t)} \kappa = 0 \qquad (8)$$

The right hand side of the first order condition consists of five terms; (1) the discounted wage in year R, minus (2) the discounted pension contributions in year R, minus (3) the discounted forgone pension benefits in year R if the individual works in year R, plus (4) the discounted accrual of pension benefits by working in year R, minus (5) the discounted monetary equivalent of leisure time forgone in year R. At the optimal retirement age R*, an individual equates the utility or monetary value of working one more year in R with the monetary equivalent of the utility loss by postponing retirement in year R. By postponing retirement(or by working) in year R, he gains the *R*th year's wage and higher pension benefits in later years(the change of pension accrual from year R to death), but he loses the *R*th year's pension benefits and monetary equivalent of leisure in year R.

R* is the solution to equation (8). We can only solve it implicitly without any further specifications for the W_R, C_R, P_R, and κ functions. Equation (8) is a variation of the age of retirement model and we can obtain the effects of exogenous changes in the wage, pension contributions, or pension benefits on the individual's optimal retirement age R* by total differentiation of the first order condition, equation (8).[4] There are several possible empirical implementations of equation (8) and its total differentiation.[5] To compare the results of the option value model with those of the age of retirement model, I will implement the optimal retirement age R* in terms of the same explanatory variables as in the option value of retirement model. Let the solution of equation (8) be:

$$R^* = WAGE_t(R^*)+CONT_t(R^*)+STAY_t(R^*)+QUIT_t(t)+LEIS(R^*) + e_t \qquad (9)$$

Equation (6) is an estimable equation from the option value model under the uncertainty case and equation (9) is an estimable equation from the age of retirement model under the certainty case. Under the certainty case of the age of retirement model, retirement plans and retirement behavior are systematically related such that workers can not choose new retirement dates once they have selected an optimal retirement age. Equation (9) represents this process in terms of retirement age R. This kind of static feature may be a reasonable assumption under a relatively stable economic environment.

Under the option value model with uncertainty, at every year workers compare the utility or monetary value of retiring at age t with the maximum utility of retiring at later years. If the utility of retiring at age t is greater than the maximum utility of retiring at later years, then workers choose to retire at age t; otherwise they continue to work one more year and evaluate the same process again at age t+1 with new information added to information set during the last year t. Equation (6) represents this process in terms of the probability of retiring at age t in every year from age t to the optimal retirement age R*. Upon retirement this process terminates, because I do not allow partial retirement or reentry after retirement.[6]

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[4] For the age of retirement model, see Fields and Mitchell(1984a, 1984b, 1984c). Total differentiation results can be found in Burbidge and Robb(1980), Fields and Mitchell(1984c), or Kim(1990).

[5] Fields and Mitchell(1984c) specified their empirical model in terms of the present discounted value of pension benefits if the individual retires at age 60 and the difference between pension benefits at age 60 and at age 65. The choice of evaluation ages is arbitrary.

[6] Quinn(1980 and 1981), Honig and Hanoch(1985a and 1985b), Gustman and

2.4 Implications of Model and Hypotheses

We can observe several characteristics from the first order conditions of the reduced form option value model (equation (6)). First, this is a discrete choice dynamic random utility model. We can estimate the model by assuming a distributional form of the error term e_t just as in the case of a static model as long as the variables are appropriate discounted expected values

Second, our reduced form model explicitly relates the retirement probability at age t to monetary variables at ages t and R* and to time invariant exogenous variables which represent the monetary equivalent of leisure time. The age R* is different across individuals in this model, but the usual Nonlinear Budget Model arbitrarily assumes it to be 65 for every individual.

Third, this model incorporates both the characteristics of "stay pension" and the "quit pension" properties.[7] Under the quit pension, the employee takes out an amount exactly equal to what he put in. The quit pension benefits formula does not depend on the years of service R, whereas the stay pension benefits formula explicitly depends on the years of service R. The $STAY_t(R^*)$ term represents the stay pension benefits and the $QUIT_t(t)$ term in equation (6) represents the quit pension benefits. Our model explicitly incorporates the stay pension benefits and quit pension benefits at the same time. If the pension benefits formula is actuarially fair, then $STAY_t(R^*)$ and $QUIT_t(t)$ cancel each other out in equation (6) at the optimal age R*. Thus, pension benefits do not affect the retirement decision or turnover rates at the optimal retirement age; except at age R*

Steinmeier(1984, 1985 and 1986), and Berkovec and Stern(1991) included partial retirement as a distinct state from full retirement. Anderson, Burkhauser, and Butler(1988) and Anderson, Burkhauser and Slotsve(1992) include partial retirement as a distinct state in studying the phenomenon of job re-entry after retirement.

[7] For the "stay pension" and "quit pension", see Bulow(1982), Kotlikoff and Wise(1985), and Ippolito(1987, 1990). Let R be the normal retirement age, "a" be the service year and "b" be the generosity factor. If the interest rate(i) and the wage growth rate are the same, then the present value of the stay pension is $P_a=baW_a$ and the quit pension is $P_{a^*}=baW_ae^{-i(R-a)}$. The difference between stay and quit pensions is attributable to wage indexing in the pension formula. A vested quit is entitled to a pension benefits beginning at the normal retirement age R which is fixed in current dollars at the age of quit "a". The wage in the quit pension formula is frozen at the nominal level prevailing at the time the worker quits.

