Chapter 49

NEW DEVELOPMENTS IN THE ECONOMIC ANALYSIS OF RETIREMENT

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Abstract

The world's population is living longer but retiring earlier, and vast numbers of adults now spend as much as a third of their lifetimes relying on public and private retirement benefits. Consequently, labor economists are deeply interested in the forces driving retirement behavior, seeking to understand why people leave their jobs at young ages, how employers respond to an aging workforce, how government programs often induce job-leaving, and the economic consequences of retirement for individuals and society. This chapter examines new developments in retirement economics, focusing first on retirement trends and retiree wellbeing. We next turn to theoretical developments in the retirement literature where new models have enriched our understanding of the role of worker heterogeneity and uncertainty about health and productivity shocks. Lastly, we review some of the lessons that may drawn from the empirical analysis of retirement patterns undertaken over the last decade, showing how natural experiments and exciting new longitudinal datasets afford new opportunities to learn about the demand for and supply of older workers. We conclude that future researchers would do well to explore how retirement decisions are made in a household context, and to integrate saving as well as consumption in the labor supply decision. In addition we argue that much remains to be learned about how workers form expectations regarding their future retirement wellbeing, and about how they adapt when expectations need to be adjusted due to changes in economic, health, family, and other circumstances.

JEL codes: J26; J21; J2

1. Introduction

Retirement is a rich society's reward. One need only recall the poor diet, bad hygiene, and widespread disease of the last century, combined with a lifetime of hard toil, to explain why few of our predecessors lived to a ripe old age. Indeed, in some developing countries today, such insalubrious conditions are still in place, dramatically reducing the chances of most of the population surviving to old age. But in the developed world, life expectancies have doubled over this last century, and old-age support systems have increased in coverage and generosity. The combination of longer lives and improved wealth has afforded ever-increasing numbers of people the expectation of retirement from paid work sometime in late middle age. Indeed, adults in many countries are now spending between a third to a half of their adult lives in retirement.

In this chapter we posit that retirement is an interesting economic phenomenon for several reasons. First, old age is often seen as synonymous with poverty and poor health. Whether or not this is true can be ascertained only by studying the retirement process, to see what work life and other factors might help predict, and prevent, poverty in old age. Second, adjustments in the number of years worked by deciding when to retire is an important labor supply decision, and as such warrants interest from those seeking to model this aspect of worker behavior. A third reason retirement is of interest is that it can also be seen as the result of employer policy regarding older worker pay and productivity, or in other words a labor demand decision. For this reason there has been much interest in how and why companies encourage retirement via a wide range of financial as

well as non-financial inducements. Finally, global aging patterns combined with early retirement trends threaten the financial stability of national pay-as-you-go social security systems in both developed and developing countries (World Bank, 1994). A better understanding of the economic and other determinants of retirement will be of help in meeting these policy challenges.

Over the last decade economists have made great strides in understanding the economics of retirement. In addition we believe that there are some very promising next steps that should be taken in the research field, exploiting for the first time rich new panel datasets on people approaching and crossing the threshold of retirement. We introduce these issues in the chapter by first exploring what is meant by retirement and outlining briefly what retirement trends indicate. Next we highlight some of the more interesting modeling issues that have emerged over the last decade in the labor economics literature on older workers, focusing on better ways of capturing heterogeneity and on dynamic formulations of worker uncertainty about health and productivity shocks. We then turn to a review of the key empirical advances made in the retirement literature, examining how pensions and social security affect retirement patterns and how in turn employer policies influence older workers' possibility sets. Several other influences on retirement are also investigated including family considerations and selection problems arising when researchers lack good panel data on observed behavior. We conclude with a discussion of what remains to be learned about retirement behavior, and we offer suggestions on interesting and potentially answerable questions with the newly available panel datasets on older workers.

2. Understanding retirement

There is little ambiguity about what is meant by labor force attachment up through middle age, inasmuch as work is generally understood to involve employment for pay as a wage or salary worker, or as a self employed person. By contrast the concept of retirement is far more complex, in that it encompasses the rich and sometimes nonlinear process by which older workers withdraw from market work. Particularly in developed countries, modern retirement has come to be equated with a wide range of behaviors among the older population including: the act of accepting a pension or social security benefits; voluntary or forced job-leaving; reductions in hours of work and/or pay; job change; and/or complete labor force withdrawal. In this section we examine some of the ways in which modern labor markets afford older workers paths out of employment, and what these paths imply, or are believed to imply, for wellbeing in old age.

2.1. What do we mean by retirement?

One way to summarize retirement patterns is to examine labor force participation rates (LFPR) in the older population. A summary of international patterns reveals that in most developed countries, the labor force attachment of older men has been declining for

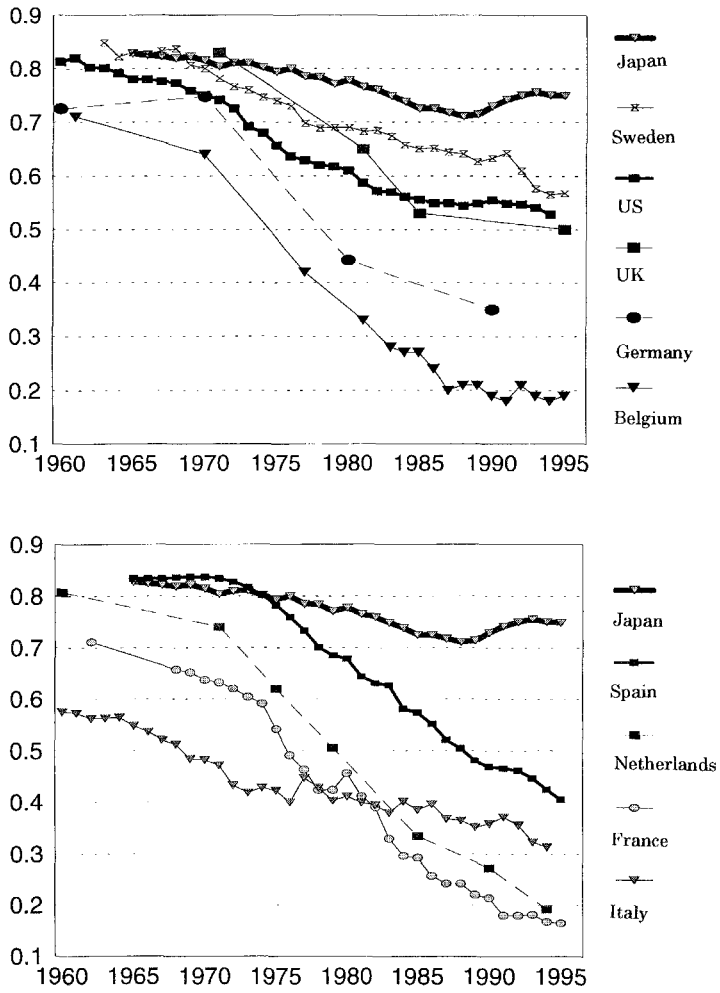

Fig. 1. (a) Labor force participation trends for men age 60–64, selected countries; (b) labor force participation trends for men age 60–64, additional countries. Source: Gruber and Wise (1999).

decades. Historic US data gathered by Ransom and Sutch (1986) indicates that in 1900 around 60% of all men aged 65 and over were working, but by 1950 the figure had declined to around 50%, falling to below 40% in 1960. For most European nations and the US, older men's attachment to the labor force continued to fall over the last few decades (Fig. 1). Today, it is rare to see men employed for pay once they attain age 65, with fewer than 15% of the male eligible population employed or seeking work in developed countries. Patterns for women are somewhat more complex, with rates rising slightly

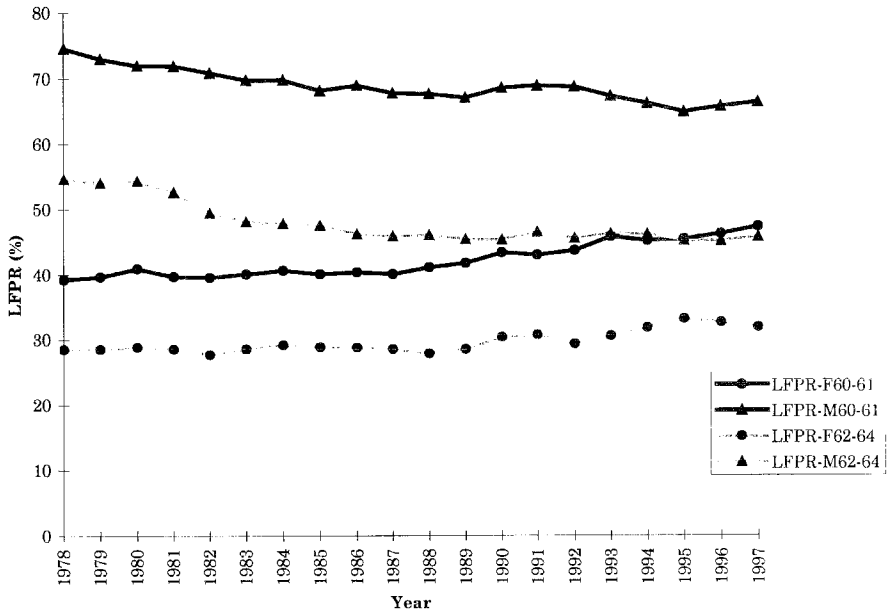

Fig. 2. US labor force attachment by narrow age and sex groups. Source: Data generously provided by the US Bureau of Labor Statistics (www.bls.gov).

in some countries and falling in others; this appears to be the result of a general upward trend in women's market work competing with the desire for and ability to consume leisure at the end of the work life. But very few women work for pay beyond age 65, with the average for the European and US nations standing at 5% or lower.

Some would argue that focusing on labor market attachment of those age 65 and older misses the point, since much labor force withdrawal takes place well before that age. This conclusion clearly applies to the US data. Fig. 2, for instance, reveals that older men's LFPR's fell between 1978 and 1997, with some leveling off in the last decade. Older women's LFPRs have risen slightly more, but there has been relatively little change in the last 20 years. In other words, there is a tremendous amount of labor market movement, much of it from work to not in the labor force, for workers in their 50s and early 60s. In this sense, much of the interesting behavior to explain occurs during this late middle age period (at least in developed countries), rather than in the mid-to-late 60s.

This perspective of retirement is strengthened by evidence on the ages at which workers accept their old-age retirement benefits, either in the form of an employer-provided pension or a government-awarded social security payment. For example, Rust (1989) found two marked peaks in retirement ages when he traced out how older Americans filed for social security benefits using Retirement History Survey (RHS) data from the 1970s. Older workers retired either at age 65 when they were eligible for unreduced social

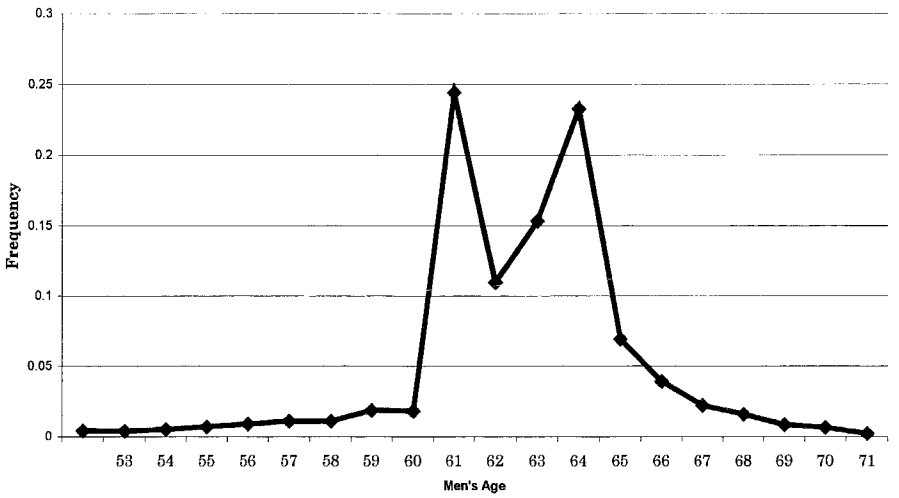

Fig. 3. Retirement age distributions for HRS men, 1992. Source: Data kindly provided by John Rust.

security payments, or as early as they were permitted to file at age 62, when their benefits were reduced in recognition of the early leaving date. This pattern is reinforced with new evidence derived from the Health and Retirement Study (HRS), a longitudinal survey of respondents from 1992 into the future.[1] This offers new evidence that the peak retirement age for US men has unequivocally dropped to age 62, and relatively few people are still employed at age 65 (see Fig. 3). Datasets on pension acceptance patterns taken from corporate payroll records also suggest that workers tend to leave the firm at markedly higher rates at particular and common ages, especially around the firm's early retirement age and the age at which the unreduced pension can be received (Fields and Mitchell, 1984; Lumsdaine et al., 1992).

