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Abstract

This paper investigates the influences on retirement behavior among older workers who were surveyed by the Health and Retirement Study (1992-2004). It is found that increases in all categories of wealth (pension, housing equity and other financial wealth) raise the probability of retiring, while good earnings prospects induce continued employment. Retirement plan types have significant impacts: workers covered by defined benefit (DB) plans are more likely to retire, while the defined contribution (DC) plan coverage significantly delays retirement. Furthermore, the probability and thus timing of retirement for DC plan participants are susceptible to the influence of business cycles through income flow fluctuations that are due to investment performance and interest rate changes. Health insurance (HI), if conditional on employment, strongly defers retirement, while alternative sources of insurance such as employer-sponsored retiree HI, spouse's HI, public HI or COBRA coverage, encourages labor force exit. The scheduled increases in the full retirement age for Social Security act to encourage younger cohorts to work longer.

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The factors affecting workers' retirement behavior have attracted much attention among academia and policy makers. This issue deserves renewed research attention and deeper understanding, given recent developments such as the decline in defined benefit (DB) pension plans and the shift to defined contribution (DC) plans, ongoing and proposed Social Security (SS) reforms, and exploding health care costs for retirees as well as for workers.

This paper investigates the determinants of retirement behavior among older workers that were surveyed by the Health and Retirement Study (1992-2004). Our analysis includes both conventional explanatory variables and new variables to reflect recent environmental changes. We revisit issues deemed important in previous studies and add new insights to the retirement literature. First, our data follows the employment-retirement behavior of older workers for up to a dozen years. Second, our modeling of the ongoing Social Security retirement age changes reveals the significant policy-driven retirement differences across cohorts. Third, we comprehensively model all major sources of health insurance coverage and have identified their varying impacts. Fourth, besides the finding of a significant difference in retirement timing between DB and DC plan participants, our construction of the DC wealth-earnings replacement rate provides a unique way to gauge the susceptibility of DC plan participants to stock market and interest rate fluctuations.

It is found that increases in all categories of wealth accumulation (retirement plan, housing equity and other financial wealth) increase the probability of retiring, but differentially, while good earnings prospects, implying high opportunity cost for retirement, induce continued

employment. It is worth noting that our construction of earnings prospects or opportunity costs forms an alternative but more straightforward way to incorporate the forward-looking incentives for continued employment, which are shown by some studies to be important.

Retirement plan types have significant impacts on retirement: besides the almost universal Social Security, workers who are additionally entitled to DB plan benefits are more likely to retire than those who are not, while the DC plan coverage significantly delays retirement. This phenomenon is presumably in part because many DB plans have work disincentives beyond certain ages while DC plans are largely age neutral, and in part because most DB plans provide a more secure retirement income flow thus lowering overall household exposure to risk.

There is a concern that the retirement behavior of the DC plan covered workers is sensitive to stock market boom and bust. Our analysis incorporates business cycle effects, as part of the total DC plan effect, by including income flow fluctuations that are due to investment performance and market interest rate cycles. These are risks particular to DC plan participants. We find new evidence to support the above hypothesis, that is, the probability and thus timing of retirement for DC plan participants are susceptible to the influence of business cycles. Workers who have significant income loss (gain) in their DC plans are less (more) likely to retire. This may impose some challenges to employers in work force management. When there are market booms, DC plan participants retire just when companies need to add workers and when there are market busts, DC plan participants stay at work just when companies want to cut the workforce.

Regarding the impact of health insurance (HI) on the retirement decision, our study reveals that HI, if conditional on employment, strongly discourages retirement, while alternative sources of health insurance such as employer-sponsored retiree HI, spouse’s HI, or public HI,

facilitate or may encourage labor force exit. This finding highlights the importance for employers, in pursuit of strategies for human resource management, to consider retirement incentives inherent in pension plans jointly with the benefits provided by other programs such as health insurance. It should also be noted that benefits modifications for retirees (such as enhancing/eliminating retiree health care coverage) may significantly alter the retirement incentives for current employees.

Various studies have investigated the importance of Social Security benefits as an explanation for early retirements. In this respect, we have rigorously incorporated the cohort-specific actuarial adjustment factors of S.S. benefits as defined by the law. Our analysis finds that the retirement behavior is significantly linked to such public policies. The ongoing increase in the normal retirement age for Social Security will encourage younger cohorts to work longer.

We carefully incorporate various demographic characteristics in the regressions to control for heterogeneity of retirement, to the extent allowed by the data. We, however, acknowledge that our reduced form model may bear some insufficiency in addressing the probably simultaneous determinations of savings and labor supply, joint retirement decisions of couples, job mobility and availability of pension and health care coverage, and other endogeneities. Structural models have been used by researchers to deal with the endogeneity issue and have advanced the understanding of retirement behavior in some directions. These models, however, are often confined to one particular aspect of behavior or the environment due to their complexity, and furthermore bear the risk of biased parameter specifications. The reduced form models, which are more transparent and comprehensive, serve as useful complements and guides to structural models.

In what follows, this paper in sequence reviews briefly the relevant literature, describes the data, discusses the results from the regression analysis, and gives concluding remarks.

Prior Studies

There is a large literature exploring the potential determinants of retirement among older workers. Many insightful theoretical and empirical research findings have contributed to a deeper understanding of this complex issue. Yet, many debates and questions can be answered by new methods and data. As a recent example, Madrian, Mitchell, and Soldo (2007), using the carefully designed Health and Retirement Study surveys, examine retirement prospects, health status and health insurance, as well as wealth and asset investments for baby boomers. This section highlights briefly the most policy-relevant strands of research and does not intend to make the review complete.