$STAY_t(R^*)$ and $QUIT_t(t)$ are different and pension benefits affect the retirement decision.

Fourth, possible testable hypotheses are derived below from the option value model. These hypotheses are derived directly from equation (6) by using the fact that $\beta>0$ and $t \leq s \leq T$.

Hypothesis 1: An exogenous increase in the expected present discounted value of gross wages(WAGE) has both substitution and income effects. The substitution effects raise the opportunity cost of retiring at year t. Therefore, the income-maximizing individual would substitute in favor of the relatively higher earnings stream and away from the pension stream, implying that he is more likely to retire later. The increase in wage has income effects which also cause more consumption of leisure assuming labor supply is a normal good. This income effect will lead to earlier retirement. The net result of an exogenous wage increase on retirement behavior will depend on the magnitudes of the substitution and income effects. The retirement equation (6) of the option value model predicts a negative coefficient for lifetime wage, implying that the substitution effects dominate the income effect. Thus a lifetime wage increase will lead to later retirement. I expect PR[R=t] will decrease with higher lifetime income. The model predicts a negative coefficient for WAGE($\alpha_1 < 0$).

Hypothesis 2: To evaluate the effects of a change in the pension benefits function on retirement behavior, we distinguish between a parallel shift and a non-parallel change in the pension benefits function. The parallel shift is a pension benefits increase that does not change the rate(steepness) at which the pension grows if retirement is delayed. The non-parallel change alters the slope of the pension benefits function. An exogenous increase in the stay pension is a non-parallel change, so it has both substitution and income effects. Its effect on retirement behavior is theoretically ambiguous. The option value model expects that the increase in the stay pension benefits causes later retirement, that is, it predicts a negative coefficient for STAY($\alpha_3 < 0$).

Hypothesis 3: We can consider the pension contributions(CONT) as forgone wages. Thus the effect of an exogenous increase in pension contributions on retirement behavior, ceteris paribus, is the same as an exogenous decrease in wage(WAGE) on retirement behavior. It has both income and substitution effects. In view of WAGE discussions, it will lead to earlier retirement. The model predicts a positive coefficient on CONT in the retirement equation ($\alpha_2 > 0$).

Hypothesis 4: An increase in the quit pension benefits results in a parallel shift of the pension benefits function because it does not change the steepness of the pension function but increases the pension benefits that an individual can take out at time t. This has only an income effect and, as long as lifetime leisure is a normal good, it will cause more consumption of leisure. Retirement at year t becomes more attractive than working to age R*, and the individual is induced to retire earlier. The model predicts a positive coefficient for QUIT($\alpha_4 > 0$).

3. DATA AND ESTIMATION RESULTS

In this chapter, I will describe the data set and discuss the empirical results. The next section describes the Survey of Consumer Finances data set and the final sample chosen for the analysis. The descriptive statistics subsection defines the independent variables used in the retirement and pension benefits equations and presents descriptive statistics for the independent variables. The results section includes the empirical estimation results from the actual retirement analysis and the planned retirement analysis. Each results subsection contains the econometric specifications, estimation results, and hypothesis testing results.

3.1 Data

3.1.1 Sample Size and Weights

The data sets used are the 1983 Survey of Consumer Finances (1983 SCF) and the 1986 Survey of Consumer Finances (1986 SCF). The 1983 SCF and the 1986 SCF are U.S. household data sets primarily designed to assess the changes in the financial position of United States households[8].

Several decisions were made in the course of preparing the final data that affected the size of the sample. First, I extracted only those survey respondents who were included both in the 1983 SCF and 1986 SCF. This decision rule is straightforward since I analyze the retirement behavior between the two survey points. This criterion reduced the sample

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[8] For background and the purpose of the SCF data, see Avery, Elliehausen, Canner, and Gustafson(1984a, 1984b).

size to 2,734. Second, I extracted only those survey respondents who reported working or being on temporary layoff in the year 1983. Since we are concerned with retirement behavior individuals must initially be in the labor force. The labor force participation rule reduced the sample size to 1,876(68.6%). Third, the sample examined here includes families whose heads are older than or equal to 40 years in 1982. Because the 1983 SCF has imputed missing values of major variables for the households where the head or spouse is over age 39, I used the 40 year age criterion. The age decision rule reduced the sample size to 1,078(57.5% observations based on the first criterion). Finally, I excluded the observations which have missing values for pension benefits, Social Security variables, and expected retirement age. I also excluded observations for individuals who did not retire voluntarily during the survey periods, because I am concerned with the effects of pension benefits on the voluntary retirement. The final sample size used in the actual retirement analysis is 834, of which 519(62.2%)[9] have pension benefits and 315 do not.

The 1983 SCF and 1986 SCF are stratified survey data. Even though the original survey design was a random sample, the final survey data do not represent a random draw from the U.S. population for a variety of reasons. To correct sample stratification,[10] I will use the weight variable(FRB 1983/1986 Weight #3 in the 1986 SCF) which is recommended for an analysis involving changes for individual families between 1983 and 1986 by the Survey Research Center.

3.1.2 Descriptive Statistics

Table 1 briefly defines each variable. The first group includes age-related variables, the second group includes monetary variables, the third group includes demographic variables for individual characteristics, the fourth group includes the

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[9] In the original 1983 SCF, 1,527 household heads (62.6 %) are covered by private pensions out of the currently working but not self-employed 2,438 heads, and 527 spouses (47.1%) are covered by private pensions out of the 1,119 non-self-employed currently working spouses.