Of course there are many different ways that older workers could behave at the end of the work life; other paths to retirement include gradually reducing hours or switching to less demanding jobs, moving to self employment, or even moving in-and-out of the labor force as health and opportunity permits. And it must also be recognized that to some, retirement may be a "state of mind" rather than an objectively defined labor force concept. This latter point applies most clearly to the pensioner who puts a few hours of work in at a part-time job, or the self-styled older "consultant" who devotes little actual time to finding remunerative activity.

Table 1 describes information taken from the 1992 Health and Retirement Study, and suggests some of the ways in which this complex set of possibilities can be characterized. For example, among the age 51–61 population, one-fifth of the men and two-fifths of the

[1] A complete description of the HRS data is available on Internet at http://www.umich.edu/ ~ hrswww/. See also Juster and Suzman (1995).

Table 1
Alternative definitions of retirement[a]

Retirement definition	Men (%)	Women (%)
All respondents		
No current job	21	40
White	19	39
Black	33	40
Hispanic	22	52
Self-reported retired	15	28
White	14	28
Black	26	29
Hispanic	14	35
Employed persons		
Working very little		
<25 h/week	4	9
<1000 h/year	4	7
Left "career" job		
10+ years job > age 45	15	8
20+ years job > age 45	8	2
Chance out of 10 of		
Working at age 62	5	4
Working at age 65	3	2

[a] Source: Derived from Gustman et al. (1995). Sample is all age eligible HRS respondents (age 51–61 in 1992) in HRS-W1 alpha release; data weighted by HRS person weights.

women had no current (paying) job, with non-employment rates higher among non-whites. A different definition finds that 15% of these men, and 28% of the women respondents, report their current labor market status as "retired". Among the employed subset of respondents, 15% of the men (8% of the women) had already left a decade-long job after the age of 45, and 8% (2%) had left a 20-year job after the age of 45. Relatively few (less than 10%) of the respondents were working on "reduced" hours jobs, fewer than 25 h per week or 1000 h per year, suggesting that this is a relatively rare path into retirement for the typical worker in his/her 50s. Looking at it from the other direction, few of those working expected to still be employed at 62, and an even smaller fraction at 65. That is, working men had only a 50:50 chance of working at age 62 and women expected a 40% probability; by the age of 65 the chances were, respectively, 30 and 20%. From these data, then, we conclude that the conventional pattern of work followed by non-work is still characteristic of most peoples' paths out of the labor market at older ages. However, it also appears that the departure age may be younger than in previous years, consistent with the aggregate LFPR data showing declines in the late 50s and early 60s age brackets. An investigation of the more complex paths into retirement will soon be possible using the promising new panel surveys currently under development.

Table 2
Self-assessed and actuarial probabilities of survival among older persons[a]

	Expected probability of survival (%)			
	Men		Women	
	To age 75	To age 85	To age 75	To age 85
HRS self-reported				
Survival rate	62	39	66	46
Actuarial life tables				
1990 survival rate	60	26	75	45
2000 survival rate	62	28	78	51

[a] Source: Derived from Hurd and McGarry (1995). Sample is all age eligible HRS respondents (age 51–61 in 1992) in HRS-W1 weighted by HRS person weights.

2.2. Evidence on retiree well-being

Above we pointed out that some analysts focus on retirement because old age may be seen as synonymous with poverty and poor health. In this section we offer a brief review of evidence on the wellbeing of the retiree population, in order to put this claim in context.

According to the simple lifecycle saving model, rational far-sighted economic men and women consume less than their income when young, saving to cover their retirement needs. In the certainty framework, then, poverty in old-age would be concentrated among those with low lifetime earnings, since saving out of low pay generates low retirement income. In a more complex model incorporating uncertainty about the length of life, however, people might end up poor in old age because they outlived their saving (Hurd, 1990). The private life annuity market confronts such uncertainty by permitting the older person to exchange a lump sum of money at, say, age 65, in exchange for a guaranteed monthly payment until death, irrespective of actual longevity. The price of this annuity, then, reflects the insurers' best estimate of future mortality patterns and the extent of risk-pooling in the covered population.

Since some older people do end up in poverty it must be asked whether they are making bad bets – about such things as their likely future mortality – or whether well-informed economically rational people simply cannot buy "fair" annuity products in the insurance market. Evidence on the first point is offered by Hurd and McGarry (1995) who use HRS data to compare older persons' self-assessed probabilities of living to 75 and 85 with alternative actuarial survival tables. They conclude that men are rather accurate in their assessment of the chances of living to age 75, and overoptimistic about the probability of living to age 85 (see Table 2). Taken literally, men are therefore likely to oversave for their retirement period, rather than the opposite. By contrast, HRS women underestimated by more than 10% their chances of living to age 75 but assessed the chance of living to age 85

Table 3
Median household net wealth ($) on the verge of retirement, by household type ($1992)[a]

Source of wealth	Married	Single	
		Men	Women
Total	610749	359122	212641
Pension	141278	111570	38318
Social security	162610	75164	69703
Net housing	94818	42592	45332
Business assets	101603	55614	18374
Financial assets	50324	35025	19638
Retirement assets	24592	10736	8057
Retiree health insurance value	9574	4353	2889
Other wealth	25950	24068	48648

[a] Source: Derived from Gustman et al. (1997). Data on employed age eligible HRS respondents in 1992 from HRS-W1 alpha release weighted by HRS person weights. Pension value derived using the projected benefit method and employer-provided plan descriptions for defined benefit plans, and contributions for defined contribution plans. Social security values derived from self reported earnings histories and authors' imputations. Median refers to those with total wealth in the 45th to 55th percentiles.

quite accurately. Therefore, women would be expected to undersave during their work years relative to the younger old-age years, but consume accurately during their latter old-age period. Evidence on the annuities market assembled by Mitchell et al. (1999) indicates that reasonably priced annuity products exist that greatly improve risk-averse people's well-being. As a consequence, older people seeking to protect against outliving their wealth can do so relatively inexpensively, and need pay far less for this insurance than in decades past.[2]

Against this backdrop, it is then instructive to ask what older people have to retire on, and whether it appears adequate to protect them against poverty at an advanced age. HRS respondents on the verge of retirement in 1992 had a median value of total wealth of just under $500,000, with half due to pensions and social security. That is, the average (median) fraction of total wealth due to pensions was 23% (18%), and 27% (43%) to social security. While these accumulated amounts would seem to be adequate to fund a reasonable retirement plan, three facts must be kept in mind. First, the median is deceiving, since wealth distributions are quite skewed. Tables 3 and 4 confirm this result, indicating that pension and social security wealth is distributed quite unevenly across different percentiles of the wealth distribution. As a result, conclusions about the middle of the distribution may not apply very far from that middle. A second issue is that the typical HRS household will likely have at least one surviving member of a couple living for at least 20 years, and perhaps longer. This means that household wealth must be spread over a long time period, making apparently large asset values smaller than they might seem

[2] There are other risks against which old-age consumption could be insured (e.g., health care bills), but these are beyond the scope of the present chapter.

Table 4
Pensions and social security as a percent of household net wealth[a]

Wealth percentile	Fraction with pension (%)	Average pension for HH with pensions ($)	Average pension for all HH ($)	% of wealth due to pension (%)
95–100	65	732861	475267	19
90–95	82	442948	363966	31
75–90	86	278805	239727	31
50–75	83	133346	109967	24
25–50	67	55557	36987	15
10–25	37	22103	8100	7
5–10	11	10775	1171	2
0–5	4	27855	1205	13
All	64	181926	116012	23
Median	76	79280	60102	18
	Fraction with social security (%)	Average social security for HH with social security ($)	Average social security for all HH ($)	% of wealth due to social security (%)
95–100	99	185825	184399	7
90–95	100	188506	187709	16
75–90	100	179766	178888	23
50–75	100	158119	157649	34
25–50	99	129542	127967	51
10–25	99	90309	89090	72
5–10	92	56755	52380	85
0–5	47	35384	16567	179
All	93	138878	133622	27
Median	99	145620	144801	43

[a] Source: See Table 3.

otherwise. Third, many older people would prefer not to liquidate their housing equity in retirement, yet this budget picture assumes housing is fungible. Hence it is useful to examine wealth patterns both with, and without, housing assets.

Judging whether these wealth values are "adequate" to sustain retirement wellbeing is inherently a difficult subject since there is no single way to evaluate adequacy. One approach is taken by Levine and Mitchell (1996), who compare the annuitized value of retirement wealth to two standards: the government-set poverty line, and an income-to-needs ratio commonly found in the welfare economics literature. Table 5 presents these results, and indicates that a relatively small fraction of married couples currently on the verge of retirement is likely to have inadequate retirement incomes. Median income is two to three times estimated needs, and projected poverty rates are 4–5% (wealth measures used in these computations do not include medical benefits or other in-kind transfers). By contrast, non-married persons anticipate lower retirement incomes, lower income-to-need ratios, and poverty rates reaching 25–40%, depending on the measure used. That study also indicates that vulnerability to old-age poverty is mainly attributable to two factors, namely poor health and poor labor market history.

A somewhat different calculation of the adequacy of retirement saving concludes that the median HRS household would have to save 23% of its annual income before retirement in order to maintain a 70% replacement ratio target after retirement (Mitchell and Moore, 1998). While an income (or wealth) shortfall does not imply that all recipients will be poor, financial planning guidelines do suggest current consumption and low retirement

Table 5
Projecting retiree income and vulnerability to poverty[a]

Measures based on projected retiree income	Married		Non-married	
	Men (1)	Women (2)	Men (3)	Women (4)
Projected annual median income ($)	32300	31900	14400	9200
Projected annual median income excluding housing wealth ($)	24500	31900	10800	7700
Projected median income-to-needs ratio	3.11	3.25	1.80	1.08
Projected median income-to-needs ratio excluding housing wealth	2.36	2.42	1.37	0.90
Projected % in poverty	3.9	4.4	22.3	34.9
Projected % in poverty, excluding housing wealth	4.9	5.3	28.2	39.6

[a] Source: Derived from Levine and Mitchell (1996); sample as in Table 3.

Table 6
Estimated saving rates needed to meet replacement targets[a]

Target	Real discount rate		
70% replacement ratio	1.00%	2.50%	4.00%
100% joint and survivor			
Wealth needed to sustain ($)	672300	564900	482400
Wealth shortfall ($)	227000	119600	37100
Annual saving to meet goal ($)	20200	10700	3300
Required saving as % of income	43.90	23.30	7.20
50% joint and survivor			
Wealth needed to sustain ($)	524800	450500	392300
Wealth shortfall ($)	79500	5200	0
Annual saving to meet goal ($)	7100	500	0
Required saving as % of income	15.40	1.10	0.00

[a] Source: Derived from Mitchell and Moore (1998).

assets will leave many in the next generation of older people less well off than they had anticipated (Table 6).

In sum, retirement must be seen as a complex process with multiple dimensions, by which older workers withdraw from the labor force. All retirees are not poor, though old-age poverty is a concern for many older Americans, particularly those in poor health and with low lifetime earnings. Improving retirement wellbeing depends in part on longer and more productive work lives, and in part on more effective saving strategies among the young. To this end, financial planners have begun to recognize the substantial opportunities in the marketplace for encouraging retirement savings (Chorney et al., 1997). In addition, labor market institutions are important determinants of the length of the work life, as well as wellbeing in retirement, a subject to which we turn in the next section.

3. Modeling retirement

This section considers recent advances in modeling retirement behavior; the next section focuses on empirical results. It is striking how much of the theoretical analysis reviewed by Lazear (1986) remains useful over a decade later. That is not to say that research in this area has slowed or halted; in fact technological advances and new datasets have resulted in a wide range of empirical findings and an ability to consider large populations to analyze behavior (Lumsdaine, 1996; Costa, 1999).