One line of research has investigated the importance of wealth accrual and pension coverage on the timing of retirement. Stock and Wise (1990) argue that workers have an incentive to remain continued employment until certain ages (often the early retirement ages in pension plans) if the expected gain in utility from postponing retirement outweighs the value of immediate retirement. Coile and Gruber (2000) examine the Social Security incentives for retirement and argue that it is in workers' best interest to stay on the job so as to maximize the Social Security wealth accrual – the "peak value". Samwick (1998) also finds that the accrual rate of retirement wealth is a significant determinant of the probability of retirement. He argues that the rapidly growing pension coverage and Social Security entitlements since the 1940s could be the underlying cause of the decline in labor force participation in the early postwar period.

A second direction of research looks at the impact of pension types on retirement behavior. Friedberg and Webb (2005) argue that DB plans tend to have age-related work (dis)incentives that first discourage and later encourage retirement, which contribute to early retirement and lead DB covered workers to retire almost two years earlier on average, compared to workers with DC plans. Munnell, Triest, and Jivan (2004) study how pensions affect expected and actual retirement ages. Regarding the actual retirement decision, they find that pension wealth increases the probability of retiring, while the opportunities of pension accruals lower the probability, and that the DB coverage per se raises probability of actual retirement, while DC coverage reduces the probability. Based on survey data about faculty retirement expectations, Flaherty (2006) finds that individuals in DC-only plan situations expect to retire nearly a year later than those in a DB plan, in the context that earlier voluntary enrollments in DB or DC plans by faculty members to some degree reveal their differential retirement preferences.

DB plans provide a steady stream of guaranteed income, while DC plans place participants in considerable exposure to investment and longevity risks. The decline in DB plans and the shift to DC plans in the past decades have aroused concern that DC plan covered workers are vulnerable to business cycles or stock market booms and busts. The empirical findings thus far are inconclusive, however. Cheng and French (2000) estimate that about 15 percent of individuals aged 55 and over had an unanticipated wealth increase of $50,000 or more in constant 1999 dollars between year-ends of 1994 and 1999. The labor force participation rates among them, however, increased in this market boom period. The authors believe that the run-up in the stock market was not the primary determinant of employment changes in those years. Among other reasons, the authors conjecture that the changes may well be attributable to the improved employment opportunities and wages in the strong economy and the reduction of work

disincentives in the Social Security system. Coile and Levine (2006) focus on aggregate trends in labor supply rather than the wealth effects on individual retirements and find no evidence that stock market changes were the driving force because, first, few households have substantial stock holdings, and second, they must be extremely responsive to market fluctuations to generate the observed aggregate employment reversal in the recession (i.e., an increase in the labor force participation rate for older workers aged 55 to 64 between 2000 and 2002).

By contrast, some other studies do find evidence that stock market fluctuations alter retirement behavior. Coronado and Perozek (2003) study the impact of the stock market boom on retirement decisions, explaining the difference between actual and expected retirement ages among HRS respondents. They find that HRS respondents who held equity prior to the bull market of the 1990s retired, on average, 7 months earlier than other respondents. The estimate by Hermes and Ghilarducci (2006) on Current Population Survey data shows that the stock market crash since January 2000 caused the labor force participation of older workers aged 55-64 to increase by 2.6 percent and 5.4 percent for men and women, respectively. Their separate estimate on HRS data shows that the probability of retirement for men aged 61-64 with DC plans fell by 10.7 percentage points from 1998 to 2002. However, their results are sensitive to the age ranges selected.[1]

Another important strand of research is devoted to the effect of health insurance on retirement decisions. Gustman and Steinmeier (1994), based on the then-modest employer contribution cost to employee HI ($2,500 per year before age 65), find a small effect of employer-provided health insurance on retirement behavior. Rust and Phelan (1997), explicitly modeling individual risk aversion and a distribution of health care expenditures in a dynamic lifecycle framework, find strong impacts of HI and Medicare on retirement, that is, a significant

fraction of “health insurance constrained” individuals “optimally” remain employed to attain HI coverage until they are eligible for Medicare coverage at age 65. Blau and Gilleskie (2001) show that the availability of employer-provided retiree health insurance increases the rate of labor exit. Blau and Gilleskie (2003) similarly show that the access and restrictions to retiree health insurance and Medicare have a modest impact on employment behavior. French and Jones (2004) argue that the value of employer-provided HI not only lies in cost reduction but also uncertainty reduction for employees. Their simulations project that an increase in Medicare eligibility age will significantly delay retirement, if workers have no other source of insurance but that tied to employment. Rust (2005) simulates faculty retirement decisions and shows that an elimination of the retiree health plan (or a substantial reduction of its generosity) as a cost-cutting measure may significantly reduce the incentive for the existing faculty to retire. Mulvey and Nyce (2005) show that, besides DB pension plans, the availability of retiree health insurance boosts the likelihood of early retirement and that linking the employer-paid insurance premium to service tenure would mitigate such early exit.

Data

In this analysis, we use the longitudinal, cross-section data from the Health and Retirement Study waves 1992-2004. The HRS dataset is representative of the national population of older workers and retirees and provides detailed information on demographics, health status and insurance coverage, income and wealth, and employment or retirement status about Americans over the age of 50.[2] The HRS respondents and their spouses are (re)interviewed every two years. We exclude those observations that lack a work-retirement transition. Specifically, the “AHEAD” cohort respondents (born in 1924) and early baby boomers (born in 1948-1953) are

dropped because the former were generally already in the retirement phase when surveyed while the latter were added to HRS survey in 2004 and therefore have only one observation. We focus on the retirement behavior of older workers in the private sector and exclude government workers (determined, for each worker, by the job with longest tenure). The analysis is focused on the retirement decision for those respondents aged between 50 and 75.