[10] For an explanation of weights and detailed calculation methods of weights, see the 1983 Survey of Consumer Finances: Technical Manual and Codebook, pp. 3-29, and the 1986 Survey of Consumer Finances: Technical Manual and Codebook, pp. 8-25.

occupation dummy variables, and the fifth group includes dummy variables for the types of employer used mainly in the pension benefits equation. The sixth group includes the weight variable used in all estimations to keep the random property of the final sample.

Table 1. Definitions of Variables

Variables	Definitions
Age Related Variables	
AGE	Current age in year 1983.
AGES	Age at which the current job was first taken.
R*	Expected retirement age.
FAGE	Age at which the individual could retire with full pension benefits.
EAGE	Age at which the individual could first retire with some pension
VAGE	Age at which the individual will be vested in main plan.
Monetary Variables	
WAGE	Present discounted value(PDV) of wage from t to R*(thousand
STAY	PDV of stay pension and Social Security benefits from R* to T.
QUIT	PDV of quit pension and Social Security benefits from t to T.
CONT	PDV of pension and Social Security benefits from t to R*.
WEALTH	Net financial assets (thousand dollars).
WAGET	Gross wage in 1983 (thousand dollars).
Individual Characteristics	
SEX	=1 if male; 0 otherwise.
MSTAT	=1 if married; 0 otherwise.
HEALTH	=1 if bad health condition; 0 otherwise.
CHILD	Number of children.
EDUC	Number of years of education.
EXP	Number of years of current job experience.
UNION	=1 if union member; 0 otherwise.
SPOUSE	=1 if spouse is working in 1983; 0 otherwise.
Occupations	
OCCU1	=1 if professional or technical worker(3 digit 1970 occupation
OCCU2	=1 if managers or administrator(3 digit 1970 occupation codes
OCCU3	=1 if sales or clerical worker(3 digit 1970 occupation codes 260-
OCCU4	=1 if craftsmen or protective service worker(3 digit 1970
Employer Types	
E1	=1 if federal or state/local government; 0 otherwise.
E2	=1 if public school/college or private school; 0 otherwise.
E3	=1 if small private sector; 0 otherwise.
E4	=1 if large private sector(more than 100 employees); 0 otherwise.
Weight Variable	
WEIGHT	FRB 1983/1986 weight #3 in the 1986 SCF

Table 2 presents the descriptive statistics for the explanatory variables in the retirement and pension equations.

Table 2. Descriptive Statistics on Explanatory Variables

(units: years, thousand 1983$)

Variable	MEAN	SD	MIN	MAX	CASE
Retirement Equation					
AGE	51.06	7.40	40.00	79.00	519
R*	61.76	5.67	41.00	84.00	519
WAGE	576.04	1,065.08	3.58	10,305.83	519
STAY	163.02	148.80	7.83	868.89	519
QUIT	111.31	146.99	0.41	799.56	519
CONT	55.82	61.99	0.40	432.61	519
WEALTH	1,014.67	3,643.22	-5.35	36,552.20	519
SEX	0.66	0.47	0	1	519
MSTAT	0.75	0.44	0	1	519
HEALTH	0.50	0.50	0	1	519
CHILD	0.65	0.96	0	5.00	519
EDUC	13.96	2.74	5.00	17.00	519
EXP	16.01	10.10	1.00	49.00	519
UNION	0.32	0.47	0	1	519
SPOUSE	0.45	0.50	0	1	519
OCCU1	0.23	0.42	0	1	519
OCCU2	0.35	0.48	0	1	519
OCCU3	0.16	0.36	0	1	519
OCCU4	0.10	0.30	0	1	519
Pension Equation					
AGES	37.74	11.74	12.00	84.00	834
WAGET	61.99	113.54	0.13	1,200.00	834
EDUC	13.73	2.94	3.00	17.00	834
SEX	0.65	0.48	0	1	834
UNION	0.22	0.42	0	1	834
E1	0.12	0.33	0	1	834
E2	0.08	0.27	0	1	834
E3	0.22	0.42	0	1	834
E4	0.42	0.49	0	1	834

* The descriptive statistics are not weighted.

3.2 Estimation Results

3.2.1 Analysis of Actual Retirement

3.2.1.1 Econometric Specifications

I derived a final estimable discrete choice(the probability of retiring at age t) equation (6) for the option value model with uncertainty and the optimal retirement age equation (9) for the age of retirement model with certainty in Chapter 2. Let y_1^* be the latent variable for the probability of retiring or propensity to retire at time t; then equation (6) becomes:

$$y_1^* = X_1'\alpha + e_t$$

$$y_1 = \begin{cases} 1 & \text{if} \quad y_1^* > 0 \\ 0 & \text{otherwise} \end{cases} \tag{10}$$

The X_1 vector includes lifetime monetary compensation variables as well as nonmonetary utility of lifetime leisure variables. For lifetime monetary compensation variables, the option value theory explicitly includes WAGE, CONT, STAY, and QUIT. For nonmonetary utility of lifetime leisure variables, there is not a general rule for which variables are included or not. Usually the specification for control variables depends on the data set used in the analysis and on the purpose of a research. I included AGE, SEX, MSTAT, HEALTH, CHILD, EDUC, EXP, UNION, WEALTH, SPOUSE, OCCU1, OCCU2, OCCU3, OCCU4.