3.1. Developments in modeling older workers' retirement decisions

Over the last decade, retirement researchers have worked to develop models that allow for heterogeneous worker behavior in a dynamic context. We review several approaches in turn.

3.1.1. The Gustman–Steinmeier model[3]

An early dynamic lifecycle model of the retirement decision was that of Gustman and Steinmeier (1986b). As in Lazear (1986), an individual maximizes lifetime utility

$$U = \int_0^T u[C(t), L(t), t]\mathrm{d}t,$$

where $C(t)$ is consumption and $L(t)$ is leisure, respectively, at time t, and T is the maximization horizon. This utility is maximized with respect to consumption and leisure subject to a lifetime budget constraint which takes the following form:

$$A_0 + \int_0^T \mathrm{e}^{-rt}\{y[L(t), t] - C(t)\}\mathrm{d}t = 0,$$

where A_0 is an initial stock of assets, $y[L(t),t]$ is a function relating compensation to leisure, and r is the real interest rate. Gustman and Steinmeier note that the solution to the maximization problem does not place restrictions on the form of $y[\cdot]$; specifically, $y[\cdot]$ can be non-linear and have discontinuities. In order for the model to be empirically tractable, it is necessary to specify the form of the utility function. Gustman and Steinmeier use a CES specification, that is

$$u[C(t), L(t), t] = \mathrm{sign}(\delta)\{[C(t)]^{\delta} + \exp(X_t\beta + \varepsilon)[L(t)]^{\delta}\},$$

"where X_t is a vector of explanatory variables which affect the relative weight of leisure in the utility function at time t, β is the associated vector of parameters which is assumed to be constant across both time and individuals, ε is a time-invariant stochastic term affecting the relative weight of leisure for the individual, and δ (with $\delta \leq 1$) is a time-invariant stochastic term defining the within-period elasticity of substitution between consumption and leisure, with the elasticity being calculated as $\sigma = 1/(1 - \delta)$" (p. 559). In this model, δ is assumed to follow an exponential distribution whereas the distribution of ε, conditional on δ, is normal with mean linearly related to δ and variance $\sigma\varepsilon^2$.

An important feature of this model is the recognition that retirement sometimes occurs gradually via the transition from full to part-time work. In specifying the compensation profile for the individual, Gustman and Steinmeier (1986b) note that the wage associated with part-time work is often lower than the full-time wage. As a result, wage profiles for full versus part-time work are estimated separately. In particular, the individual faces a discontinuity in the compensation profile as part-time wages are assumed to be below full-time wages. In addition, the part-time wage profile may be kinked due to incentives built into the benefit stream (e.g., the social security earnings test).

3.1.2. The Stock–Wise Model[4]

A different approach to modeling retirement is developed by Stock and Wise (1990), who

[3] The description in this section is taken largely from Gustman and Steinmeier (1986a).

[4] The description in this section is taken from Lumsdaine et al. (1992).

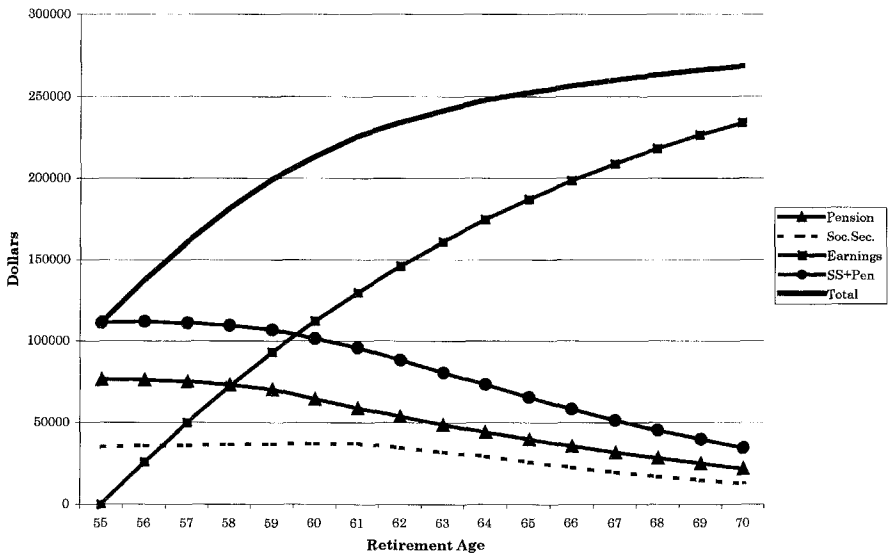

Fig. 4. Elements of compensation by retirement age. Source: Lumsdaine et al. (1995).

propose an "option value" model, where individuals retire at the age that achieves the maximum gain from postponing retirement versus retiring in the current period. The motivation for their model is from Lazear (1979), who suggests that by delaying retirement, individuals retain the option to retire at a later date, under potentially more advantageous terms.

At any given age, based on information available at that age, it is assumed that an employee compares the expected present value of retiring immediately with the value of retiring at each future age, to age 70 (which was chosen to represent the mandatory retirement age). The maximum of the difference in expected present values of retiring at each future age versus immediate retirement is called the option value of postponing retirement. If the option value is positive, the person continues to work; otherwise she retires. Fig. 4 illustrates various components that a sample individual from a large Fortune 500 firm might consider when formulating her retirement decision. For example, at age 55 an employee would compare the expected present value of the retirement benefits (social security plus pension) that she would receive were she to retire then – for this individual, approximately $111,000 – with the value of wage earnings and retirement benefits in each future year. The expected present value of retiring at 60 (discounted to age 55), for example, is about $210,000. Future earnings forecasts are based on the individual's past earnings, as well as the earnings of other persons in the firm. The precise model specification follows.

A person at age t who continues to work will earn Y_s in subsequent years s. If the person retires at age r, subsequent retirement benefits will be $B_s(r)$. These benefits will depend on

the person's age and years of service at retirement and on his earnings history; thus they are a function of the retirement age. We suppose that in deciding whether to retire the person weighs the indirect utility that will be received from future income. Discounted to age t at the rate β, the value of this future stream of income if retirement is at age r is given by

$$V_t(r) = \sum_{s=t}^{r-1} \beta^{s-t} U_{\mathrm{W}}(Y_s) + \sum_{s=r}^{T} \beta^{s-t} U_{\mathrm{R}}(B_s(r)), \tag{1}$$

where $U_{\mathrm{W}}(Y_s)$ is the indirect utility of future wage income and $U_{\mathrm{R}}(B_s(r))$ is the indirect utility of future retirement benefits. It is assumed that the employee will not live past age T. The gain, evaluated at age t, from postponing retirement until age r is given by

$$G_t(r) = E_t V_t(r) - E_t V_t(t). \tag{2}$$

Letting r^* be the age that gives the maximum gain, the person will postpone retirement if the option value, $G_t(r^*)$, is positive,

$$G_t(r^*) = E_t V_t(r^*) - E_t V_t(t) > 0. \tag{3}$$

The utilities of future wage and retirement income are parameterized as

$$U_{\mathrm{W}}(Y_s) = Y_s^{\gamma} + \omega_s, \tag{4a}$$

$$U_{\mathrm{R}}(B_s) = (kB_s(r))^{\gamma} + \xi_s, \tag{4b}$$

where ω_s and ξ_s are individual-specific random effects, assumed to follow a first order autoregressive process

$$\omega_s = \rho\omega_{s-1} + \varepsilon_{\omega s}, \qquad E_{s-1}(\varepsilon_{\omega s}) = 0, \tag{5a}$$

$$\xi_s = \rho\xi_{s-1} + \varepsilon_{\xi s}, \qquad E_{s-1}(\varepsilon_{\xi s}) = 0. \tag{5b}$$

The parameter k allows the utility associated with a dollar of income while retired to be different from the utility associated with a dollar of income accompanied by work. Abstracting from the random terms, at any given age s, the ratio of the utility of retirement to the utility of employment is $[k(B_s/Y_s)]^{\gamma}$. Given this model, retirement decisions are described in terms of $\Pr[G_t(r^*) > 0]$; the parameters of the indirect utility function $V_t(r)$ are estimated via maximum likelihood.

3.1.3. A stochastic dynamic programming model

The key simplifying assumption in the Stock–Wise option value model is that the retirement decision is based on the maximum of the expected present values of future utilities if retirement occurs now versus each of the potential future ages. By contrast, a stochastic dynamic programming approach considers instead the expected value of the maximum of current versus future options. The expected value of the maximum of a series of random variables will be greater than the maximum of the expected values, so to the extent that this

difference is large, the Stock–Wise option value rule will underestimate the value of postponing retirement relative to the stochastic dynamic programming model. Of course, which model is more consistent with individual behavior remains a separate question. Thus we consider a model that rests on a dynamic programming approach as an alternative to the simpler Stock–Wise model.

It is important to understand that there is no single dynamic programming model. Rather, because the dynamic programming decision rule evaluates the maximum of future disturbance terms, its implementation depends importantly on the error structure that is assumed. It is generally necessary to assume an error structure – and thus a behavioral rule – that simplifies the dynamic programming calculation. In particular, although the option value model allows correlated disturbances, the random disturbances in the simplest specification of a dynamic programming model are assumed to be uncorrelated. New econometric techniques allow this assumption to be relaxed (see, e.g., Keane and Wolpin, 1994). Whether one rule is a better approximation to reality than the other may depend not only on the basic idea, but on its precise implementation. Next we describe two versions of the dynamic programming model.

In most respects a simple dynamic programming model is analogous to the option value model. At age t, an individual is assumed to derive utility $U_w(Y_t) + \varepsilon_{1t}$ from earned income or $U_R(B_t(r)) + \varepsilon_{2t}$ from retirement benefits, where r is the retirement age. The disturbances ε_{1t} and ε_{2t} are random perturbations to these age-specific utilities. Unlike the additive disturbances in the option value model, these additive disturbances in the dynamic programming framework are assumed to be independent and serially uncorrelated. Future income and retirement benefits are assumed to be nonrandom; there are no errors in forecasting future wage earnings or retirement benefits.

A dynamic programming model is based on the recursive representation of the value function. At the beginning of year t, the individual has two choices: retire now and derive utility from future retirement benefits, or work for the year and derive utility from income while working during the year and retaining the option to choose the best of retirement or work in the next year. Because the errors (ε_{it}, $i = 1, 2$) are assumed to be i.i.d., $E_t(\varepsilon_{it+\tau}) = 0$ for all $\tau > 0$. In addition, in computing expected values, each future utility must be discounted by the probability of realizing it, that is, by the probability of surviving to year τ given that the worker is alive in year t, $\pi(\tau \mid t)$. With these considerations, the value function can be written as

$$W_t = \max(W_{1t} + \varepsilon_{1t}, W_{2t} + \varepsilon_{2t}), \tag{6}$$

where

$$W_{1t} = U_w(Y_t) + \beta\pi(t+1 \mid t)E_t W_{t+1},$$

$$W_{2t} = \sum_{\tau=t}^{T} \beta^{\tau-t}\pi(\tau \mid t)U_R[B_\tau(t)],$$

where β is the discount factor and, as in the option value model, T is the year beyond which the person will not live.