The final data set consists of the following cohorts: HRS (born in 1931-1941) with survey data 1992-2004, Children of Depression (born in 1924-1930) with survey data 1998-2004, and War Babies (born in 1942-1947) with survey data 1998-2004. Each respondent therefore has up to seven observations. An implicit assumption here is that retirement is reversible – survey respondents may return to work (although not necessarily with the same firm) after retirement. This is not a stringent assumption given the documented findings of retirement reversal in the literature. Ruhm (1990) and Maestas (2007) each find that about a quarter of retirees moved to "unretirement", while many others reversed from full retirement to partial retirement. More recently, Chan and Stevens (forthcoming) show that about one third of older individuals who are ever partially or fully retired in the HRS data have reversed their retirement status. Clearly, this evidence is more consistent with a "spot" view of the labor market than a "long-term contract" view.

Retirement is the result of a complex decision-making process. Various economic and demographic factors are expected to jointly influence and facilitate the transition from employment to retirement, or a reversal when applicable. We estimate a probit regression model to identify factors that may help explain the probability of retirement at any age. As retirement behavior is person- or household-specific, demographic characteristics naturally play an important role. In the empirical study, we first control for such factors as age, gender,

educational attainment level, marital status, spouse employment status, good or bad health, self-employment, occupation, union membership, longevity expectation, and employment-retirement transition through a bridge job. Particularly interesting are the impacts of the following broader environmental factors: retirement plan coverage, vulnerability of DC plan accounts to the business cycle, wealth adequacy, earnings prospects, Social Security rules, and health insurance coverage.

The Appendix describes the construction of all variables used in the regression analysis. Table 1 below summarizes the basic data statistics of HRS respondents who are eventually entered in the regressions. These demographic and financial statistics indicate that the data sample seems to be fairly representative of the population of older workers. The HRS respondent-level weights are used in the regressions to make the analysis nationally representative. All wealth and income values are in constant 2004 dollars and the unit of measurement is $10,000.

Table 1 here

Empirical Results: Estimating and Explaining the Probability of Retirement. In the probit regression model, the binary dependent variable takes the value of 0 or 1, indicating that the survey respondent is “not retired” or “retired”, respectively, if the HRS labor force participation data indicates so. We group partial and full retirements together in the main regression, but also treat them separately in an ordered probit model; the results are not sensitive to the alternative specification (see *Robustness Tests* below). A respondent is also classified as retired if he/she is older than 65 but the labor force participation status is missing, if disabled or not in labor force but older than 62, or if disabled, younger than 62 and receiving Social Security Disability Insurance benefits. The variable value of 0 otherwise indicates full- or part-time employment

including those unemployed but looking for a full time job.[3] The regressors are those relevant variables listed above. Table 2 below reports the complete regression results for the benchmark and alternative specifications. The probit marginal effects on most of the variables are statistically significant at 1 or 5 percent level and others at 10 percent. The pseudo R^2 is roughly 0.30 in all regressions, which suggests that our econometric specifications fit the data well. The average retirement probability observed in the data is 22 percent and our models predict a probability of about 15 percent using average values of all variables. We first report briefly the results on the demographic control variables and then highlight the key findings in the benchmark Specification 1 that may be more policy relevant.

Table 2 here

Demographics. Various demographic variables, which are from the HRS surveys and included in the regression, are found to have an influence on retirement decisions. The probability of retirement naturally increases when workers get older (about 3.1 percentage points for one year increase in age). Workers who have higher educational attainment, are male, have bad health, or are union members, tend to have higher probabilities of retiring at any age. Self-employed workers and married workers are more likely to work longer. On the other hand, married workers often show some accord in the retirement timing with their spouses – workers have a greater tendency to stop working when their spouses are retired. Life expectancy affects retirement decision – workers who anticipate a good chance of living to advanced ages are more likely to retire later.

A somewhat surprising finding is that workers tend to have a lower retirement probability when their current job is physically challenging, despite the inclusion of health status, wealth and income variables and other characteristics in the regression. Similarly, Munnell, Triest and Jivan

(2004) also find that this dummy variable increases *actual* retirement age, though it has a negative impact on *expected* retirement age. “Self selection” may be a plausible (but untested) explanation. That is, these workers may actually prefer to remain active after years of physical work.

We also control for the situations where workers have taken a bridge job, given the importance of a bridge job in the employment-retirement transition (Ruhm (1990), among others). The dummy variable takes value 1 if the respondent’s tenure on current job is no more than 2 years and is planning to retire in 2 years, or is older than 60 when the planned retirement year is missing. The dummy is also set to 1 if the worker has retired from a bridge job defined here. Not surprisingly, workers who have taken a bridge job have a higher probability of retiring simply because they have been in the transition.

Retirement Plan Coverage. The recent changes in private pension systems, especially the increasing reliance on DC plans for the provision of retiree benefits, have attracted widespread interest regarding whether the shift is shaking up retirement patterns. DB plans generally use a predetermined formula to calculate retirement benefits based on salary and number of service years. Regardless of capital market conditions, in a traditional DB plan, retirees receive a steady flow of income benefits for as long as they are alive. DC plan participants, by contrast, bear the risks of investment fluctuations and longevity. The uncertainty of retirement account accumulations and the risk of outliving funds may cause DC plan participants to become more cautious in their work decisions.