In the age of retirement model under certainty, workers choose the optimal retirement age that gives the maximum lifetime utility. After the optimal retirement age is chosen, workers can not or need not change their retirement age since this model assumes the certainty case where the retirement plan is not systematically different from retirement behavior. Equation (11) restates the final estimable optimal retirement age equation for the age of retirement model.

$$R = X_2'\beta + u_t \tag{11}$$

R is the observed retirement age in the actual retirement analysis and the planned retirement age in the retirement plan analysis. The X_2 vector includes the same monetary compensation variables and nonmonetary utility of leisure variables except AGE as in the probability equation for the option value model. I exclude the AGE variable from the control variables because the optimal retirement age determined under the age of retirement model does not depend on the worker's actual age. In the age of retirement model with certainty, workers choose their optimal retirement age only once when they start the retirement decision process. They keep that age permanently after it being chosen.

We can estimate the probability of retirement equation (10) by assuming a functional form for the error term e_t. If we assume that e_t is normally distributed, then we can estimate the retirement equation (10) by probit. We can estimate the age of retirement equation (11) using ordinary least squares method. Since the 1983 SCF and 1986 SCF are stratified samples, I will use the weight variable(WEIGHT) previously mentioned. Thus the estimation method of equation (11) will be weighted least squares or generalized least squares.

Since I am interested in the effects of pension benefits on retirement behavior, I restrict our sample to individuals who are working on pension-covered jobs. In this case, the final sample size will be 519 out of the full sample size of 834 individuals. If we only select the individuals who have pension benefits, there may be a selection bias problem since the error term of the pension equation may be correlated with that of the probability of retirement equation (10) or that of the age of retirement equation (11). Even though 315 workers chose the job without pension benefits their potential pension benefits would be greater than zero, had they chosen the pension-covered job. Thus we can not use the full 834 observations with the restriction of zero pension benefits for 315 observations.

To correct the selection bias problem incurred in our sample selection methods, I estimate the pension equation separately. Let y_2^* be the propensity to take a job with pension benefits, then the pension equation will be equation (12).

$$y_2^* = W'\gamma + v_t$$
$$y_2 = \begin{cases} 1 & \text{if} \quad y_2^* > 0 \\ 0 & \text{otherwise} \end{cases} \tag{12}$$

The indicator variable $y_2 = 1$ when the worker ended up a pension-covered job and $y_2 = 0$ when the worker ended up a job without pension benefits.

I assumed that the individual takes a job with pension benefits if the value of the pension-covered job exceeds that of a job without pension benefits. To reflect factors of the individual's demand for pension-covered jobs, I include the individual's age when he first took his current job(AGES), sex(SEX), wage in year 1983(WAGET), and the union status (UNION) in the explanatory variables. Firms have an incentive to provide pensions when monitoring costs are high or hiring and training costs are high. To reflect factors of the firm's supply of pension-covered jobs I include firm characteristics(E1, E2, E3, E4) and worker's education(EDUC). The observed results of the pension equation are the outcome of the firm's supply of pension-covered jobs and worker's demand for pension covered jobs. [11]

The selection bias corrected probability of retiring equation for the option value model will be equation (13):

$$y_1^* = X_1'\alpha + e_t$$

$$y_2^* = W'\gamma + v_t$$

$$\begin{bmatrix} e_t \\ v_t \end{bmatrix} \sim N\left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} 1 & \rho \\ \rho & 1 \end{bmatrix} \right)$$

$$y_1 = \begin{cases} 1 & \text{if } y_1^* > 0 \\ 0 & \text{otherwise} \end{cases}$$

$$y_2 = \begin{cases} 1 & \text{if } y_2^* > 0 \\ 0 & \text{otherwise} \end{cases} \qquad (13)$$

The selection bias corrected age of retirement equation for the age of retirement model will be equation (14):

[11] Luzadis(1986) explained the theoretical background for choosing pension benefits among defined benefits, defined contributions and no pension. Allen, Clark, and McDermed(1993) estimated a latent variable equation that a particular worker will be covered by a pension. They included the marginal tax rate, pension vesting dummy, and racial differences in addition to our explanatory variables.

$$R = X_2{}'\beta + u_t$$

$$y_2{}^* = W'\gamma + v_t$$

$$\begin{bmatrix} u_t \\ v_t \end{bmatrix} \sim N\left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} 1 & \rho \\ \rho & 1 \end{bmatrix} \right)$$

$$y_2 = \begin{cases} 1 & \text{if} \quad y_2{}^* > 0 \\ 0 & \text{otherwise} \end{cases} \tag{14}$$

There are several methods to correct the selection bias problem[12] . I used the two stage estimation method proposed by Heckman(1974) for the age of retirement equation (14). To correct the selection bias problem in the probability of retirement equation(13), I used the bivariate probit with selection bias corrections because independent variables in both equations(13) are latent variables. For identification of equation (13) or (14), we need one of the following two conditions to hold: (a) $\rho = 0$ or (b) at least one variable in X_1 or X_2 is not included in W. The identification condition (b) is satisfied in our models. If $\rho = 0$, then there is no selection bias. For positive ρ , large algebraic values of e_t are more likely and for negative ρ, small values of e_t are more likely.[13]

3.2.1.2 Estimation Results

The latent dependent variable $y_1{}^*$ for the retirement equation (13) is the probability of retirement in a given time t. Since this probability could not be observed directly I used the actual retirement observations during the 1983 SCF and 1986 SCF survey period. y_1 for a worker who retired during this period is 1 and y_1 for a worker who is still working at the end of the survey period is 0. Sixty workers(11.6%) out of 519 actually retired during the survey period.