With a suitable assumption on the distribution of the errors ε_{it}, the expression (6) provides the basis for a computable recursion for the non-stochastic terms W_{it} in the value function. Lumsdaine et al. (1992) consider extreme value and normal distribution versions of this dynamic programming model. To understand the way these models are estimated, we will consider one of these versions. Following Berkovec and Stern (1991), the ε_{it} are assumed to be i.i.d. draws from an extreme value distribution with scale parameter σ. It is also necessary to choose a terminal age, S, which may or may not coincide with T.[5] Then together with (6),

$$E_t W_{t+1}/\sigma \equiv \mu_{t+1}$$

$$= \gamma_e + \ln[\exp(W_{1t+1}/\sigma) + \exp(W_{2t+1}/\sigma)]$$

$$= \gamma_e + \ln\{\exp[U_w(Y_{t+1})/\sigma]\exp[\beta\pi(t+2 \mid t+1)\mu_{t+2}] + \exp(W_{2t+1}/\sigma)\}, \tag{7}$$

where γ_e is Euler's constant. Thus (7) can be solved by backward recursion, with the terminal value coming from the terminal condition that $\mu_S = W_{2S}$. The extreme value distributional assumption provides a closed form expression for the probability of retirement in year t:

$$\Pr[\text{retire in year } t] = \Pr[W_{1t} + \varepsilon_{1t} < W_{2t} + \varepsilon_{2t}] = \frac{\exp(W_{2t}/\sigma)}{\exp(W_{1t}/\sigma) + \exp(W_{2t}/\sigma)}. \tag{8}$$

Individual-specific terms are modeled as random effects but are assumed to be fixed over time for a given individual. In the case of extreme value errors, single year utilities are specified as

$$U_w(Y_t) = Y_t^{\gamma}, \tag{9a}$$

$$U_R[B_t(s)] = [\eta k B_t(s)]^{\gamma}, \tag{9b}$$

where ηk is constant over time for the same person but random across individuals. Specifically, it is assumed that η is a log-normal random variable with mean one and scale parameter λ: $\eta = \exp(\lambda z + 1/2\lambda^2)$, where z is i.i.d. $N(0,1)$. A larger λ implies greater variability among employee tastes for retirement versus work; when $\lambda = 0$, there is no taste variation.

To summarize, a version of a dynamic programming model of retirement is given by the general recursion equation, Eq. (6). It is implemented as shown in Eq. (7) under the assumption that the ε_{it} are i.i.d. extreme value. The retirement probability is computed according to Eq. (8). The fixed effects specification is given by Eqs. (9a) and (9b). The unknown parameters to be estimated are $(\gamma, k, \beta, \sigma, \lambda)$. Because of the different distribu-

[5] In practice, S is chosen to be large. Before the elimination of mandatory retirement, S was the age of mandatory retirement.

tional assumptions, the scale parameter σ is not comparable across option value and dynamic programming models.

3.1.4. Other retirement models

Another version of a dynamic programming approach to modeling retirement appears in Berkovec and Stern (1991), who use the method of simulated moments to estimate a dynamic programming model of retirement behavior. They allow three states – full-time work, part-time work, and retirement. In addition, unlike in the Stock–Wise (1990) framework, retirement is not an absorbing state; rather, in retirement, an individual chooses each period whether to remain retired or to begin a new full- or part-time job. The Berkovec–Stern model is important in that it allows uncertainty with regard to future wages to enter into the dynamic programming specification. In particular, the error terms in the model are assumed to follow a factor structure which permits unobserved heterogeneity. The distribution of the errors for each individual is simulated using ten draws from the assumed error distribution. This method avoids the intractability of multidimensional integrals, which would otherwise arise due to the backwards recursion and conditionally dependent error structure. One drawback of this approach, as well as the structure devised by Rust, described above, is that it cannot handle sharply nonlinear budget constraints. Abrupt accrual spikes that characterize company-sponsored pension plans are therefore not incorporated into the budget constraints relevant to older workers. As a result, both the Rust and Berkovec–Stern techniques recognize that their models only apply to those workers not covered by defined benefit pension plans. By contrast, the option value approach takes full account of the important pension benefit spikes at early and normal retirement ages.

3.1.5. Joint retirement/consumption decision making

Dynamic models such as those of Gustman and Steinmeier (1986b), Stock and Wise (1990), and Lumsdaine et al. (1992) are important in that they attempt to capture the consumption-leisure tradeoff in a lifecycle context. Despite this advance, there remain areas in which these models fall short, namely in their ability to incorporate uncertainty. In particular, it is assumed that future lifecycle compensation paths are known.

A more general model of retirement behavior is that of Rust and Phelan (1997), who describe a dynamic programming model that allows for individual subjective uncertainty along a number of dimensions, with respect to future mortality, health status and expenditures, marital status, employment, and income. A key feature of this model is that the labor force participation and social security application decisions are treated separately. Maximum likelihood estimation is used to estimate the value of the parameter vector θ that maximizes the following likelihood function:

$$L(\theta) = \prod_{i=1}^{I} \prod_{t=1}^{T_i} P_t(d_t^i \mid x_t^i, \theta, \alpha) p_t(x_t^i \mid x_{t-1}^i, d_{t-1}^i, \theta, \alpha),$$

where d_t^i represent the set of control variables for individual i, x is the subset of the vector of state variables that is observable to both the econometrician and the individual, α represents the current policy scenario, $p(\cdot \mid \cdot)$ is the transition probability density, and $P(\cdot)$ is the conditional choice probability. For computational tractability, Rust and Phelan assume that the unobservable state variables follow an i.i.d. extreme value distribution. This restriction implies that the observable state variables capture all the dependence in the model.

Technological advances in the last decade have resulted in the feasibility of estimating complicated dynamic behavioral models regarding the labor force participation and retirement decisions. Rather than taking consumption as given, these models allow researchers to consider the joint labor-leisure decision and the tradeoffs this entails. Initially individual heterogeneity was included in a restrictive fashion (assuming i.i.d. random effects), but subsequent advances in methodology and computation have allowed for limited types of dependence, either through the "option value" approximation of Stock and Wise (1990), the factor structure model of Berkovec and Stern (1991), or the dependence via the observable state variables in Rust and Phelan (1997). Insuring empirical tractability, however, still requires strong assumptions about the underlying error distribution. The other important contribution of these recent developments is that these models are beginning to incorporate uncertainty regarding future outcomes.

These advances also suggest directions for future research. Dynamic models of multiple decisions will add another dimension of computational difficulty but from a modeling perspective could be incorporated into the Rust–Phelan framework. For example, an extension along these lines would be a model of the joint labor supply decision among spouses, with heterogeneous errors that are correlated within household. Another extension might include the savings decision as an additional control variable; previous models have assumed that all income in time t is consumed in that period (i.e., no savings).[6]

3.2. *Understanding the demand for older workers*

Thus far we have shown how retirement has come to be seen by economists as a decision made by workers selecting desired leisure consumption patterns late in life. Nevertheless a complete model of the retirement process also requires us to ask why some companies offer, or withdraw, an offer of employment to older workers at some determined, and often uniform, age. In this section we discuss several of the factors driving employer-side demand for older workers, in an effort to sketch out what we know and what remains to be learned about why some companies sever the employment arrangement for older employees.

Modeling the demand for older workers would seem to be a relatively simple matter as long as a spot market model is believed to characterize most of the labor market. That is, in

[6] While the Rust–Phelan model allows for savings in principle, in practice this assumption was made due to both data limitations and computational difficulty. Rust–Phelan also argue that for most blue collar workers, saving is very close to zero.

a static world, when employers are competitive and maximize profit, the firm will hire labor to the point where compensation paid equals the worker's marginal product. The cost-minimizing dual of the problem generates an empirically estimable labor demand relationship of the general form $L^* = L^d(w, r, Y)$ where w is the wage rate, r is the price of capital services, Y is the level of the firm's output. The generalization to multiple types of labor, say workers of different ages, is straightforward. For instance, when a trans-log cost function characterizes the employer's technology, the cost equation (Hammermesh, 1993) is

$$\ln C = \ln Y + a_o + \sum_i a_i \ln w_i + 0.5 \sum_i \sum_j b_{ij} \ln w_i \ln w_j,$$

with

$$\sum_i a_i = 1, \qquad b_{ij} = b_{ji}, \qquad \sum_j b_{ij} = 0 \qquad \text{for all } j.$$

In this setting, an empirically estimable form relates the ith group's share of total costs (s_i) to the relative prices of all inputs in a linear form as follows:

$$s_i = a_o + \sum_j b_{ij} \ln w_j.$$

Alternatively if the production function is trans-log, the share equations become a function of the quantities of all inputs x_j (Mitchell and Levine, 1988):

$$s_i = a_o + \sum_j \gamma_{ij} \ln x_j.$$

This formulation implies that the demand for any particular demographic group is a function of compensation paid to younger as well as older workers, capital prices, and output levels. Depending on the model, demand elasticities may then be derived to indicate either the change in employment expected to result from changes in input prices or changes in quantities of labor of different types.

Much of the extant labor demand research presumes that a spot labor market is an adequate description of reality, at least in the aggregate. By contrast, retirement researchers in the last decade have departed dramatically from this perspective, by positing that many (although probably not all) employees are covered by longterm contracts, where productivity and pay profiles may and do deviate from each other at any given time. This is motivated by noting that many workers with a company-sponsored pension experience discontinuities in total compensation at particular points in the pension formula – e.g., at vesting, at the early retirement age, and at the normal retirement age (Kotlikoff and Wise, 1985; 1987). Since these pension spikes are not typically offset with plummeting wages, pay and productivity are seen as unlikely to match as they must in a spot market setting. Consequently, for this segment of the labor market, it appears more appropriate to presume the existence of a longterm, perhaps implicit, contract in which compensation over the

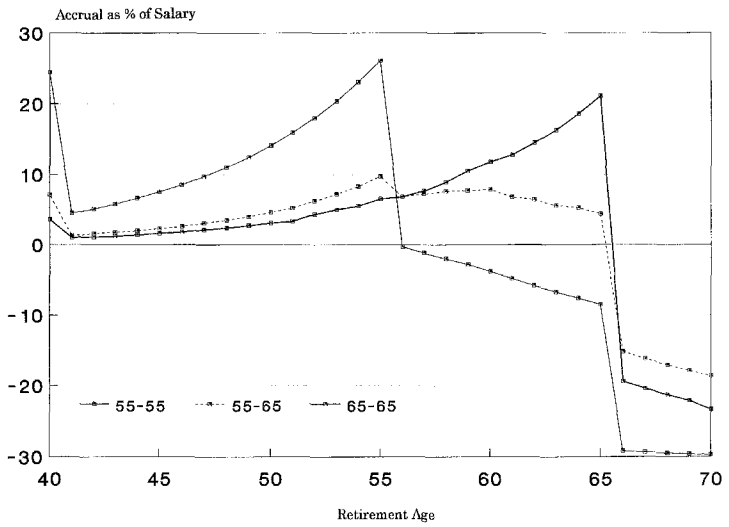

Fig. 5. Illustrative defined benefit pension accruals as a % of salary, for selected early and normal retirement ages. Source: Lumsdaine and Wise (1994).

work life (including pension and other benefits) is set equal in expected present value terms to expected marginal product over the work life (Lazear, 1979).

One prediction of such a longterm contract model is that reduced benefits will be paid to those who change jobs, benefit reductions that could take the form of a pension capital loss for someone leaving prior to the company's retirement age. Another implication is that pay towards the end of the work life is likely to exceed the worker's productivity. This means that the employer will have an incentive to recontract with older workers when the long-term arrangement nears its end. At that point, however, some employees would prefer to remain employed, inasmuch as their pay exceeded their next best job alternatives. This preference would simply be exacerbated if productivity declines with age. Requiring mandatory retirement ensures that the worker's career compensation would not come to exceed his career value to the firm (Lazear, 1979). A different approach would be to recontract with older workers by lowering pay at older ages, a widespread practice in Japan, where retirees will often return to their career employer at half the pay and having fewer responsibilities (Rebick, 1993).

In many countries including the US, law and custom bar employers' ability to cut older workers' pay and benefits when those workers remain employed at the same firm. Consequently, other labor market mechanisms were developed to induce "overpaid" older workers to depart. One such mechanism is to structure defined benefit pension plan rules in such a way that workers lose money by deferring retirement past a certain date, as illustrated in Fig. 5. Another method of recontracting with older workers includes the "early retirement window" provisions mentioned above, which are financial packages

offered to workers as retirement inducements. These have become a fixture on the American labor market scene in the last two decades, particularly as firms facing more competitive product markets downsized and restructured.

A general point to make about companies with deferred compensation arrangements such as pensions is that their workers face some risk that this deferred income might be lost should the employee lose his job prior to retirement, or should the firm go bankrupt without prefunding the pension (Lazear, 1979, 1983; Hutchens, 1987, 1989). Accepting additional uncertainty about pay would be expected to elicit a risk premium, one workers would bear if the longterm contract paid more than the worker could obtain on the spot market. Employers may then structure their longterm contracts so as to share the additional risk and potential return, as in the case of the very popular 401(k) pension plans which provide an employer match, but only to long-service workers.