We identify the retirement plan coverage based on the value of wealth in that plan form, which is attributable to all work histories, not necessarily confined to the current job. Specifically, a person is covered by a DB plan if the present value of his/her future or current DB benefits is

greater than zero. Similarly, a positive DC account balance means that there is DC coverage. In the regression, we find that DB pension plan coverage has a significantly positive effect on the retirement hazard. Besides the almost universal Social Security coverage, workers who are additionally entitled to DB plan benefits are more likely to retire than those who are not, with the probability of retiring at any age being 4.1 percentage points higher. The impact of DC plan coverage differs, however, in a negative manner and is also statistically significant. Workers, whose non-S.S. retirement income is mainly DC plan wealth, exhibit a lower probability of labor force exit by 3.6 percentage points.

Wealth Adequacy. The standard life cycle theory postulates that retirement is the wealth decumulation phase in contrast to the wealth creation phase in the working years. Wealth adequacy, among other things, determines whether such a transition is desirable and whether a reasonable standard of living can be maintained in the retirement years, which are ever-increasing in cost with continued rapid inflation of health care and long-term care costs.

Wealth is defined at the household level, as reported in the HRS. This measure is probably valid because retiring household members may consider the whole family economic situation as the relevant background rather than the wealth held separately under each household member's name. Nevertheless, we adjust the household wealth for household size in an alternative specification. The results are not sensitive to these different wealth measures (see *Robustness Tests* at end of this section).

We include four categories of wealth in the regression without *a priori* imposing a common coefficient on any form of wealth. Social Security and DB plan wealth, both measured by present discounted values of future benefit payouts, are pooled together given their similar annuity nature. DC wealth includes both DC plan and IRA account balances. Net housing equity

refers to the value of primary and secondary houses less mortgages and home loans. Non-housing financial wealth includes all other household financial assets net of debt, excluding housing equity, retirement plans, and IRAs. The regression results show that all types of wealth help encourage retirement, which is by no means surprising. Interestingly, they have differential impacts. An improvement in wealth adequacy, for instance, a $100,000 windfall in the above four categories, would imply higher probability of retiring by approximately 0.8, 0.4, 0.1 and 0.3 percentage points, respectively.

Earnings Prospect or Opportunity Cost. Individuals are compensated when they are working and their labor earnings typically form the major source for consumption and savings. The transition to a full (partial) retirement implies the cessation (reduction) of such earnings, which can be viewed as the opportunity cost for retirees. The higher the earnings prospect, the higher is the opportunity cost. Presumably, the probability of retirement is lower when the marginal gain of working an extra year is large. In our construction, the opportunity cost for a switch to a partial retirement is the full-time earnings last year, while the opportunity cost for a complete labor force exit is the previous full- or part-time earnings, depending on whether he/she was working full or part time last year.

The opportunity cost is also adjusted by a growth/depreciation factor estimated on the CPS March surveys 1989-2007 by gender and age. The calculation of growth factors is immune to cohort differences in earnings levels and is aggregated across cohort age-earnings profiles.[4] For instance, the annual earnings reduction for male workers aged 70 averages 1 percent in real terms.

The regression shows that an earnings prospect of $100,000, implying significant opportunity cost for retirement, would reduce the probability of retiring by roughly 3.1

percentage points, other things equal. This shows a tradeoff for retiring workers in that continued employment leads to more earnings and higher pension and wealth accrual while the income effect at the same time increases the desire for leisure (retirement).

Social Security Rules. The U.S. population is aging and fewer workers are projected to contribute to the Social Security system relative to the number of beneficiaries, which is deemed financially unsustainable absent reforms on current payroll contribution rates and benefit payout levels. As one of the measures already being used to improve the financial solvency of Social Security, the full (normal) retirement age (FRA) is being gradually increased from 65 to 67. Various studies have conjectured that this move will induce more employment among older workers.

To capture the impact of Social Security rules on retirement behavior, we include the early retirement benefit reduction factor in percentage terms as a regressor (negative values). This variable is simply the permanent actuarial benefit reduction factor defined by SSA based on birth year if a person claims Social Security earlier than FRA. For instance, it takes the value of -20 percent if a person born in 1937 with FRA 65 starts claming a S.S. retirement benefit at age 62, -13.3 percent at age 63, -6.7 percent at age 64 and 0 percent at age 65, while a person born in 1938 and a person born in 1960 who start claiming S.S. at age 62 would receive less S.S. benefits by 20.83 percent and 30 percent, respectively, because their FRAs are 65 and 2 months and 67, respectively.[5]

The regression result suggests that a reduction of 10 percentage points in S.S. benefit implies a lower probability of retiring by approximately 1.2 percentage points. Perhaps the easiest way to interpret this effect is look at the possible retirement decisions between the 1937 and 1943 birth cohorts, for instance. Their FRAs are 65 and 66, respectively. Their respective

benefit reductions are 20 percent and 25 percent at the earliest retirement age 62. This 5 percentage points difference imposed by the 1 year difference in FRA would imply a lower probability of retiring at age 62 for the 1943 cohort by more than a half percentage point, *ceteris paribus*. The alternative Specification 2 in Table 2 would suggest a much larger effect: approximately 1.7 percentage point difference in retirement probability between the 1937 and 1943 cohorts. That is, younger cohorts will probably exhibit less early retirement.

Implication of Business Cycle for DC plan participants. Compared to DB plans, DC plan values are vulnerable to business cycles. Though DC participants may have the chance to skim substantial investment returns in a booming capital market, their retirement transition may turn out to be quite bumpy when investment performance is poor. In addition to the possible shrinkage of DC wealth, a DC participant is also faced with market fluctuations of interest rates if she/he were to purchase a life annuity in the commercial market, a necessary product for insurance against longevity risk.