The latent dependent variable $y_2{}^*$ for pension equation (13) is the probability of

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[12] For an excellent survey, see Maddala(1983). For a specific method of selection bias correction, see Heckman(1974,1976,1979), Olsen(1980), Lee (1982, 1983).

[13] See Butler(1993).

taking a pension-covered job. y_2 equals 1 for workers who took a pension-covered job and y_2 equals 0 for workers who took a job that was not covered by a pension. Five hundred and nineteen workers(62.2%) out of 834 have a pension-covered job in our sample.

The dependent variable R in the age of retirement equation (14) is an observed retirement age. During two survey periods 84 workers retired, 60 workers have pension benefits and 24 workers do not.

To correct possible sample selection bias I estimated the retirement and pension equations jointly by the bivariate probit with selection bias correction method. The bivariate estimation results are reported in the first and second columns of Table 3.

The estimated correlation between the error terms in the retirement equation and the pension equation(ρ) is 0.56029, where ρ is marginally statistically significant at the 13 percent level. Those with taste for having a pension on their job are more likely to retire earlier. Since the dependent variable in the probit estimation is the probability of retiring at age t, the negative value of coefficient means a tendency for later retirement and the positive value of coefficient means a tendency for earlier retirement.

For hypothesis testing about one coefficient or linear combinations of several coefficients, we can use the Wald test with the Chi-Squared table. For a set of linear restrictions $R\beta = q$, the Wald statistic is $W = (R\hat{\beta} - q)' \{R\ Var(\hat{\beta})\ R'\}^{-1} (R\hat{\beta} - q)$. For hypothesis testing about one coefficient, we can use the t-value directly because the Wald statistic for a single coefficient restriction is the square of the t-value of that coefficient. In Chapter 2, we expected and hypothesized negative coefficients on the wage(WAGE) and the stay pension(STAY) variables and positive coefficients on the quit pension(QUIT) and the pension contributions(CONT) variables. Estimation results from the bivariate probit with selection bias correction confirmed all of these sign expectations.

Option value theory expects a negative coefficient on STAY. The estimated coefficient on STAY is -0.01242 and significant at the 5 percent level; thus we can accept Hypothesis 2 at the 5 percent level. Theory expects a positive coefficient on QUIT, and the estimated coefficient on QUIT is 0.01590. It is significant at the 1 percent level; thus we can accept Hypothesis 3 at the 1 percent level.

Table 3. Selection Bias Corrected Actual Retirement Equation

Model / Variable	Bivariat Probit Coefficient	Bivariat Probit t-Ratio	WLS wit Selection Coefficient	WLS wit Selection t-Ratio
	Retirement Equation (519 Observations)			
ONE	-8.55503	-5.227***	68.1615	18.110***
WAGE	-0.00112	-1.156	0.01513	3.121***
STAY	-0.01242	-2.115**	0.08599	4.329***
QUIT	0.01590	3.237***	-0.08208	-4.580***
CONT	0.00348	0.220	-0.29063	-4.408***
AGE	0.08388	3.010***		
SEX	-0.39476	-1.255	0.15793	0.112
MSTAT	-0.95503	-2.311***	-2.18560	-1.378
HEALTH	-0.00300	-0.010	1.11160	0.855
CHILD	-0.15570	-0.465	-1.54557	-1.304
EDUC	0.16382	2.541**	-0.52644	-2.253**
EXP	0.06311	4.282***	-0.05011	-1.044
UNION	0.98487	3.183***	0.04849	0.037
WEALTH	-0.00019	-1.546	0.00011	1.340
SPOUSE	0.83575	2.052**	0.60894	0.422
OCCU1	-0.65345	-1.694*	4.19976	2.982***
OCCU2	-0.49699	-1.029	3.80044	2.661***
OCCU3	-0.97917	-2.469**	3.19088	2.231**
OCCU4	-0.96066	-1.610	3.88463	2.241**
ρ	0.56029		0.82383	
λ			2.62884	
Log - L	-402.27		-147.25	
Z=0	$\chi2(4)$=34.49	(0.00)***	$\chi2(4)$=36.63	(0.00)***
X=0	$\chi2(14)$=56.51	(0.00)***	$\chi2(13)$=22.37	(0.05)**

* Significant at 10 percent
** Significant at 5 percent
*** Significant at 1 percent

WLS with Selection Correction Model:

R - squared	0.804540	Adjusted R - Squared	0.718729
F(18, 41)	9.3757	Chi-squared[18]	97.94

As theoretically expected, the coefficient on WAGE in the bivariate probit model is -0.00112. Unfortunately, even though the sign is correct the WAGE coefficient is not significant, thus we can not reject an alternative hypothesis that the coefficient on WAGE is positive or 0. The theory expects a positive coefficient on CONT as discussed in Hypothesis 4. The estimated coefficient on CONT is 0.00348. Even though it has an expected sign, it is not significant. Thus we can not reject an alternative hypothesis that the coefficient on CONT is not positive.