3.3. Modeling other influences on retirement

3.3.1. Health and disability problems

In addition to the economic factors mentioned above, there are several other factors that powerfully influence workers' retirement decisions. Prominent among these other factors considered in the retirement literature of the last several decades is the role of poor health, which is thought to have two central effects – on the budget constraint, and on preferences.

Focusing first on the budget constraint, most would acknowledge the detrimental effect of poor health on employee compensation opportunities. Many ill employees will be less productive in the short run, suffer more absenteeism in the medium run, and be less likely to invest in longterm skills in the long run. If, in fact, older workers experience greater health problems than do younger employees, then poor health would be expected to detract from their employability and their compensation offers. In response to this lower pay, older workers might be likely to leave their jobs, reduce hours, and eventually retire.[7]

To the negative effect of illness on wages must be added the possibility that poor health can alter the value of peoples' time in other ways. For instance, an injured worker with the possibility of receiving disability benefits may chose not to work so as to enhance his/her chances of being deemed eligible for the benefit program. Poor health can also change one's time horizon: for instance, a middle-aged worker who received a cancer diagnosis with a year left to live would no doubt rethink how to spend the (greatly foreshortened) leisure time remaining. Or an ill person needing to devote several hours per day to health treatments would simply have fewer hours per day in which to work. Working in the opposite direction is the fact that in the US, at least, most health insurance is linked to the worker's job, which means that those in poor health are generally most needful of continuing to work in order to preserve health care benefits. The general message, therefore, is that a good model of retirement should take into account several ways in which poor health

[7] This depends of course on the substitution effect dominating the income effect when pay falls, and evidence suggests it does among older workers; see Fields and Mitchell (1984).

alters the worker's budget constraint, directly and also in terms of the indirect effects that health problems can have on income and benefits on and off the job.

Another way poor health can influence retirement is by changing people's perception of the utility of work versus leisure. This can happen because the worker's job becomes more stressful and demanding given reduced physical or mental capacity, or it might occur if the ill person values home time more when feeling unwell. A related issue is that an older person's time spent with family members may become more important if, during that time, the older person receives health care and other support previously unnecessary. The role of the family becomes potentially even more complex if one recognizes that other family members' labor supply and caregiving decisions are likely to be endogenous to the older worker. Thus, for instance, a younger wife's decision to retire may be strongly influenced by her older husband's health problems, and vice versa. Yet a different way in which health problems might influence retirement outcomes is by influencing the decision-making process directly. For example, a worker suffering physical stress, emotional depression, or having some other mental or physical problem (and sometimes its treatment) may suffer impaired decision-making skills, including those skills needed to plan and then act rationally regarding work and retirement decisions. In this event, good retirement models must acknowledge that poor health has the potential to alter older workers' utility of work versus leisure in complex ways, in addition to changing the budget constraint as described above.

Retirement models to date have focused selectively on a subset of the complex links between health problems, health treatments, and work/retirement decisions, because health is intrinsically unobservable, inevitably measured poorly by researchers using imperfect proxies. Lazear's earlier survey (1986) said very little about these links, and even the most sophisticated current retirement modeling efforts have not made health status endogenous. For example, Rust and Phelan (1997) add to realism by incorporating in their dynamic programming framework the possibility that health shocks influence older worker behavior, but even in this highly complex and rich format, health surprises are exogenous and not couched in a family model. A challenge in the next decade will be to devise models to test the effect of both chronic and acute health problems on retirement, to examine how workers respond by choosing different treatment paths, and how work patterns in turn behave as health and work evolve simultaneously through the latter part of the work life.

3.3.2. Institutional rigidities

In addition to factors such as health and earnings affecting retirement opportunities, it has been argued that several institutional rigidities might be forcing older workers into retirement. As we have already seen, one such factor is mandatory retirement, another is pensions, and a third we will discuss briefly in this section is hours constraints.

A great deal of labor economics research in the 1980s emphasized the role of implicit contracts in regulating the conditions under which a relationship between long-time workers and their employers might be constructed and then wound down. One mechanism long

in effect at the end of the work life was mandatory retirement, a practice now illegal but once quite prevalent in the US labor market, and one still widespread in the rest of the world. The essence of this argument, nicely summarized by Lazear (1979), is that deferred compensation schemes may be designed to reward long worker tenure. In this context, mandatory retirement is then used to insure that workers leave when the terms of the long term contract are completed. That is, workers are underpaid when young and overpaid when old relative to their productivity in the deferred compensation world; one way to insure that total compensation does not exceed lifetime value to the firm is to require that workers leave at some (previously agreed on) point. Subsequent analysis pointed out that enforcing a mutually-agreed-departure date can be achieved in ways other than mandatory retirement, including promises of post-retirement monetary rewards – such as pensions – or as in Japan, post-retirement job placements with other employers.[8]

Other workplace rigidities have also been indicated as drivers of retirement, including inflexibilities regarding hours or days of work associated with teamwork and other integrated work environments. Looking even more broadly, the set of workplace conditions detrimental to continued work for older employees might be thought to include job pace and job stress, the need for acquisition of new skills on the job, and perhaps even employer attitudes toward older workers. This latter point might be demonstrated, for instance, in employer willingness to retrain injured workers, accommodate employee health problems on the job, and more generally make allowances for the types of problems older workers might experience. The extent to which job rigidities and employer attitudes impel retirement is an empirical question, though the modeling issue is whether these factors are really exogenous. Thus far, most of these factors have not been much incorporated in economic retirement models though there is ample room to include, for example, fixed costs of hiring and keeping workers, constraints due to requirements of work teams, and the like.

3.3.3. Family decision-making and caregiving responsibilities

While most economic models have focused on financial incentives and their influence on the retirement decision, many researchers acknowledge the importance of sociological or behavioral influences as well. In terms of the lifecycle framework, this suggests that decision-making in a family context might provide a more accurate picture of an individual's retirement decision. We begin this section by reviewing non-pecuniary aspects of the retirement decision and then discuss how these may be incorporated into the models described above.

Much of the retirement literature has attempted to model retirement as an individual decision, yet the above discussion highlights the need to consider retirement decisions in a family context, with a variety of pecuniary and non-pecuniary forces influencing such decisions. The complexities involved in estimating dynamic decision models at the indi-

[8] Another rationale for pensions is offered by Bodie (1990). He contends that employers are able to complete an imperfect annuity market for employees who would otherwise be unable to obtain retirement and life insurance coverage on their own as individual purchasers.

vidual level become magnified when considering joint decision-making. Because of this, most of the literature has focused on static models or limited dynamic models (Pozzebon and Mitchell, 1989, for instance, focus on married women's retirement behavior, conditional on their spouse's, so that the husband's retirement decision enters into the wife's, but not vice versa). Although this is an important first step, a true model of joint retirement planning would have couples engaged in simultaneous decision-making.

One of the impediments to such joint dynamic modeling is data limitations; even surveys involving a respondent and spouse often fail to have complete and detailed information for both individuals in a couple, let alone other individuals whose needs might also enter into family decision-making. Assuming the data were available, however, we can consider ways to modify the models discussed above to allow for joint retirement decisions and caregiving.

In principle, adding additional decisions into a dynamic model is straightforward. For instance, as Berkovec and Stern (1991) considered multiple states, we might consider all possible combinations of states (A,B) as separate states, where A refers to the husband's state and B the wife's, and A and B are either working or retired. Thus in each time period, a couple decides between four possible states. Incorporating the possibility of part-time work would expand the number of states further. Similarly, as with Rust and Phelan's (1997) joint model of retirement and consumption behavior, we might consider adding a spouse's retirement decision directly into the dynamic model. The simultaneity of the decision might be captured via the correlation structure of the error terms. Stock and Wise's (1990) option value model might be employed as before to gain tractability; family concerns such as caregiving could enter into the utility specification directly or might appear as part of the parameterization.[9] Models of multiple dynamic decisions, once computationally intractible, are becoming increasingly feasible, both due to technological advances and improved data resources.

3.4. Other modeling issues

In the past decade, models of an individual's retirement decision have advanced tremendously, both in terms of dynamic lifecycle specifications and in the development of simulations/approximations with which we can allow more complicated error structures. Employer-side models of *demand* for older workers, however, have lagged behind the supply-side developments and are not well developed to date. This is particularly true when we take into account total compensation (and not just wages). In order to improve models of the demand for older workers, we need more and better data on labor inputs, including quality, and price, including total compensation, as well as outputs. This will likely come from detailed surveys of firms.

Despite limited research in this area, there is some evidence that deferred compensation

[9] For instance, k, the parameter which allows a dollar associated with work to have different utility than a dollar associated with leisure, could be further expanded to include a dollar associated with caregiving. See, e.g., Lumsdaine et al. (1990b) for an example in which k varies with age.

is adopted by employers that want to select employees with "low" discount rates who are unlikely to turn over, by employers that cannot monitor output well (Ippolito, 1993), and by employers wanting to force recontracting at some age (Lazear, 1986). Hence, compensation arrangements are endogenous, which implies retirement patterns are endogenous too, to some extent. Ideally our models will be structural, with demand and supply simultaneously determined, although identification of such models presents additional difficulty.

As with individuals, one difficulty in modeling demand is deciding how to model uncertainty in the firm. Evidence that window plans, for example, are offered when a firm is in financial trouble suggests that worker's expectations regarding the probability of layoff may change when the pension plan is altered. This may result in take-up rates that are high relative to what we would predict solely by evaluating the economic determinants of the individual's decision without taking into account the shift in preferences. Accurate forecasts of firm response and behavior are critical to understanding workers' responses.

As institutional barriers to flexible hours break down, we will need to develop models that describe a continuous transition to retirement. Some progress has been made in modeling retirement as a dynamic (rather than absorbing) state. It is becoming increasingly important that models of retirement allow for other types of labor force transition, such as reentry. Rust (1994) notes that failure to allow for this attaches undue uncertainty to the retirement decision.

Our models are also far from truly understanding the role that individual perceptions and self-selection play. For example, in deciding whether to leave a career job, a worker may need to evaluate the probability of finding another job. It is important for the modeler to know whether an individual's assessment of this probability reflects the truth. Understanding potential misperceptions will improve the way in which we can model the decision process. As yet, most models allow for only a limited amount of uncertainty.

It will also be important to extend the decision dynamics of our retirement model beyond that of the individual. Early theoretical work by Clark and Johnson (1980) described the determinants of husbands' and wives' retirement in a joint household utility function with husband's and wife's retirement years as arguments. A similar framework with more individual worker heterogeneity is developed in Gustman and Steinmeier (1994b). Researchers have yet to determine whether this model of family labor supply generates more interesting empirical predictions than would some alternative formulation, say, a household bargaining model of the type developed by McElroy (1990) for younger workers. As we saw above, however, the decision dynamics are much more complicated than just the spousal consideration. Dynamic models of retirement in the family context are still not very developed.

In sum, a variety of non-pecuniary aspects of the retirement decision should be incorporated into the next generation of models. Some of these are quantifiable, such as the substitution effect of caregiving versus continued work to pay for third party care. Other effects are more difficult to measure, for example, the attitudes of coworkers or the individual's views of work and retirement.

4. Empirical lessons from the retirement literature

The models of the previous section have been estimated empirically; in this section we discuss some of these results and present additional evidence about workers' retirement decisions.

4.1. Retirement, pensions, and social security benefits

4.1.1. Labor supply effects

Many empirical studies have investigated the retirement responses to changes in social security and pension plan provisions. From a policy perspective, the focus on social security has been especially timely, as current policy dictates an increase in the normal retirement age, liberalization of the earnings test, and an increase in the delayed retirement credit. Because of the projected shortfall in the Social Security Trust Fund, these changes have been seen as a mechanism to induce individuals to postpone retirement (Burtless and Moffitt, 1984; Leonesio, 1993).

Studies that have focused on social security rule modifications (such as extending the normal retirement age, increasing the delayed retirement credit, and eliminating the earnings test) suggest that their impact will not be substantial (Fields and Mitchell, 1984; Leonesio, 1990). Gustman and Steinmeier (1991) argue that the estimated modest change in aggregate retirement behavior is partly the result of workers altering their time of application for benefits, rather than modifying their labor force departure behavior.

