Retirement Incentives and Labor Supply

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Abstract

In this chapter, we review the evidence on retirement and study the role of incentives in the retirement decision. The key patterns of withdrawal from the labor market are presented and some of the factors that might explain the large and discrete drops in hours of work at the point of 'retirement' are presented. We study the main retirement incentives that individuals face and place these financial and other incentives in the context of a structural approach to modeling retirement. We use this approach to frame issues of how government and private pension schemes affect retirement behavior. Noting that the typical household nearing retirement today in most developed economies is one in which both husband and wife work, we examine the theory and evidence on modeling incentives in couples and for joint decision-making. We conclude with a discussion of some of the gaps in our understanding of the employment of the elderly and raise some central questions that should be addressed by future research.

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2.1 Introduction

Virtually all developed countries face challenges to the affordability of public (and, in some cases, occupational) pension programs. The shortfalls arise for two reasons. First, populations in developed countries are aging rapidly. Second, until recently, older individuals in developed countries have been retiring earlier. These two developments created serious strains on public pension programs.

In order to address these issues and help public and occupational pension programs to remain solvent, there have been significant reforms across many countries to pensions and regulations relating to older workers. These policy changes have been accompanied by non-trivial increases in the labor supply of the elderly over the same period. This trend has occurred in multiple countries, raising the question of whether the policy reforms have caused the increases in labor supply.

Employment among the elderly is an important factor in helping developed countries to deal with the ongoing demographic transition towards an older population. It is therefore a topic that has attracted significant attention from policymakers and researchers. In this chapter, we review the evidence on how employment rates among the elderly have changed in developed countries over recent decades and discuss the main factors that are thought to influence older workers' labor supply. We do this within an economic framework of life-cycle decisions about consumption, saving, and labor supply.

In addition to the policies discussed in this chapter, many countries have also changed regulations affecting labor demand. In particular, many have abolished mandatory retirement ages, meaning employers can no longer make workers redundant or refuse to hire them on the grounds of age alone. Such demand-side policies are also likely to have been important in affecting employment rates, but discussion of these is beyond the scope of this chapter.

We start, in Section 2.2, by describing trends in employment of older women and (in particular) men over the last few decades and put these patterns in the context of a longer historical context. Most of our focus in this chapter is on the extensive margin of labor supply among the elderly. We motivate this focus in Section 2.3 by describing patterns of withdrawal from the labor market and some of the factors that might explain the large and discrete drops in hours of

work that are seen for most people at the point of 'retirement'.

In order to better understand whether policy reforms have been important for explaining the rise in employment amongst the elderly, it is essential to know how sensitive labor supply is to the financial incentives caused by these reforms. To further examine these incentives, Section 2.4 discusses some of the key retirement incentives that individuals face and summarizes key papers that have examined the retirement response to these incentives. We then place these financial and other incentives in the context of a structural retirement model in Section 2.5. We use the model to frame issues of how government and private pension schemes affect retirement behavior. The discussion in that section builds upon French and Jones (2012). Lumsdaine and Mitchell (1999) also provide a useful survey of similar issues.

In recent years, increasing attention has been paid to joint decision-making within families. This has largely been motivated by the fact that individuals in couples are often observed to exit work at roughly the same time as each other, in a way that cannot simply be explained by the individual incentives to retire that each member of the couple faces – suggesting instead that some interactions between the behavior of the two members of a couple are important in determining when each quits employment. The growing labor force attachment of women over recent decades means that the typical household approaching retirement today in most developed economies is one in which both husband and wife work. As a result, understanding how the circumstances and behavior of one member of a couple affects those of the other member has become an increasingly important part of understanding employment among the elderly. Section 2.6 examines the theory and evidence on the joint retirement behavior of couples – extending the discussion of the life-cycle model presented in Section 2.5 to allow for one partner's behavior and/or incentives to affect the other. Different motives for retirement in couples are considered, focusing on attempts to separate preferences from financial incentives. We find that ignoring the role of family decisions in modeling retirement can distort the picture of retirement and bias the analysis of retirement policies.

Our main conclusion is that the labor supply of older workers is responsive to changes in retirement incentives. This means that the trend towards lower effective taxes on older workers in many developed countries is likely to continue to fuel the recent trend towards later retire-

ment. This, in turn, is likely to reduce the financial strain on public pension schemes. But we are still some way from fully understanding the precise channels through which external factors (such as reforms to public pension schemes) affect retirement behavior. Despite a large body of important evidence that has been assembled, new patterns of retirement raise new questions about retirement behavior. For example, although the research we review has established that financial incentives from pension schemes have significant effects on the employment of older people, in many countries (such as the United States (US) and the United Kingdom (UK)) retirement incentives from pension plans are now much smaller than in previous years, yet many people in those countries still retire at certain announced 'retirement ages'. There remains much to be learned. Section 2.7 concludes with a discussion of some of these gaps in our understanding of the employment of the elderly and raises some central questions that should be addressed by future research.