As derived in Chapter 2, the final estimation equation of the option value model relates the probability of retirement in a given time t to monetary compensation (Z variables: WAGE, CONT, STAY, and QUIT) as well as the unmeasured monetary differences that represent the utility of lifetime leisure(X variables). The joint hypothesis that all coefficients on the Z variables are zero is rejected at the 1 percent level of significance. The calculated Chi-Squared value with 4 degrees of freedom is 34.4883 in the bivariate model. From this joint hypothesis test, we can say that monetary compensation matters in the explanation of retirement behavior.

The joint hypothesis that all the coefficients on X variables are zero is also rejected (56.5089 Chi-Squared value with 13 degrees of freedom) at the 1 percent level of significance. From this joint hypothesis testing, we can say that variables representing the utility of lifetime leisure as well as monetary compensation must be included in the analysis of pension benefits effects on actual retirement behavior. Thus, the pure income maximization model without controlling for variables which represent lifetime leisure might not be appropriate for an analysis of pension benefits effects on actual retirement behavior.

The dependent variable R in the age of retirement equation (14) is an observed retirement age. During two survey periods 84 workers retired, 60 workers have pension benefits and 24 workers do not.

The selection bias corrected results are reported in the third and fourth columns of Table 3. Since the dependent variable in the weighted least squares estimation is the observed retirement age, a positive value of coefficient means a tendency for later retirement and a negative value of coefficient means a tendency for earlier retirement.

The estimated correlation between error terms in the retirement equation and pension equation(ρ) is 0.82386 and the estimated coefficient on the inverse Mill's ratio(λ)

is 2.62844, where λ is marginally statistically significant at the 12.7 percent level.

The coefficients on monetary variables are all significant at the 5 percent level under the age of retirement model. Thus, we can not reject hypotheses 1 to 4. Since we assumed that the error term follows the normal distribution, we can use the t-test for single hypothesis test and we can use the Wald test for a joint hypotheses test in the WLS with selection bias correction.

The joint hypothesis that all coefficients on the Z variables are zero is rejected at the 5 percent level of significance. The calculated Chi-Squared value is 36.6277 with 4 degrees of freedom in the WLS with a selection bias correction model. Thus monetary compensations matter in the explanation of observed retirement behavior. We can reject the joint hypothesis that all coefficients on the X variable are zero at the 5 percent level ($\chi^2(13) = 22.3730$).

3.2.2 Analysis of Planned Retirement

To analyze the effects of pension benefits on retirement plan, I use two different estimation methods. The first is a multinomial logit model and the second is a weighted least squares model with a Heckman selection bias correction term. The multinomial logit model is a direct extension of two period logit model.

3.2.2.1 Multinomial Logit Model

3.2.2.1.1 Econometric Specifications

The general form of the multinomial logit model can be written as

$$\ln\left[\frac{P_{ij}}{P_{i0}}\right] = \beta_j' X_i \quad \text{for } j=1,2,3,\ldots J. \tag{15}$$

where i indexes observations (i=1,2,3,...N) and j indexes alternative choices (j = 0,1,2,...J). P_{ij} is the probability that the planned retirement group j is chosen by individual i, X_i is the ith observation of a kx1 vector of explanatory variables. β_j is a kx1 vector of unknown parameters that can be estimated.

In addition to β_0=0, we can normalize on any other outcome as well and obtain

$$\ln\left[\frac{P_{ij}}{P_{ik}}\right] = (\beta_j - \beta_k)' X_i \quad \text{for } j, k=0,1,2,3,\ldots J. \tag{16}$$

In equation (16), differences between β vectors for different outcomes represent the partial derivative of the logarithm of the odds of one alternative relative to another. We can see in equation (16) that the odds ratios in the multinomial logit model are independent of the other alternatives. The odds ratio for the *j*th and *k*th choice is unaffected by the total number of choices considered, J. This property is called the independence of irrelevant alternatives(IIA), and it is the result of the independent error terms assumptions.

3.2.2.1.2 Estimation Results

I reduced the variation in the planned retirement age according to each individual's pension benefits formula. The dependent variable is grouped into three ranges according to pension ages: before the early retirement age(Group 1), between early retirement and the normal retirement age(Group 2), and over the normal retirement age(Group 0).

Table 4 presents the estimation results for MNL. We find that the stay pension benefits and quit pension benefits are the most important and significant monetary variables for retirement planning. The coefficients on the stay pension and quit pension have their expected signs, and they are significant at the 5 percent level in the early retirement group. Higher stay pension benefits lead to later retirement, but their effects on the planned retirement age are decreasing. Higher quit pension benefits lead to earlier retirement, but their effects on the planned retirement age are decreasing.

The coefficients for the lifetime wage and pension contributions are not significant. This may be due to the fact that in the 1983 SCF period the wage growth rate is underestimated because of the recession in that year. The calculations of lifetime income and pension contributions are based on this underestimated wage growth rate[14] .

For the demographic variables, in general, experienced older men living with a working spouse tend to plan to retire later, and well-educated, married individuals with union membership tend to plan to retire earlier. The coefficient for working spouse is significant at the 1 percent level in both states. A working couple tends to plan to retire later, and this tendency becomes larger as age approaches normal retirement age.