Another reason that changes in social security provisions may have little effect is because of private pension plans that often encourage workers to withdraw from the labor force at much younger ages (as early as 55), far earlier than the social security early retirement age of 62 (Honig and Reimers, 1989). Simulations using data from two individual Fortune 500 firms confirm that changes in social security policy will have very little effect on worker's pension acceptance ages (Stock and Wise, 1990; Lumsdaine et al., 1996a), mainly because pension wealth proves to be larger than social security benefits. This is not to say social security will have no effect. Even for individuals who have access to both pension and social security benefits, the complete elimination of social security would have a large impact on labor force participation.[10] In addition, for workers who are liquidity constrained, raising the early retirement age would induce later retirement (Stewart, 1995).

Turning now to the effects of pensions on retirement, lessons about a consistent set of behavioral findings are summarized as follows (Gustman et al., 1994):

- Workers with generous pensions retire somewhat earlier than those with smaller pensions. These differences are statistically significant but small: a 10% increase in

[10] Using data from a large Fortune 500 firm, Lumsdaine et al. (1996a) estimate that 64% of currently employed 50-year-olds will leave the firm by age 62; without Social Security, only 49% will leave.

the present value of total retirement income at age 60 is predicted to induce earlier retirement by only about one to two months.

- Employees offered more money to delay retirement tend to do so. Here too, the estimates are statistically significant but small quantitatively: a 10% increase in the reward to delay retirement induces later retirement by less than 6 months.
- Retirement models do a reasonably good job tracking retirement hazard rates as long as researchers have good quality data on actual (nonlinear) pension benefit accrual patterns.

Estimated response magnitudes to pension plan offerings might be overstated, to the extent that firms design their pension plans to attract workers with tastes for retirement akin to those the company finds most efficient. Thus an early retirement benefit program might appear to be correlated with a high fraction of early retirees, but the correlation might not be proof of causation, to the extent that this benefit program reflects employee and employer preferences for optimal turnover. This is one reason that researchers have turned to examine worker responses to unanticipated early retirement windows, on the argument that this type of data better represents worker response to exogenously changing pension opportunities.

Most of the empirical work on early retirement window plans has considered one or a small number of similar firms, due to the difficulty in obtaining detailed information on pension plans for a large cross-section of individuals. Window plans became popular in the 1980s as a method of altering the composition of a firm's labor force. Early studies include Hogarth (1988), who looks at New York State employees, Lumsdaine et al. (1990a,b) who consider a large Fortune 500 firm, and Ausink and Wise (1993) who investigate changes to the Air Force pension plan provisions.[11]

As an example of the powerful effects of window plans on workers' retirement behavior, consider Fig. 6, which shows retirement patterns before and after the imposition of a window plan (Lumsdaine et al., 1990a,b). In 1982, the firm offered a lucrative window plan to workers 55 and over who were vested in the firm's pension plan; for some workers, this bonus was worth more than a year's salary. It is clear that this bonus had a large effect on workers' departure rates, since retirement rates triple for workers offered the most lucrative bonuses. The cumulative effect of these departures was also substantial. Conditional on being in the firm at age 50, 77% of these workers would have retired by age 60 post-window versus only 37% pre-window.

A broader perspective on the prevalence of window plans is presented by Brown (1999) using 2 years of panel data from the HRS. One finding is that window plan offerings seem to have become more prevalent over the early 1990s and appear to have been offered to relatively better-off employees. He also finds that many of the window plan accepters took

[11] With the elimination of mandatory retirement, universities are also interested in early retirement windows, as a means of encouraging retirement of their older workers. Pencavel (1997) considers the ex-post response of workers in the University of California system; similar studies have been undertaken at Stanford University (Gillam and Shoven, 1996) and Princeton University (Ashenfelter and Card, 1996).

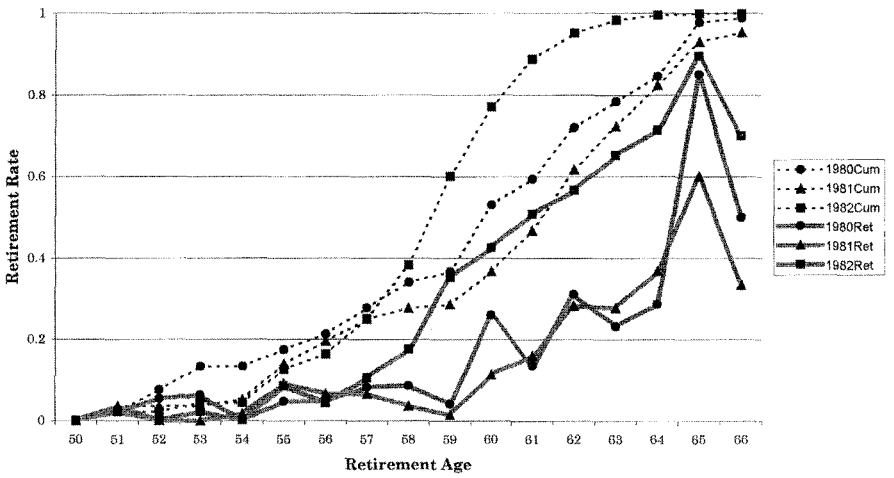

Fig. 6. Retirement patterns before (1980–1981) and after (1982) an early retirement window plan. Source: Lumsdaine et al. (1990b).

"bridge" jobs rather than immediately leaving the labor force, consistent with Ruhm (1990). Not surprisingly, the decision to accept a window plan offering depends on financial incentives; the average offer accepted was significantly higher than the average offer declined. This work is the first evidence of the powerful effects of early retirement window plans using data representative of the population.

Researchers using data from the last decade have reasonably assumed that window plans could be seen as a "natural experiment". That is, window plans were presumed to be unanticipated, in large part because they were adopted by firms that historically had not altered their pension plans. Today, however, multiple window offerings and enhanced retirement "sweeteners" have come to be the norm. Therefore the next generation of retirement models must now adapt to worker's changing expectations. One phenomenon, for example, is that workers may delay retirement in anticipation of a future window plan offering (see, e.g., Lumsdaine et al., 1995). Models that just compare pre- and post-retirement rates, therefore, might overstate responses to a change in the plan. Just as the existence of a window plan can induce additional retirements, the absence of one might inhibit retirements.

A different sort of "natural experiment" consists of cross-national evidence, drawing on the experience of countries that have changed their social security systems over time. Data on the US, Japan, and Western Europe summarized by Gruber and Wise (1999) show that these law changes apparently had large effects on retirement patterns in a wide range of cases. For example, in France special early retirement benefits were introduced for jobless older people, and the normal retirement age for social security benefits was lowered from 65 to 60. Concurrently, labor market attachment patterns shifted markedly, with more

people retiring earlier. In Germany prior to 1972, the social security retirement age was 65, and then early retirement was permitted along with generous unemployment and disability benefits. Within 8 years, men's average retirement age had plummeted 6 years. Therefore, this aggregate time series data supports the lessons of the microeconomic evidence: economic incentives to retire early are potent influences on older workers' labor supply.

4.1.2. Labor demand and older workers

Estimating labor demand models has proven to be difficult because microeconomic company-level data have been virtually unavailable beyond a handful of case studies (Gustman and Mitchell, 1992). And of course in cross-sectional analysis, substantial cross-firm variation is needed to estimate response parameters of interest. As an alternative, time-series aggregate data has been used, but here several additional problems are encountered. One is that changes in worker quality must be expected in a time series, but such quality changes are extremely difficult to control for empirically using aggregate data. Another problem is that capital costs are notoriously unreliable for aggregate time series. And a third issue confronted by those wishing to estimate labor demand elasticities is that compensation costs are hard to measure with precision.

With these issues in mind, Mitchell and Levine (1988) employed a demand system formulation to assess the likely impact of the aging of the baby boom generation on relative wages of older versus younger men and women. The empirical analysis revealed substantial substitution as well as complementarity across workers of different sex and by age. For example, older female employees (age 55+) were estimated to be substitutes with mature men (age 35–54); but older male employees were complementary workers with young men (age 20–34). These estimated elasticities were then used to predict likely wage changes in the year 2020, as the large number of baby boom workers reached maturity. The authors concluded that wages would be expected to rise for both older and prime-age workers (age 20–54), contrary to the view that older workers will necessitate more incentives for early retirement.

An issue this type of study raises is whether older workers actually represent different "quality" employees than do younger workers. Labor economists tend to assume that pay exceeds productivity at older ages (Parsons, 1996), yet this proposition is remarkably difficult to prove since lifetime productivity profiles are not typically directly observed in publicly available datasets. There is a psychological literature examining the link between performance on certain clinical tests and age, and it shows that in many manual dexterity areas older people are less able. Conversely, however, in several other regards older people have superior skills than do their younger peers (Mitchell, 1990). One must also recall that clinical findings are not necessarily generalizable to the job setting, yet the workplace is a difficult place to measure output, particularly when people collaborate in work teams. Relatively little research examines on-the-job productivity patterns with age, though one exception is an in-depth study of age-linked changes in academic performance, by Smith (1994). That research tracks publication output and teaching performance among

academics across a wide range of higher educational institutions, and concludes that productivity does not seem to decline precipitously with age. However, workplace accident data indicates that older workers are more often fatally injured, as compared to their younger counterparts (Mitchell, 1988).

Another issue raised by this analysis, as well as that of many others seeking to measure worker productivity, is that of sample selection. In the present context, this could mean that observed productivity and pay might be high among workers, but workers with subpar performance might switch jobs, move to a less demanding occupation, or retire altogether. As a result, measuring pay and productivity only among people who remain employed at older ages would not reveal evidence of falling productivity with age, yet productivity declines would be driving the retirement process. This problem plagues much of the literature on workplace performance and age (Mitchell, 1990).

While productivity is hard to measure, there are also problems with measuring pay patterns with age. A surprising finding of the empirical labor economics research over the last decade is that earnings profiles do not fall as workers age, as a matter of course. That is, pay profiles tend to rise or at least remain constant until a worker has completed more than 40 years of work experience, and even after that point pay for full-time jobs declines only negligibly – less than a percent per additional year of work (Gustman and Steinmeier, 1985). Thus the common view that earnings profiles in cross-sectional data have the familiar inverted U-shape is attributed to the fact that people move into part-time, bridge jobs with lower wages at older ages. It should be noted that this finding is robust to controls for selection bias that might be due to "selective" retirement.

Evidence that pay does not fall with age suggests, but does not confirm, that the longterm contract model applies to an important segment of the labor market (Montgomery et al., 1992). Additional facts supportive of the longterm contract model include the following:

1. There is substantial cross-sectional heterogeneity with regard to demand for older workers, since in some industries older workers are "grown" internally but never hired from outside, whereas in others age appears to be no obstacle to being hired (Hutchens, 1988).
2. Companies providing pensions appear to be those that pay higher-than-average wages (Lazear, 1979), perhaps because workers in these "good" jobs would be less likely to quit prior to retirement age so as to avoid a "capital loss" from quitting – where the capital loss is measured as the difference between the worker's discounted accrued pension benefit based on work and earnings to date, versus the presumably higher benefit payable if he remained to retirement (see Even and Macpherson, 1992; Allen et al., 1993; Gustman and Steinmeier, 1993).
3. Long term compensation arrangements – e.g., pensions – have been found to be more prevalent in specific occupations – those where the employer finds it more difficult to supervise output (i.e., jobs not involving repetitive tasks; see Hutchens, 1988, 1993; Parsons, 1988) and jobs which are particularly physically demanding (Fields and Mitchell, 1984).

4. Companies with pension plans have half the turnover rates among younger workers as do firms without such plans, and are less likely to discharge their older workers. This is probably because such employers face substantial recruitment, hiring, and training costs, and may also actively use their pension plans to select and reward those with longer time horizons (for details see Gustman et al., 1994).
5. Companies with early mandatory retirement ages prior to the law change were also those that adopted strong pension penalties for continued work after mandatory retirement was repealed (Mitchell and Luzadis, 1988; Luzadis and Mitchell, 1990).
6. Older workers experiencing a layoff also appear to have a harder time finding reemployment in their same industrial/occupational sector, as compared to younger workers, a result that would seem to imply that some companies discriminate against older workers. Most surprising is the fact that when older workers are re-employed following a layoff, they appear to be paid more than younger workers facing the same displacement process (Hutchens, 1993).