To reflect the effects of business cycle and the timing of annuity purchase, we calculate the lifetime payouts that can be generated by the DC wealth at market annuity prices, expressed as a percentage of average earnings over survey years 1992-2004. In the calculation, a joint and survivor life table is used (full benefit to survivor). Interest rates are the going 30-year Treasury bond yields in the survey years. A higher replacement rate implies better preparation for retirement. To isolate the timing effect, the same duration of annuity payout is used (age 65 to 100) regardless of the respondent's age; otherwise this variable would include an age effect.

This DC plan payout-earnings replacement rate is similar in notion to the Social Security and DB pension payouts as percentage of pre-retirement income, which are commonly used to measure financial preparedness for retirement. It is worth noting that actual annuitization is not a

prerequisite for this measure to validly reflect DC plan exposure to business cycles. Rather broadly, any retirees who live off interest income from their DC account (e.g. an interest-only strategy) will be affected by changes in interest rates in the same direction as with annuity factors.[6]

This variable has a statistically significant affect on retirement. Specifically, a drop of 10 percentage points in the replacement rate, due to poor investment performance on DC wealth or due to hike in annuity purchase prices in the market, implies a lower probability of retirement in any year by approximately 1 percentage point.

Health Insurance. For most workers, employer sponsored health insurance is an integral part of the benefits package. Such health insurance coverage may be particularly valuable among the older workers because the probability of falling ill and the risk of suffering catastrophic health care costs generally increase with age. Health care costs and insurance premiums have been on an upward trend in recent decades. Absent employer sponsorship or another source of support, workers upon retirement may face steep increases in health and insurance costs, which is likely to discourage early retirement. On the other hand, if an employer provides retiree health insurance (RHI), its employees need not be tied to continued employment and thus have more flexibility in retirement timing. Alternatively, a worker covered by a health insurance via his/her spouse's employer also has such flexibility.

Another critical channel of health insurance is through the government-run public insurance and welfare programs. For instance, Medicare, a federal health insurance program, covers most people age 65 or older and some people younger than 65 with disabilities. Medicaid covers people with limited income or resources for a living. These public programs help support and may actually encourage retirement beyond a certain age (like 65 for the case of Medicare).

Under certain circumstances such as employment termination and other events, workers have the rights to continue their group health insurance on a temporary basis, paying up to 102 percent of the premium, according to the Consolidated Omnibus Budget Reconciliation Act (COBRA). The premium, determined on a group basis, is generally lower, because it is subsidized by other plan members, for the older workers compared with health insurance on the retail individual market. That is, COBRA provides an alternative way, absent RHI or spousal HI coverage, for retiring workers to bridge their transition into retirement especially in ages 63-65 prior to Medicare eligibility because COBRA generally stipulates a maximum of 18 months continuation coverage, ended with eligibility for Medicare.

In the regression analysis, we include a dummy variable to indicate whether a HRS respondent is covered by health insurance via his/her own employer. This is an employment-based HI coverage. A separate dummy variable reflects whether the respondent has access to HI coverage that is not tied to employment, that is, he/she is eligible to retiree HI coverage by his/her previous or current employer, or he/she is covered by the health plan sponsored by his/her spouse' employer. Another dummy variable is used to indicate whether the respondent is covered by Medicare, Medicaid, VA/CHAMPUS or other government health insurance. It is observed that these types of HI coverage work as substitutes – many workers switch to an HI coverage delinked to employment, in working years as well as upon retirement. As public HI mainly eases life in retirement, the RHI and spouse's HI coverage help bridge the transition from employment to early retirement if a worker is not eligible for Medicare yet. As an alternative, COBRA also facilitates the transition and a dummy variable is included to indicate this option for workers aged 63-65.[7]

The regression result shows that health insurance coverage, if conditional on employment, significantly discourages retirement – the probability of retiring in any year being approximately 16.5 percentage points lower. When HI coverage is available through own employer RHI or spouse's HI, the worker is more likely to retire – the probability is roughly 7.6 percentage points higher. Government-sponsored HI programs have an unsurprisingly positive effect on retirement – a higher probability of retirement by approximately 10.8 percentage points for those under such coverage. The COBRA option boosts retirement by about 1.7 percentage points.

The regression apparently reveals tremendous impact of all major sources of health insurance coverage on retirement. This finding highlights the importance of integrating retirement incentives in pension plans with the benefits provided by health insurance. A plausible further inference from this finding is that, for an employer to strategically manage human resources, enhancing or eliminating health care coverage for its retirees may have significant impact on current employees' retirement incentive.

Robustness Tests. To check the robustness of our regression results, we test various specifications. Specifically, we allow for possible nonlinear effect of age by including age squared and age cubed (Specification 2 in Table 2), and dummy variables for some specific ages, adjust wealth for married couples to account for their joint consumption by dividing their household wealth in all categories by square root of 2 (Specification 3), adjust wealth as in Specification 3 and exclude observations on spouses to restrain the regressions on one person in the same household (Specification 4), run an ordered probit model to treat partial and full retirements separately, run a random effects probit model on the panel data,[8] subtract the self-reported employer and employee contributions from the calculation of DC wealth-earnings replacement rate to further isolate the business cycle impact, and use an additional variable to

reflect retirement age flexibility in DB plans (defined as the difference between earliest and full retirement ages, perhaps an indication of early retirement incentives).[9] These alternative specifications only slightly change the magnitudes of coefficients and maintain the same signs.[10]

Conclusions

This paper identifies empirically the critical determinants of retirement behavior of older workers, after carefully controlling for demographic factors. It shows that the likelihood of retirement increases with wealth adequacy and decreases with improved employment opportunities and earnings prospects. More importantly, the findings in this study may suggest that the labor force participation pattern is now undergoing significant transition. Workers under defined contribution plans tend to retire later and their timing of retirement is sensitive to business cycles. Changes in the Social Security rules such as a hike of normal retirement age will push for a longer work career for the younger cohorts. Exploding health care costs make employer-sponsored health insurance increasingly valuable, which, in the context of the elimination of retiree health insurance by some employers,[11] may turn out to strongly induce continued employment until eligibility for Medicare.