2.2 Trends in Employment amongst the Elderly

2.2.1 Post-War Trends in Employment

In the last 20 years, we have seen a rapid increase in employment rates of the age 55+ population in developed countries. All 14 countries listed in Table 2.1 saw an increase in the employment rate of 55- to 64-year-olds between 1999 and 2007 and Table 2.2 shows that this trend has continued for most countries over the 2007–13 period that covered the global financial crisis.

Tables 2.3 and 2.4 show employment patterns of the population aged 15–54. Table 2.3 shows that, over the period 1999–2007, employment rose for those aged 15–54 in most countries we consider, with the US being a major exception. There is an active debate in the US about what factors explain the historically unprecedented steady decline in labor force participation of both men and women since the turn of the century ((Moffitt, 2012)). However, as Table 2.3 suggests, this phenomenon is somewhat peculiar to the US. The US was one of only two countries (the other being the UK), of the 14 developed countries shown, to have experienced a decline in overall employment rates of adults aged 15–54 between 1999 and 2007.

Table 2.1: Changes in employment rate of 55- to 64-year-olds, 1999 to 2007

Country	Change in employment rate, 1999 to 2007			Employment	Employment
	Men	Women	All	rate in 1999	rate in 2007
New Zealand	13.5	17.1	15.3	56.5	71.8
Netherlands	12.8	14.8	13.8	34.9	48.8
Germany	12.6	14.6	13.5	37.8	51.3
Australia	9.2	16.0	12.5	44.0	56.5
Canada	6.9	13.4	10.2	46.8	57.0
France	8.6	11.1	9.9	28.3	38.2
Belgium	7.8	11.3	9.7	24.7	34.4
Spain	7.2	11.3	9.5	35.1	44.5
United Kingdom	6.5	8.4	7.4	49.3	56.8
Sweden	6.1	6.1	6.1	64.0	70.1
Italy	3.8	8.0	6.0	27.6	33.7
Denmark	5.0	5.2	4.7	54.2	58.9
United States	1.3	6.5	4.1	57.7	61.8
Japan	2.0	3.1	2.7	63.4	66.1

Note: Countries listed from largest increase in employment to smallest. Employment rate shown is calculated across both men and women.

Source: Authors' calculations using data from the OECD and the UK Labour Force Survey.

Table 2.2: Changes in employment rate of 55- to 64-year-olds, 2007 to 2013

Country	Change in employment rate, 2007 to 2013			Employment	Employment
	Men	Women	All	rate in 2007	rate in 2013
Germany	10.5	14.2	12.3	51.3	63.6
Netherlands	10.2	12.6	11.3	48.8	60.1
Italy	7.8	10.3	9.0	33.7	42.7
France	7.9	7.0	7.4	38.2	45.6
Belgium	4.9	9.8	7.4	34.4	41.7
Australia	3.3	6.8	4.9	56.5	61.4
Sweden	3.9	3.3	3.6	70.1	73.7
Canada	1.2	5.4	3.3	57.0	60.3
Denmark	1.6	3.9	2.7	58.9	61.7
United Kingdom	0.7	4.6	2.7	56.8	59.5
New Zealand	-1.4	6.4	2.5	71.8	74.3
Japan	-1.7	3.0	0.7	66.1	66.8
United States	-1.4	-0.4	-0.9	61.8	60.9
Spain	-9.1	6.1	-1.3	44.5	43.2

Note and source: As Table 2.1.

Table 2.3: Changes in employment rate of 15- to 54-year-olds, 1999 to 2007

Country	Change in employment rate, 1999 to 2007			Employment	Employment
	Men	Women	All	rate in 1999	rate in 2007
Spain	6.7	18.3	12.6	57.9	70.5
Italy	3.1	8.6	5.7	58.4	64.2
France	2.4	6.5	4.4	65.4	69.8
New Zealand	3.9	4.6	4.2	71.5	75.7
Australia	2.5	5.5	4.0	72.0	76.0
Netherlands	0.2	6.7	3.3	76.9	80.2
Canada	1.5	5.0	3.3	73.5	76.8
Belgium	0.9	4.9	2.9	65.2	68.0
Japan	0.4	3.2	1.8	70.2	72.0
Sweden	1.6	0.7	1.2	74.1	75.2
Denmark	-0.4	2.5	1.0	80.5	81.5
Germany	-1.1	2.5	0.7	72.3	73.0
United Kingdom	-0.9	0.5	-0.2	74.3	74.1
United States	-3.2	-2.7	-2.9	76.0	73.1

Note and source: As Table 2.1.