Despite this interesting array of empirical facts, it remains the case that longterm contract models of the demand for older workers have not been fully elaborated in terms of their empirical implications. This is mainly because of the lack of good data on firm-side inputs, outputs, and prices (including total compensation). As a result we still do not yet have a good idea of how employers design their earnings and pension benefit structures to achieve particular labor market ends. It is anticipated that the longitudinal Health and Retirement Study will shed additional light on the question of how employers' perceptions of and treatment of older workers influence job change and retirement patterns, as well as the link between age-linked physical and mental changes and the process of moving out of the labor force.

4.2. Retirement and other economic variables

4.2.1. Evidence on the effects of health and disability on retirement

During the 1980s the Retirement History Study (RHS) yielded a rich research vein for sociologists and economists interested in studying the links between retirement and poor health. This survey was a nationally representative dataset on men and their spouses, as well as single women, born early in the 1900s and reaching retirement during the 1970s. Most of these studies found that poor health encouraged early retirement (Sammartino, 1987; Rust, 1989; Quinn et al., 1990), but there was also evidence that early retirees reported being in worse health than more objective measures would suggest (Bazzoli, 1985). This gave rise to a literature seeking better measures of "true" health status as compared to reported health, including work by Anderson and Burkhauser (1985) and Bound (1991) who used age of death evidence to proxy health status during the work life. On the whole, this research concluded that (1) indicators of poor health were correlated with early retirement, (2) estimated health effects were moderated when economic variables were included, and (3) both self-reported health and mortality data measured underlying health status with error.

The next wave of empirical research exploring the health/retirement nexus is now using the new Health and Retirement Study (HRS), a nationally representative and longitudinal dataset of men and women initially age 51–61 in 1992. The richness of this survey is just beginning to be acknowledged, particularly the extensive questions about peoples' past health and disability conditions, their current health problems and medical treatments, and their expected future health outlook. Potential uses of this survey have begun to be outlined in initial research by Burkhauser et al. (1996) who explore the health and poverty status of people who retire prior to age 62; they find that most early retirees are better off, and less likely to be in poor health, than those delaying retirement to some later age. There is also suggestive analysis by Dwyer and Mitchell (1998) who find a low correlation between self-assessed mental health and cognitive test functioning, but strong correlation between subjective physical health problems, with early planned retirement.

As the health/retirement link is further investigated, it will be necessary to pay more attention to the interaction between health and other factors. One such factor is the availability of health insurance, either from employers or the government. Because Medicare does not become available until age 65, rising health care costs suggest that the availability of retiree health insurance will become increasingly important for enabling early retirement.[12] Theoretically, retiree health insurance should provide incentives that are similar to private pension plans, namely increased labor force attachment and reduced job mobility. While several recent studies have explored this influence, the size of the estimated effect is far from being pinned down (see Gruber and Madrian, 1996; Gustman and Steinmeier, 1994a; Rust and Phelan, 1997). Another mitigating factor is the nature of the job on which people find themselves as they near retirement age. For instance, early research using the RHS concluded that people in physically demanding jobs retired earlier (Gustman and Steinmeier, 1986a). But whether the health problems caused the job to be demanding, or whether instead the working conditions induced health problems, has not been easy to tease out with available data.

A different factor conditioning the ability to work at older ages is probably employer attitudes towards older workers and their willingness to adjust to workers' health problems. For instance, people return to work significantly more quickly after a temporarily disabling health problem when their employer encourages return-to-work by making workplace accommodations (Burkhauser et al., 1996; Charles, 1996). The HRS also asks whether the older worker feels discriminated against, because of age, and this type of working condition variable can also be used to predict responsiveness to older workers (see, e.g., Hurd and McGarry, 1993). And finally, perhaps the most important mitigating factor influencing how retirement behavior responds to health problems is the worker's family status (see Weaver, 1994). Not much is currently known about this empirically though Pozzebon and Mitchell (1989) found that women workers in the RHS retired later when their husband was ill – perhaps because of the availability of job-related health insurance and/or the need to pay for third party care.

[12] Recent proposed legislation could delay the age of Medicare availability further, to 67.

In conclusion, economists have just begin to investigate the effect of health on retirement.[13] What we know now is that the linkage is complex, and not unidirectional. The fact that the HRS is now available for analysis bodes well for future explorations in this area.

4.2.2. Evidence on the effects of institutional rigidities on retirement

As noted earlier there is ample room for additional research on the effects of institutional rigidities on retirement. In addition to studies on the labor supply effects of pensions, there have also been a handful of empirical efforts to link pension characteristics to attributes of the employers sponsoring the pension plans. One effort to examine the extent of endogeneity of these pension plan design decisions (Hutchens, 1986) concludes that pensions are most prevalent in jobs that are seen as difficult to supervise (e.g., jobs that do not involve repetitive tasks). In a different study, Lazear (1979) concluded that pensions were more prevalent in high-wage firms. And in yet a third analysis, Luzadis and Mitchell (1990) noted that pension systems that initially had rewarded continued work later moved to induce early retirement by offering windows when mandatory retirement was eliminated.

Along with these institutional rigidities affecting the demand for older workers are a set of ideas that have not been fully explored as of yet in the economics literature (Gustman and Steinmeier, 1986a; Hurd, 1996). These factors have to do with intentional age discrimination and unintentional bias due to work policies such as hours constraints that limit workers' choices. The question before the profession, at present, is how we should be thinking about these limitations in light of workers' market mobility and ability to switch jobs (albeit not always at equal or higher pay).

An initial foray into this question is provided in an intriguing new study of older workers' employment and wage growth before and after the passage of state and federal age discrimination laws (Neumark and Stock, 1997). Under the longterm contract model sketched above, laws outlawing mandatory retirement and age discrimination would be expected to increase older workers' employment rates, and probably flatten lifetime earnings profiles for the next cohort of workers (for whom mandatory retirement was impermissible). The first hypothesis was supported in their analysis of US Census data from 1940 to 1990: in fact, older workers' employment did rise after the passage of age discrimination legislation, with little or no effect on younger workers' employment. More surprising was the finding regarding pay profiles; the earnings profile of the "unprotected" younger workers became *steeper* rather than flatter after the law changed, rising by about 0.6% per year on top of the overall age/earnings growth rate estimated at 3–5% per year. (Some steepening of older workers' pay profiles was also discerned, and no parallel effect was found for earnings of self-employed individuals, where the age discrimination laws presumably would not be binding). This empirical result will probably require modifications of the Lazear-type contracting model, if corroborated in future work.

[13] Readers are referred to Currie and Madrian (in this volume) for more extensive discussion of the links between health and health insurance, and labor supply.

Table 7
Perceived constraints on older workers' jobs[a]

	Men (%)		Women (%)	
	Full-time	Part-time	Full-time	Part-time
Hours constrained				
Want more hours but cannot	15	18	15	21
Want fewer hours but cannot	12	5	15	3
Laid off >age 45 from 10+ year job				
Working at new firm	6	8	5	3
Self-employed	2	4	1	1

[a] Source: See Table 3.

Other empirical evidence using microeconomic data is beginning to emerge. Table 7 shows that a substantial minority of full-time HRS workers wanted more flexibility regarding their job work hours, with 12% of the full-time men and 15% of the full-time women workers wanting fewer hours of work on the job than currently available. In addition, 15% of full-time men and women wanted *more* hours of work, indicating that not all older workers find themselves against minimum hours constraints. A relatively small group, around 5–6%, had been laid off from a "career" job (of 10+ years duration) after the age of 45 and was working at a new firm, with a much smaller proportion now self-employed. More evidence on the degree of on-the-job flexibility appears in Table 8, which indicates that as many as one-third of the HRS workers believed they could partially retire while remaining with their employer. On the other hand, between 14 and 17% believed they

Table 8
Perceived attributes of older workers' jobs[a]

	Agree (%)	Disagree (%)
Boss prefers younger workers		
Men	18	83
Women	15	85
Pressure to retire		
Men	18	83
Women	14	86
Pay fair		
Men	81	20
Women	73	28
Can partly retire		
Men	34	65
Women	32	68

[a] Source: See Table 3.

Table 9
Job demands on older workers[a]

	Always/usually (%)	Sometimes (%)	Rarely/never (%)
Physical effort			
Men	41	30	30
Women	39	28	33
Stooping			
Men	30	37	34
Women	24	40	36
Heavy lifting			
Men	20	32	49
Women	15	25	60
Keep up pace			
Men	49	20	31
Women	61	15	24
Good eyesight			
Men	87	9	4
Women	92	5	2
Learn new things			
Men	52	38	9
Women	53	23	7
Use computers			
Men	23	21	55
Women	39	17	43

[a] Source: See Table 3.

faced pressure to retire, and 15–18% felt that their employer favored younger over older workers (Table 8). It may be that the perception of age discrimination against older workers has risen over time, inasmuch as the HRS percentage is twice the level reported between 1966–1980 in the National Longitudinal Survey of Older Men (Johnson and Neumark, 1997). There, 8% of all employed men over age 55 believed they were discriminated against because of their age, a belief that proved to be correlated with somewhat shorter subsequent job tenure (of 1 year less in duration). Interestingly, the earlier survey showed that people reporting age discrimination retired no earlier (i.e., did not leave the labor force at a younger age). It also showed that older workers reporting age discrimination in one job also did so when they moved to subsequent employers, suggesting that great care must be taken in estimation to control for person-specific effects that might mistakenly be attributable to specific employers. Table 9 indicates that many of the HRS workers felt their jobs were physically demanding, required physical effort, and induced stress and required pressure to keep up the pace. In addition, intellectual and emotional job demands were prominently mentioned among the older workforce.

4.2.3. Family considerations and caregiving responsibilities

Because of limited data on the extended family, retirement research in economics has focused

primarily on individual workers' decisions. Similarly, datasets used in retirement research in sociology often have detailed information on social interactions and family structure but lack sufficient detail about key economic variables. Taken together, the two literatures suggest important interactions between economic and social/behavioral variables.

Particularly relevant for retirement research is the potential impact of caregiving responsibilities. As retirement has become more of a luxury and less a necessity, the decision to retire is less a result of health concerns (careneeding) and more likely related to other demands such as caregiving. Yet most of the retirement literature to date does not focus on caregiving, and conversely most caregiving research explores limitations to labor force participation across all ages. Of course longer life expectancy and earlier retirement suggest that retirement-age individuals are more likely to face caregiving responsibilities in conjunction with the retirement decision. Caregiving demands may arise from a variety of sources – from spouses, parents, children, and others – but thus far little work specifically explores the extent of interactions between caregiving and retirement.

Many studies have found an empirical relationship between caregiving and labor force participation. There is also substantial evidence that a disproportionate amount of the caregiving responsibilities falls on women, not just in child-rearing but also in caring for older parents or infirm spouses. Looking across ages, a survey of caregiving research concludes that between 7 and 33% of informal caregivers quit their jobs due to their caregiving responsibilities (Gorey et al., 1992). There is additional evidence that caregiving responsibilities influence even those people choosing not to exit the labor force; that is, there is a significant correlation between caregiver strain and work interference (Scharlach et al., 1991). There appears to be a positive relationship between caregiving and employment for young and middle aged women; those who undertake caregiving and employment simultaneously are more likely to give up caregiving then their jobs (Moen et al., 1994). However, the relationship between caregiving and employment changes as individuals near retirement age. Women age 55–64 are more likely to transit from a state of both working and caregiving to a state of caregiving only. This observation does not necessarily imply a causal relationship between caregiving and retirement; women in this age group are more likely to stop working as time passes, relative to earlier age groups.[14]

In any event, as life expectancies increase, there is a greater probability that workers nearing retirement will need to consider care for a member of the "oldest old", typically a parent, when making their retirement decision. McGarry and Schoeni (1995) document substantial care assistance to elderly parents in the HRS; the number of hours per day spent with the care recipient averaged 7.2 h. It is also likely that different types of caregiving will have different impacts on the retirement decision. For example, Ettner (1995) finds that coresidence of a disabled parent significantly decreases female work hours. In contrast, as noted above, Pozzebon and Mitchell (1989) find evidence of delayed retirement among working women when their spouse is in poor health.