Employers, when crafting benefit packages to strategically manage human resources, and policy makers, when designing public policies to improve worker well-being, need to take into account all benefits programs in an integrated manner. To retain older but still productive workers and promote an orderly retirement process, employers may want to carefully tailor their retirement schemes to meet both corporate and employees' needs in a dynamic and competitive labor market.

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Appendix: Data and Variable Description

The data source is the Health and Retirement Study waves 1992-2004 (Rand version G). The table below describes the construction of all variables used in the regressions. All dollar values are in constant 2004 terms and the unit is $10,000.

Variable Name	Definition
Binary Dependent Variable	
Retirement	This variable equals to 1 if a respondent is partially or fully retired when the labor force participation data indicates so. He/she is also treated as retired if he/she is older than 65 but the labor force status is missing, if disabled or not in labor force but older than 62, or if disabled, younger than 62 and receiving Social Security Disability Insurance benefit. The observation is dropped if the respondent is not in labor force and younger than 62. The variable is equal to 0 otherwise, including those unemployed but looking for a full time job.
Retirement Plan Coverage	*(omitted reference: Social Security coverage only)*
DB only	Dummy variable equal to 1 if the respondent is covered by DB plan only (based on DB & DC wealth), 0 otherwise
DC only	Dummy variable equal to 1 if the respondent is covered by DC plan only (based on DB & DC wealth), 0 otherwise
Both DB and DC	Dummy variable equal to 1 if the respondent is covered by both DB and DC plans (based on DB & DC wealth), 0 otherwise
Wealth ($10,000)	
SS&DB Wealth	Household wealth in Social Security and DB pension plan (present discounted value)
DC Wealth	Household wealth in DC plan and IRAs
Net Housing Equity	Value of primary and secondary houses less mortgages and home loans.
Non-Housing Financial Wealth	Total household assets – all debt – housing equity, excluding IRA
Impact of Business Cycle	
DC Replacement Rate	This variable is the annuity payouts that can be generated by the DC wealth at market annuity prices, expressed as a percentage of average earnings over survey years 1992-2004. It reflects the effects of business cycle and the timing of annuity purchase. A higher replacement rate implies better preparation for retirement. In the annuity calculation, a joint and survivor life table is used (full benefit to survivor). Interest rates are the going 30-year Treasury bond rates in the survey years. To isolate the timing effect, the same duration of annuity payout is used (65-100) regardless of the respondent's age; otherwise this variable would include the age effect.
Social Security Impact	*(partially cohort effect)*
Early Retirement Benefit Reduction (%, non-positive value)	This is the permanent actuarial benefit reduction factor in percentage if the respondent claims Social Security earlier than full retirement age (FRA) defined by SSA based on birth year. For instance, it takes value -20% if a person born in 1937 starts claming S.S. benefit at age 62, -13.3% at age 63, -6.7% at age 64 and 0% at age 65, while a person born in 1938 and a person born in 1960 who start claiming S.S. at age 62 would receive less S.S. benefits by 20.83% and 30%, respectively, because their FRAs are 65 and 2 months and 67, respectively. This variable is set to -50% for respondents younger than 62 because they are not eligible for S.S. (0% inappropriate). The regression results are not sensitive to alternative values such as -40%, -100% or others.
Earnings Prospect ($10,000)	

Variable Name	Definition
Earnings or Opportunity Cost	This variable reflects the earnings if the respondent chooses to work or opportunity cost if she chooses to retire. For a full-time worker, this variable equals earnings (wage/salary income + bonuses/overtime pay/commissions/tips + 2nd job or military reserve earnings, professional practice or trade income). The opportunity cost for a switch to a partial retirement is the full-time earnings last year, while the opportunity cost for a full retirement is the previous full- or part-time earnings, whichever applicable. In the construction of opportunity costs, previous earnings are adjusted by a growth/depreciation factor, which is calculated on CPS March surveys 1989-2007 by gender and age.
Health Insurance Coverage	
HI conditional on R's employment	Dummy variable equal to 1 if the respondent is covered by health insurance via his/her own employer, 0 otherwise.
HI unconditional on R's employment	Dummy variable equal to 1 if the respondent is covered by retiree health insurance via his/her own employer, or by his/her spouse's HI or retiree HI, 0 otherwise.
HI via public program	Dummy variable equal to 1 if the respondent is covered by Medicare, Medicaid, VA/CHAMPUS or other government health insurance, 0 otherwise.
COBRA	Dummy variable equal to 1 if the respondent is aged 63-65 and currently have (or had in last survey year) employer provided health insurance, 0 otherwise.
Demographics	
Age	Actual age
Male	Dummy variable equal to 1 if the respondent is male, 0 otherwise.
Bad Health	Dummy variable equal to 1 if self-reported health status is fair or poor, 0 otherwise (good, very good, and excellent).
Self Employed	Dummy variable equal to 1 if the respondent is self employed, 0 otherwise.
Current Job Physically Challenging	Dummy variable equal to 1 if current job requires lots of physical effort, lifting heavy loads, or stooping/kneeling /crouching), 0 otherwise. The value for retirees is determined by their previous job.
Bridge Job	Dummy variable equal to 1 if the respondent's tenure on current job is no more than 2 years and is planning to retire in 2 years, or is older than 60 when the planned retirement year is missing, 0 otherwise. The dummy is set to 1 if a worker has retired from a bridge job defined here.
Union Member	Dummy variable equal to 1 if the respondent is covered by labor union, 0 otherwise. The value for retirees is determined by their previous job.
Married	Dummy variable equal to 1 if the respondent is married, 0 otherwise.
Spouse Retired	Dummy variable equal to 1 if the respondent's spouse is retired, 0 otherwise.
High School Diploma or GED	Dummy variable equal to 1 if the respondent has high school or GED degree, 0 otherwise.
Some College Education	Dummy variable equal to 1 if the respondent has some college education (degree less than a BA), 0 otherwise.
College Degree and above	Dummy variable equal to 1 if the respondent has a BA degree or greater, 0 otherwise. *The omitted category is education less than high school.*
Longevity Expectation	Self-reported subjective probability (0 – 100%) of living to age 75+.