All other countries saw increases and in some cases substantial increases. Though Denmark and Germany saw a decline in the employment rate of men, this was more than offset by rising employment rates among women – in contrast to the US, where employment rates for both men and women declined significantly.

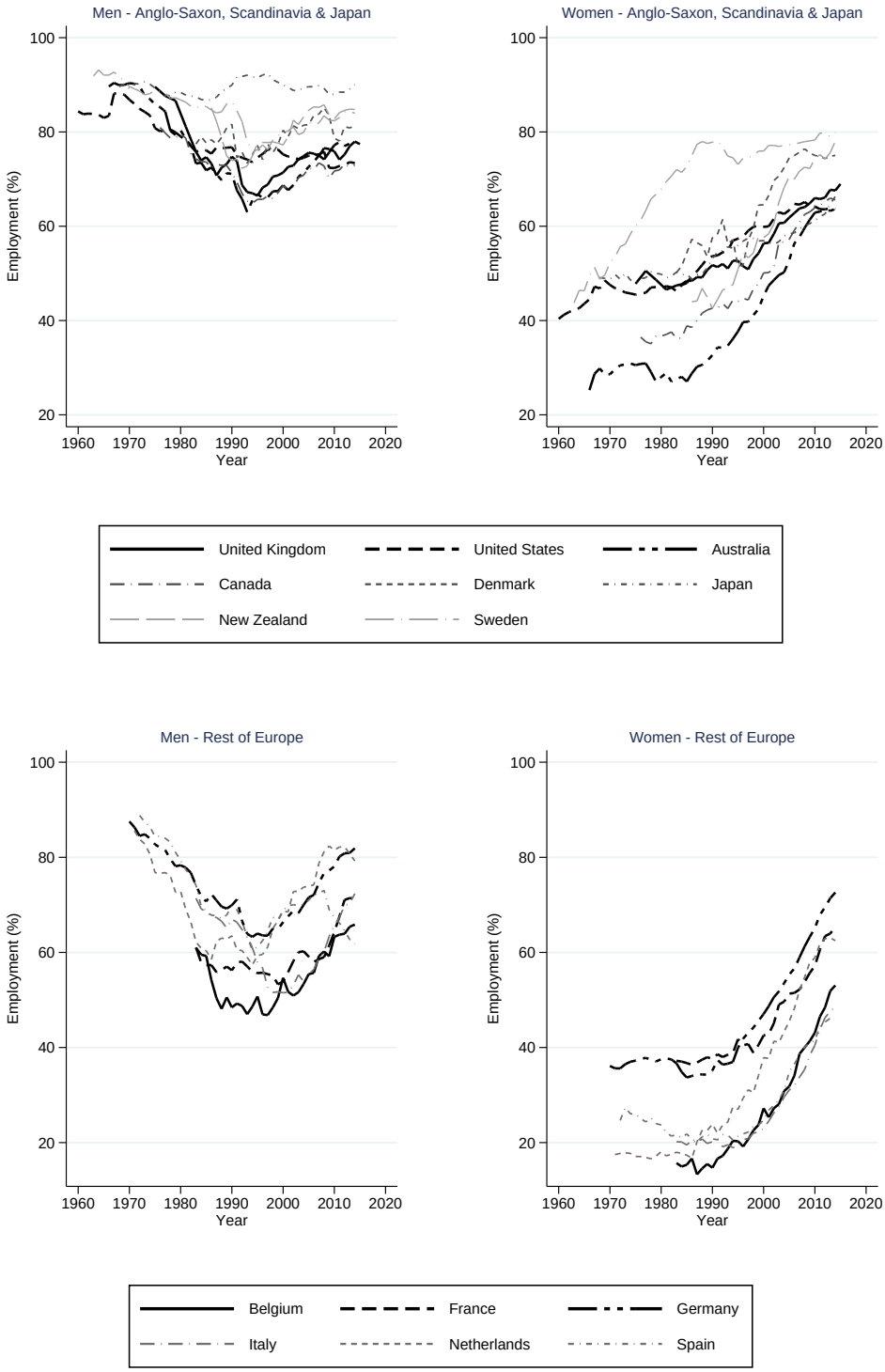
However, comparing Tables 2.1 and 2.3 shows that, with the exception of Spain, the employment increase was larger for those aged 55–64 than for those aged 15–54. Comparing Tables 2.2 and 2.4 shows that the differences in employment changes by age is even more dramatic over the 2007–13 period. For all countries except Japan, employment grew more rapidly for the 55–64 age group than for the 15–54 age group over this period. For most countries, employment rates rose for the 55–64 population, which is in stark contrast to what happened to the employment rates of younger adults.[1]

Increases in employment rates of older individuals since 1999 continue a trend that began in (at least) the 1980s for women and the mid 1990s for men in most of the countries, as Figures 2.1–2.4 show.