The number of grandparents participating in grandchild care is also increasing, so that

[14] We thank Ed Lazear for this point.

retirement decisions may involve simultaneous caregiving considerations, for both older and younger generations. The number of children living in a home maintained by their grandparents grew by 44% in the last decade (Jendrek, 1993); and in the first wave of the HRS, half of married women with grandchildren spent over 100 h caring for a grandchild in the year preceding the survey (Soldo and Hill, 1995).

It is clear that the next generation of retirement models must focus more concretely on how caregiving responsibilities influence workers' retirement behaviors. The interaction between caregiving and retirement involves complex decision-making, encompassing not only the standard labor/leisure tradeoffs that influence the retirement decision, but also for many women, and probably increasingly for men, the retirement decision will also involve a leisure versus home-work choice as well. Empirical evidence on this set of issues is on the research agenda.

4.2.4. Selection issues

Microeconomists often worry about selection problems in the data they use (see, e.g., Heckman, 1979). Put another way, how can we be sure that our datasets are representative? For example, there is a large group of individuals who is discouraged from applying for social security due to the earnings test (Bondar, 1993). It is estimated that approximately 40% of insured men and women ages 62–64 do not file for benefits and that about 5% of men and 15% of women age 65 and older do not. The existence of this group limits the accuracy with which we can project the effects of changes in social security policy. Another example where selection may be present is in measuring the incentive effects of pension plan provisions on labor force attachment. This is the subject of work by Clark and colleagues (Clark et al., 1988; Clark, 1994) as well as Gustman and Steinmeier (1993), who seek to ascertain whether pensions "bond" workers to firms so they remain on the job for a long time, or whether pensions are a "sorting" device designed to select workers not likely to change jobs.

In general, we are still a long way off from adequately dealing with selection issues in the empirical retirement literature. Cross-sectional studies are useful to measure the effect of economic and health factors on those in the sample; but a cross-sectional study omits many of the disabled and ill because they probably die at younger ages. Studies of worker attitudes towards jobs and employer willingness to adjust to worker disabilities with age, suffer from a similar problem – that is, workers (those whose employers did not adapt the workplace on the employees' behalf) are not likely to remain on the job and thus are unlikely to be in the sample.

Earlier panel datasets have been criticized due to sample attrition bias, a bias that is often thought to become more severe as a panel ages.[15] The upshot of all this is that panel

[15] A recent study by Fitzgerald et al. (1998) investigates this assertion with respect to the approximately 50% attrition in the Panel Study of Income Dynamics (PSID) and argues that the quantitative effects of this attrition are small. Another example of selection is that those in nursing homes (or medical institutions) are not frequently surveyed. The Health and Retirement Study, as well as its companion analysis of older people (the Assets and Health Dynamics – AHEAD) explicitly does seek respondents even if they are in nursing homes.

data which capture the transition into retirement and health decline are required, so as to observe without as much selection what the processes are as individuals progress through the lifecycle.

4.3. Expectations and uncertainty

There are many possible ways to model empirically the information set that workers and firms have when they make their retirement decisions, and how and when these expectations are formed and updated. For example, workers are sometimes asked to provide an "expected date of retirement" when they begin work. If it is fairly costly to change one's mind, then the retirement decision might actually be formulated decades before the actual event. On the other hand, we might want to know how workers respond to unexpected changes in social security or pension plan provisions. In order to understand this, it is important to understand how people form expectations. In particular, it is important to consider the information set that individuals use when maximizing their expected utility and what the consequences are of misperceptions regarding this information set. For example, behavior such as a return to work after leaving a career job might be explained by individual miscalculation with regard to the budget constraint.

At a given point in time, individuals base their decisions on their expectations of the future. Modeling behavior therefore involves approximating these expectations. Two difficulties arise when considering the individual's budget constraint – dynamic uncertainty and the role of preferences.

From an empirical perspective, dynamic uncertainty arises because the econometrician does not know when the individual makes the decision to retire. But incorrect approximation of the worker's expectations could result in incorrect forecasts of behavior. Another source of dynamic uncertainty arises because workers cannot perfectly forecast future economic conditions. Additionally, uncertainty arises because many people do not fully understand the inputs into the retirement decision (see, e.g., Bernheim, 1989; Bernheim and Levin, 1989). Thus instead of using the "actual" budget constraint (that which is optimal at a given point in time for a specific information set, assuming perfect foresight), behavior may be better approximated by the econometrician by using a "notional" budget constraint (one that mimics the individual's impressions about the decision; see Anderson et al., 1986).

Rust (1989) raises the issue of approximating continuous processes with discrete variables and its effect on dynamic modeling. For example, such models often assume that workers re-examine the retirement decision once a year, usually on their birthdates. Yet in reality we know that individuals may retire at any time. In addition, workers may initially think about retirement in the context of social norms, for example, focusing on key ages in their pension plan documents. In this event some component of the retirement decision may occur early on in one's career. Lumsdaine et al. (1996a) consider the utility loss from adopting an "age-65" rule-of-thumb versus using a dynamic model to evaluate the optimal age of retirement. They find that for many people, the utility loss associated

with rule-of-thumb behavior is not substantial. This suggests that some people may decide to retire at age 65, for example, just because they have been conditioned (perhaps due to social security nomenclature) to think of this as the "normal" retirement age.

The Health and Retirement Study represents a unique opportunity to investigate how expectations are formed. A variety of subjective questions are asked (e.g., "how likely are you to be working past age 62?" and "how likely are you to live past age 85?"). The panel nature of the dataset implies that over time, researchers will be able to determine the accuracy with which individuals form expectations. As noted earlier, subjective assessments approximate actual life expectancies well and vary along demographic lines in ways analogous to actual probabilities (Hurd and McGarry, 1993). This suggests that subjective assessments regarding the probabilities of working past a certain age may be useful in modeling retirement. Preliminary evidence from the HRS indicates that of the 642 individuals who retired by wave 2 but were full-time workers in wave 1, and reported in wave 1 an expected age of retirement between 50 and 70, 74% retired within a year of their expected age.

Another important aspect of retirement behavior modeling is the role of preferences. Two studies seek to identify interesting distributions of utility function parameters, including rates of time preference and degrees of risk tolerance. In the simple intertemporal consumption model of Samwick (1998), the workers' problem is assumed to be characterized by a value function that depends on additively separable per-period utility as follows:

$$V_s(A_s) = \underset{\{C_t\}}{\text{Max}} \left[E_s \sum_{t=s}^{T} (1+\delta)^{s-t} u(C_t)\right] \qquad \text{with } u(C) = \frac{C^{1-\rho}}{1-\rho}.$$

His simulation model seeks to uncover the distribution of δ, the worker's rate of time preference, from the distribution of behaviors in the data. A point that becomes immediately clear is how difficult it is to identify all the multiple parameters that might be of interest. Samwick experiments with two different assumed values of ρ, the relative risk aversion parameter, and holds constant in the simulation other unknown parameters such as the expected rate of earnings growth, interest rates, and the variances of shocks to income. His approach also assumes that retirement ages are fixed, so the technique cannot be said to be directly informative about the set of retirement issues of immediate interest here. A different approach, by Barsky et al. (1997), uses HRS survey respondents' answers to questions like the following:

> "Suppose that you are the only income earner in the family, and you have a good job guaranteed to give you your current (family) income every year for life. You are given the opportunity to take a new and equally good job, with a 50–50 chance it will double your (family) income and a 50–50 chance that it will cut your (family) income by a third. Would you take the new job?"
>
> If the respondent replied yes, he or she was then asked: "Suppose the chances were 50–50 that it would double your (family) income, and 50–50 that it would cut it in half. Would you still take the new job?"

> And if the reply was negative, the next question was: "Suppose the chances were 50–50 that it would double your (family) income, and 50–50 that it would cut it by 20%. Would you then take the new job?"

The responses indicated that more than 65% of the respondents said they were unwilling to accept the first gamble, corresponding to a relative risk aversion coefficient of at least 3. The implied risk aversion parameters were then correlated with a host of explanatory variables including several found to be negatively associated with risk tolerance, such as income, age, and purchase of health and life insurance. Factors positively associated with risk tolerance were smoking and drinking, people holding stocks and home renters, and respondents who were Hispanic, Catholic, and lived in the West. That study, too, did not link estimated utility parameters to retirement behavior, suggesting an interesting avenue for future research.Not only are preferences difficult to identify because the dimensionality of individual beliefs is very large, but in a dynamic context, it is also necessary to model changes in preferences over time. Thus, for example, individuals may prefer leisure to labor with greater intensity as they age. Lumsdaine et al. (1990b, 1996b) allow for limited change in preferences by including in their specification a parameter (k in Eq. (4b)) that varies with age.

Aggregate uncertainty also plays a role in an individual's decisions. For example, the popular press has focused on the solvency of the social security trust fund; perhaps as a result, many young workers doubt that they will receive benefits by the time they retire (Burtless, 1996). Similarly, workers now know that even pension plan provisions may change with little or no warning. Many firms are shifting to defined contribution plans – while these do not contain the incentive effects typical of defined benefit plans, they transfer investment risk from the firm to the worker. Thus workers may face greater uncertainty regarding the adequacy of their retirement savings in the future.

5. Conclusions

Economic studies of retirement in the last decade have greatly enriched the theoretical and empirical models used to explore behavior of workers as they age and move out of the labor market. Much of the modeling and empirical work has examined retirement from the labor force as primarily a discrete choice outcome, rather than a continuous process, and one that has been seen as mainly motivated by worker-side behavior rather than employer-driven. Of course, these worker-side decisions are powerfully influenced by economic factors such as pensions, social security, and retiree health insurance plans, and in many cases these benefit packages are designed by employers seeking a particular set of retirement and turnover results in their labor forces.

A consistent empirical finding across studies is that older people appear to have strong preferences for leisure, such that it takes a rather substantial change in pensions and/or social security to change peoples' retirement behavior by much. Thus companies instituting early retirement window plans have had to offer quite generous pension sweeteners, in

order to achieve much of a reduction in force. The literature also leaves us with some puzzles, including why retirement patterns spike at age 62 and 65, even after controlling for pension income available at those ages. The empirical literature of the last decade also shows us that poor health plays an important role in older workers' labor supply decisions, though there remains much work to be done in explaining the health/retirement link. It stands to reason that a health shock such as a work disability increases the chances of a worker leaving his job, and employer accommodation can reduce or cushion the effect.

We also anticipate that retirement modelers and empirical researchers will be seriously tested in the next few years, as several demographic, economic, and social changes play out. For instance, analysts have shown that retirement income programs reduce labor supply among older workers, but only about half of the longterm trend toward men's early retirement in the US can be explained by social security and pension changes (Anderson et al., 1999). A related question is whether policy changes have symmetrical effects on older peoples' work patterns. This latter point is of special interest since it appears that in the US of late men's retirement ages may have ceased to fall (Quinn and Burkhauser, 1994). What explains this change (the strong job market, changes in retirement incentives, or other factors) has not yet been determined. Architects of public pension programs are similarly interested in whether benefit cutbacks prompted by budget shortfalls will induce people to work longer, as theory and empirical evidence to date suggests. Company sponsored pension systems are also changing as firms move from a defined benefit to a defined contribution pension format. The 401(k) plan in particular is growing exceptionally quickly: these are company-based investment accounts that permit workers to tax-defer wages and invest them in a mix of capital market assets (McGill et al., 1996). How these new plans will influence retirement patterns is of keen interest to the policymakers of the next decade. In all, retirement researchers can look forward to a wide variety of "natural experiments" with which to evaluate determinants of retirement using next-generation theoretical and empirical models.

Above we have described the enormous opportunities afforded retirement researchers interested in using several new panel data sets. In our view the highest priority research questions to explore with these data include the following:

1. How can we better understand workers' decisions regarding how much to work, to save, and to consume, particularly in a family/household context?
2. How can we better understand how employers see older workers, relative to their productivity and their compensation costs?
3. How can all these behaviors be cast in a dynamic context, so as to allow the natural readjustments that certainly take place in the real world?
4. What are the key differences between peoples' expectations about their retirement wellbeing and their "objective" wellbeing, and what do the gaps predict, if anything, for behavior?
5. How should retirement models be extended to incorporate links with saving and consumption?

Answering these questions will not be easy, but we are fortunate to face the next decade with important new datasets and interesting dynamic models that will make these investigations possible.

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