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[14] The annual wage growth rate in 1983 is 6.1 percent for both age groups(age 36 to age 55 and age over 55) in our final data set of 519 observations. Average annual wage growth between 1970 and 1983 is 9.2 %, and that of 1983 to 1986 is 7.2 %

Table 4. Estimations for Retirement Plan

	MNL				WLS /w Selection	
	Group 1		Group 2			
	Coefficient	t-Ratio	Coefficient	t-Ratio	Coefficient	t-Ratio
N	100		80		519	
ONE	-1.06359	-0.685	1.96422	1.184	62.1684	39.084***
WAGE	0.00035	0.539	-0.00082	-0.646	0.00133	1.040
STAY	-0.01936	-2.850**	-0.00334	-0.564	0.05956	6.267***
QUIT	0.01220	2.399**	0.00654	1.370	-0.06538	-7.953***
CONT	-0.00269	-0.287	-0.00418	-0.382	-0.04843	-3.177***
AGE	-0.00950	-0.355	-0.04701	-1.653*	-	-
SEX	-0.48552	-1.533	-0.06927	-0.210	1.40947	2.434***
MSTAT	1.37151	2.783**	0.89425	1.887*	-1.49450	-1.836*
HEALTH	0.58092	2.146**	-0.05667	-0.198	0.02972	0.062
CHILD	0.15892	1.215	-0.70853	-3.206**	-0.07771	-0.314
EDUC	0.17083	2.903**	0.03443	0.573	-0.36080	-3.495***
EXP	-0.07922	-4.356**	-0.06473	-3.502**	0.10266	3.416***
UNION	0.05049	0.189	0.44513	1.490	-0.25342	-0.483
WEALTH	0.00011	0.670	-0.00010	-0.360	0.00034	1.546
SPOUSE	-0.99256	-2.728**	-1.10278	-2.926**	-1.68380	-2.702***
OCCU1	0.16974	0.403	0.06149	0.132	2.36079	2.991***
OCCU2	-0.04988	-0.113	0.55208	1.245	3.31717	4.284***
OCCU3	-0.93333	-2.357**	-0.98991	-2.110**	2.50099	3.540***
OCCU4	-0.13952	-0.286	-0.22095	-0.470	2.43112	3.053***

Log-likelihood = -412.10

* Significant at 10 percent
** Significant at 5 percent
*** Significant at 1 percent

Even though men tend to retire later than women, the coefficient on SEX is not significant in either age group. The coefficient on marital status(MSTAT) is significant in Group 2 at the 1 percent level, and married individuals retire earlier in this stage. The effect of having children on planned retirement is significant in the early retirement and normal retirement groups. Having children leads to later retirement in Group 2 whose age lies between the early retirement and normal retirement and it is significant at the 1 percent level, but it does not have the expected sign in Group 1. The effect of health on retirement planning changes between groups. In general, the job occupation dummies are not significant.

3.2.2.2 Planned Age of Retirement Model

In the previous multinomial logit model, we reduced the planned retirement age variation by grouping them on certain criterion. In the second planned retirement analysis model, I am going to use planned retirement age as the dependent variable directly. Thus, I will use the weighted least squares method since the expected retirement age is a continuous variable.

3.2.2.2.1 Econometric Specifications

I will use equation (14) in the planned age of retirement analysis. This is the same equation used in the analysis of the actual age of retirement model. Bernheim and Levin(1989) and Bernheim(1988, 1989) raised some issues with respect to using expected value operators in both the dependent and independent variables. Their main arguments concern problems of econometric identification.

The econometric identification problem arises when calculation of the expected Z variables(monetary compensation variables; WAGE, CONT, STAY, and QUIT) only depends upon the X variables(nonmonetary utility for lifetime leisure) in equation (14). In our model, the SCF used the actual 1983 wage and worker's age and expected retirement age to calculate WAGE. Both the age and current wage variables are excluded from the X variables. Therefore WAGE is identified. To calculate pension contributions(CONT), the SCF used the current wage, marginal tax rate and employer's contribution. All three variables are excluded from the X variables. To calculate the stay pension benefits, the SCF used the individual's expected first year benefits, Social Security mortality table and the discount rate. None of these three variables are excluded among the X variables, so STAY is identified. To calculate the quit pension benefits, I used the stay pension benefits, service years at time t and service years at time R* which are recommended by Lazear and Moore for the option value model. The service years at R* is not included among the X variables, so QUIT is identified.

Even though all expected variables are identified, we are not sure of the mechanism of expectations. The calculation of expected variables may be susceptible to measurement error. In addition to measurement error, WAGE, STAY, QUIT, and CONT are all stochastic variables. The unbiasedness of ordinary least square(OLS) or weighted least square(WLS) depends on the assumption of $E[(Z'Z)^{-1}Z'e] = (Z'Z)^{-1}Z'E(e)$. With stochastic independent variables or independent variables measured with error this crucial assumption is violated. However, this causes no real problems since we can examine the properties of the estimator conditional on Z. If we assume $E(e|Z) = 0$, then we are assured of conditional unbiasedness of OLS or WLS.

3.2.2.2.2 Estimation Results

The sixth and seventh column of Table 4 presents the estimation results from weighted least squares with Heckman selection bias corrections. Lambda is 1.91554 and it is significant at the 1 percent level.