Source: Authors' constructions based on Health and Retirement Study 1992-2004 survey data.

Table 1 Summary Data Statistics

Variable	Median	Mean	Std. Dev.	Min	Max
Retired	0	0.23	0.42	0	1
Age	59	58.42	4.19	50	74
Male	0	0.46	0.50	0	1
Married	1	0.75	0.43	0	1
Spouse retired	0	0.22	0.41	0	1
Bad health	0	0.13	0.34	0	1
Probability of living to age 75+ (%)	75	67.77	26.84	0	100
Self-Employed	0	0.13	0.34	0	1
Current job physically challenging	0	0.23	0.42	0	1
Bridge job	0	0.04	0.20	0	1
Union member	0	0.22	0.41	0	1
High school degree or GED	0	0.38	0.49	0	1
Some college education	0	0.23	0.42	0	1
College degree and above	0	0.24	0.43	0	1
DB coverage only	0	0.17	0.37	0	1
DC coverage only	0	0.30	0.46	0	1
Both DB and DC coverage	0	0.35	0.48	0	1
Health insurance, conditional on employment	1	0.62	0.49	0	1
Health insurance, unconditional on employment	1	0.58	0.49	0	1
Health insurance, public	0	0.10	0.29	0	1
COBRA	0	0.08	0.27	0	1
S.S. early retirement benefits reduction (- %)	-50	-39.30	17.94	-50	0
Social Security Wealth (PDV)	15.70	16.71	7.32	0	66.5
Defined Benefit pension wealth (PDV)	14.06	23.82	34.12	0	1485.5
S.S. + DB Wealth (PDV)	21.29	28.62	28.86	0	1521.1
Defined Contribution plan wealth	1.49	7.98	22.79	0	2163.9
Net housing equity	8.22	12.13	29.91	-638.4	2280.7
Non-housing financial wealth	1.88	9.98	42.47	-91.9	3675.5
Total household wealth	41.88	58.72	77.33	-617.8	4791.7
Earnings prospect or Opportunity cost	3.01	4.01	5.59	0	404.6
Total household income	6.03	8.14	10.66	0	593.0
DC wealth-earnings replacement rate (%)	2.91	15.96	43.54	0	400.0

Note: Wealth and income variables are in constant 2004 terms and the unit is $10,000.
Source: Authors' calculations based on Health and Retirement Study 1992-2004 survey data.