All the monetary variables have their expected signs and are significant at the 1 percent level except WAGE. The most powerful monetary compensation variable is stay pension benefits. A 10 percent increase in stay pension benefits($16,302) over the lifetime will lead the worker to plan to retire 11.7 months later. The next most powerful monetary variable is quit pension benefits. A 10 percent increase in quit pension benefits($11,131) will induce retirement 8.7 months earlier. A 10 percent increase in pension contributions($5,582) from now to normal retirement age will induce retirement 3.2 months earlier. The least effective monetary variable is wage. A 10 percent lifetime wage increase ($57,064) from t to the normal retirement age will induce negligible 0.9 months delay in retirement.

The employer's most effective tool to induce early retirement can be the quit pension benefits. A $10,000 increase in the quit pension benefits will cause 7.8 months early retirement. The employer's most effective tool to induce later retirement can be the stay pension benefits. A $10,000 increase in the stay pension benefits will cause 7.2 months later retirement.

Table 5 summarizes the six hypotheses test results for the option value model and the age of retirement model. The first hypothesis(H1) is that an exogenous increase in lifetime wage induces later retirement. The second hypothesis(H2) is that an exogenous increase in the stay pension benefits induces later retirement. The third hypothesis(H3) is that an exogenous increase in the quit pension benefits induces earlier retirement. The fourth hypothesis(H4) is that an exogenous increase in the pension contributions induces earlier retirement. The fifth joint hypothesis(H5) is that the monetary compensation matters in the retirement analysis. The sixth joint hypothesis(H6) is that lifetime leisure variable matters in the retirement analysis.

Table 5. Hypothesis Testing Results for Actual and Planned Retirement

	Actual Retirement		Planned Retirement		
	OVM	AOR	OVM(MNL)		AOR(WLS)
	Bivariate	W/S	Group1	Group2	W/S
H1(WAGE)	?	***	?	?	?
H2(STAY)	**	***	***	?	***
H3(QUIT)	***	***	**	?	***
H4(CONT)	?	***	?	?	***
H5(Z)	***	***	***	***	***
H6(X)	***	**	***	***	***

** Significant at 5 percent *** Significant at 1 percent
OVM: Option value model AOR: Age of retirement model
W/S: Weighted least squares with selection bias correction

We derive some implications on the retirement analysis from test results. First, the monetary compensation as well as lifetime leisure variable matter in the retirement analysis. Thus a pure income retirement model is not appropriate in the retirement analysis.

Second, the monetary compensation variables have the signs predicted by option value theory and are significant both in the actual retirement model and in the planned retirement model. Thus, the planned retirement analysis is also a useful method in addition to the actual retirement analysis.

Third, the most. significant and consistent variables are the quit pension benefits and the stay pension benefits. This implies that using the stay pension benefits and quit pension benefits in the retirement analysis is at least as good as using the base wealth and pension slope variable used in the original age of retirement model, because the stay pension benefits and the quit pension benefits variables are not defined ad hoc.

4. CONCLUSION

This paper presented theoretical and empirical models of actual and planned retirement decisions to analyze the effects of pension benefits on retirement behavior. The dynamic stochastic model of the option value theory is used to derive multinomial discrete choice equations for the estimation.

The discrete choice equation derived from the reduced form option value theory directly relates the probability of retirement in a given year to the monetary compensation at age t and planned retirement age controlling the unmeasured utility of lifetime leisure. The monetary compensation includes the lifetime wage, stay pension benefits, quit pension benefits, and pension contributions. It gives the expected effects of the four monetary variables on the probability of retirement at time t. Higher lifetime wage and stay pension benefits lead to later retirement; higher quit pension benefits and pension contributions lead to earlier retirement.

Using the 1983 and 1986 Survey of Consumer Finances data of United States, I estimated the actual retirement equations and the planned retirement equations. I summerize the major findings in this estimation and testing.

(1) The monetary compensations as well as lifetime leisure variables matter in the retirement analysis. Thus a pure income retirement model is not appropriate in the retirement analysis.

(2) As expected by theory of the option value of pension, I find that higher lifetime wage and stay pension benefits lead to later retirement. Higher quit pension benefits and pension contributions lead to earlier retirement.

(3) I find that selection bias correction matters when we use only individuals who are working at pension-covered jobs.

(4) I find consistent results both on actual retirement and planned retirement analysis. This suggests that the planned retirement analysis is also a useful method in addition to the actual retirement analysis. From a practical point of view, the planned

retirement analysis requires less data than the actual retirement analysis. From a theoretical point of view, the planned retirement analysis correctly evaluates the role of health variables on retirement behavior because in the planned retirement analysis the health variable is not affected by the retirement process.

(5) The most significant and consistent variables are the stay pension benefits and the quit pension benefits. The stay and quit pension benefits determined by the option value model and pension contributions are important tools that the employer can use to affect the employee's retirement behavior. The employer or pension provider can use the quit pension benefits (stay pension benefits) and pension contributions (lifetime wage) to induce earlier (later) retirement.

A few concluding remarks for further research are in order. First, I derived and estimated the reduced form equations from the option value theory and the age of retirement theory. Even though the reduced form estimations are useful tools in the analysis of the pension benefits effects on retirement behavior, more general structural form equations are needed for the evaluations of the effects of pension policy changes on retirement behavior.

Second, I find consistent results between actual retirement analysis and planned retirement analysis using the Survey of Consumer Finance data. To find whether these consistent results came from the specific data or not, both planned and actual retirement analyses using other data are needed.

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