Table 2 Probit Regression Results – Marginal Effects on Retirement Decision

Binary Dependent Variable: 1 = retired, 0 = not retired

	Specification 1		Specification 2		Specification 3		Specification 4	
Independent Variable	dF/dx	z	dF/dx	Z	dF/dx	z	dF/dx	z
DB Coverage Only	0.04052	4.12***	0.04113	4.22***	0.03769	3.83***	0.04127	3.53***
Both DB & DC Coverage	-0.02477	-2.73***	-0.02328	-2.60***	-0.02705	-2.98***	-0.02322	-2.14**
DC Coverage Only	-0.03603	-4.60***	-0.03389	-4.37***	-0.03645	-4.65***	-0.04162	-4.22***
S.S.+DB Wealth (PDV)	0.00079	4.46***	0.00078	4.44***	0.00112	4.85***	0.00097	4.42***
DC Wealth	0.00037	1.88*	0.00038	1.98**	0.00041	1.55	0.00065	2.09**
Net Housing Equity	0.00014	1.95**	0.00013	1.90*	0.00023	2.36**	0.00031	2.29**
Non-Housing Financial Wealth	0.00025	2.95***	0.00024	2.97***	0.00024	2.35**	0.00015	1.34
Earnings Prospect or Opportunity Cost	-0.00305	-2.53**	-0.00302	-2.55**	-0.00313	-2.46**	-0.00269	-1.99**
DC Wealth-Earnings Replacement Rate (%)	0.00083	10.54***	0.00081	10.46***	0.00085	10.66***	0.00088	7.91***
S.S. Early Retirement Benefit Reduction (-%)	0.00115	4.95***	0.00348	9.39***	0.00116	4.98***	0.00128	4.49***
Health Insurance, conditional on Employment	-0.16487	-24.82***	-0.16119	-24.59***	-0.16458	-24.76***	-0.17522	-19.85***
Health Insurance, unconditional on Employment	0.07610	14.12***	0.07377	13.87***	0.07522	13.94***	0.08137	12.09***
Health Insurance, Public	0.10844	12.25***	0.14512	13.98***	0.10874	12.27***	0.11492	10.54***
COBRA	0.01651	1.90*	0.09817	1.17	0.01628	1.87**	0.00003	0.00
Age	0.03016	24.76***	-0.70202	-1.49	0.03019	24.78***	0.02815	19.14***
Age Squared	--	--	0.01479	1.85*	--	--	--	--
Age Cubed	--	--	-0.00009	-2.16**	--	--	--	--
High School Degree or GED	0.02394	3.21***	0.02410	3.28***	0.02342	3.14***	0.02095	2.27**
Some College	0.02359	2.76***	0.02359	2.80***	0.02313	2.71***	0.02033	1.96**
College and Above	0.03064	3.32***	0.03061	3.36***	0.03061	3.31***	0.02530	2.27**
Male	0.04337	7.25***	0.04184	7.09***	0.04372	7.30***	0.04596	6.37***
Bad Health	0.09800	12.40***	0.09434	12.07***	0.09832	12.44***	0.09981	10.69***
Self-Employed	-0.05567	-6.75***	-0.05478	-6.76***	-0.05615	-6.82***	-0.05271	-5.13***
Current Job Physically Challenging	-0.01881	-3.23***	-0.01904	-3.32***	-0.01895	-3.26***	-0.03023	-4.29***
Bridge Job	0.05726	4.89***	0.05427	4.78***	0.05680	4.86***	0.05785	4.13***
Union Member	0.01863	2.75***	0.01858	2.78***	0.01803	2.66***	0.02000	2.42**
Married	-0.06473	-9.28***	-0.06303	-9.15***	-0.05217	-7.31***	-0.05445	-6.65***
Spouse Retired	0.16756	23.37***	0.16458	22.23***	0.16796	23.40***	0.16374	16.60***
Probability of Living to age 75+	-0.00027	-2.84***	-0.00026	-2.81***	-0.00026	-2.79***	-0.00041	-3.62***

	Specification 1	Specification 2	Specification 3	Specification 4
No. of Obs.	31604	31604	31604	21074
obs. P	0.217	0.217	0.217	0.210
pred. P (at x-bar)	0.149	0.145	0.149	0.144
Wald Chi2	5308.7	5322.0	5317.9	3367.5
Prob > chi2	0.00	0.00	0.00	0.00
Log pseudo likelihood	-11650.5	-11613.2	-11645.0	-7720.4
Pseudo R2	0.2959	0.2981	0.2962	0.2879

Note:

a. Wealth and income variables are in constant 2004 terms and the unit is $10,000.
b. Specification 2 allows for non-linear effect of age; Specification 3 adjusts wealth by dividing household wealth by square root of 2 for married couples; and Specification 4 drops observations on spouses and adjusts household wealth for married couples as in Specification 3.
c. The HRS respondent-level weights are used in the probit regressions.
d. *, **, and *** denote significance at the 0.10, 0.05, and 0.01 level, respectively.

Source: Authors' regression results based on Health and Retirement Study 1992-2004 survey data.

Endnotes

[1] The magnitude and sign of the interaction term between DC coverage and year 2002 in their nonlinear probit model is conditional on the independent variables. See Ai and Norton (2003) for a discussion.

[2] Source: http://hrsonline.isr.umich.edu. The data and documentation are the Rand version G.

[3] The separation of partial employment from partial retirement is directly based on the HRS definition: "If he/she is working part-time and mentions retirement," the labor force status of the survey respondent "is set to partly retired" and "if there is no mention of retirement," the status "is set to working part-time". Source: RAND HRS Data Documentation, Version G, March 2007, p.1035.

[4] The earnings growth/depreciation factors are calculated in several steps: 1) calculate average full-time earnings of workers by age and gender for each cohort (e.g. age-25 workers in CPS1989, age-26 workers in CPS1990, … and age-44 workers in CPS2007 are considered as one birth cohort); 2) calculate earnings growth rate at each age for each cohort; 3) average growth rates across birth cohorts; 4) use a polynomial of age to fit the observed growth rates; and 5) these fitted and smoother growth rates are the factors used for the adjustment on opportunity cost.

[5] This variable is somewhat arbitrarily set to -50 percent for workers younger than 62 and thus ineligible for Social Security. Zero percent is clearly not applicable. Regression results are not sensitive to alternative values such as -100 percent (a stringent value to

represent ineligibility) or -40 percent (a value just next to -30 percent that is applicable to the 1960 and younger cohorts).

[6] Technically, this DC plan wealth-earnings replacement rate can be viewed as an interaction term between two regressors (DC wealth and labor earnings), but in a quotient form, and adjusted by an annuity factor.

[7] The HRS data do not provide information about COBRA take-up among workers nor about whether their employers had 20 or more employees as required by COBRA. In a parsimonious way, we assume all workers aged 63-65 are eligible for COBRA if they currently have or in previous survey year had employer-provided health insurance.

[8] A fixed-effects probit model is inappropriate because it fails to distinguish the effects of those time-invariant variables. A random-effects probit model, however, may yield inconsistent estimates because the assumption that the regressors are independent of error terms does not necessarily hold.

[9] The testing power of the last two experiments may be weakened by the limited data availability. This analysis uses the self-reported DC plan contributions in the public HRS data. It is also difficult to directly identify whether DB benefit payouts are actuarially favorable for early retirees.

[10] All results are available from authors upon request.

[11] Mulvey and Nyce (2005, p.119), for instance, document that the share of medium and large employers that sponsored some retiree health insurance declined from over 80 percent before 1980 to only 40 percent by 2003.