Over the last half a century, trends in employment of older men and trends in employment of

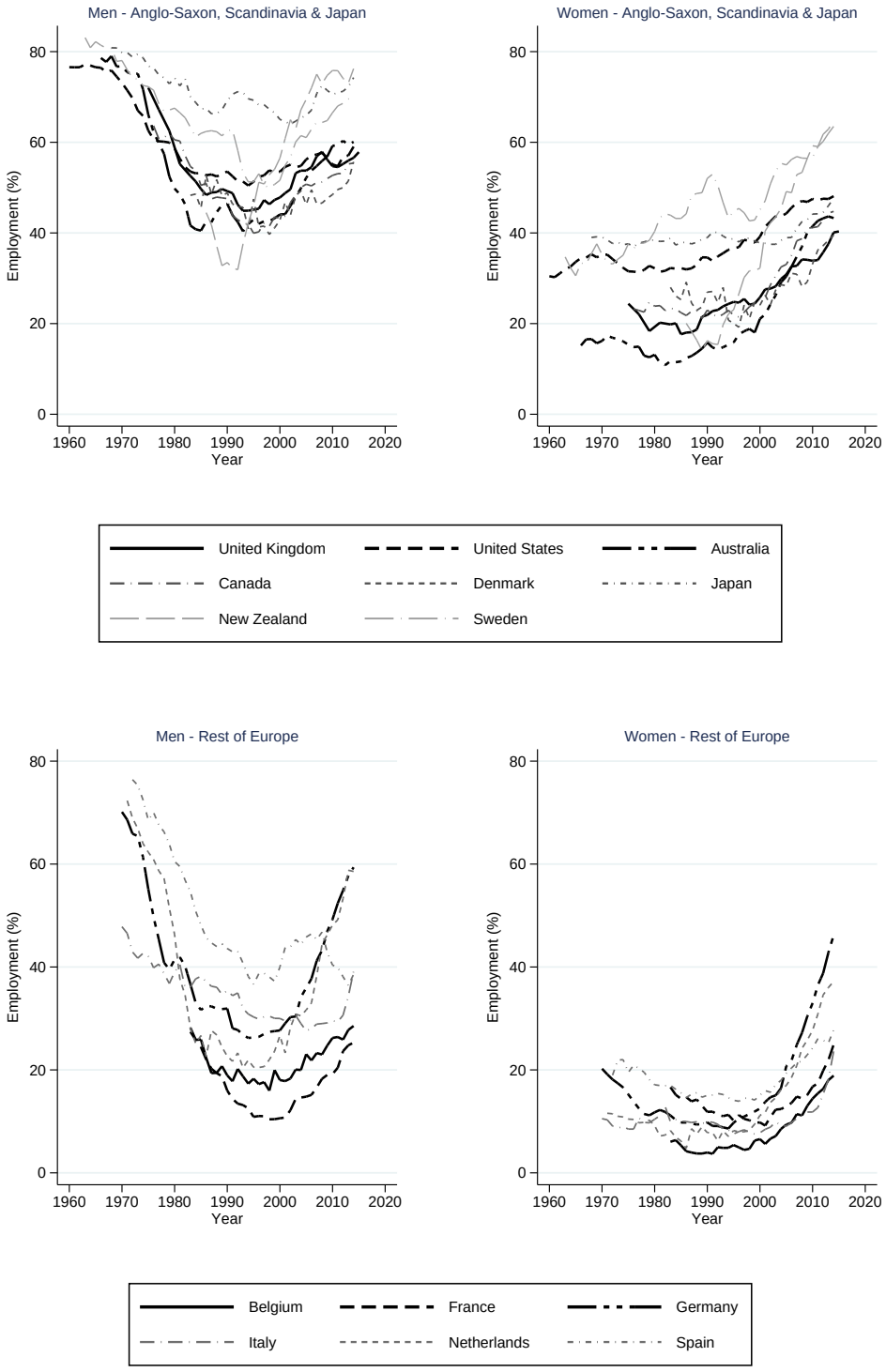
[1]While employment rates of younger adults did increase between 2007 and 2013 in Germany, the 2.9 percentage point increase seen for younger adults was well below the 12.3 percentage point increase in employment rates among those aged 55–64.

Figure 2.1: Employment of those aged 55–59



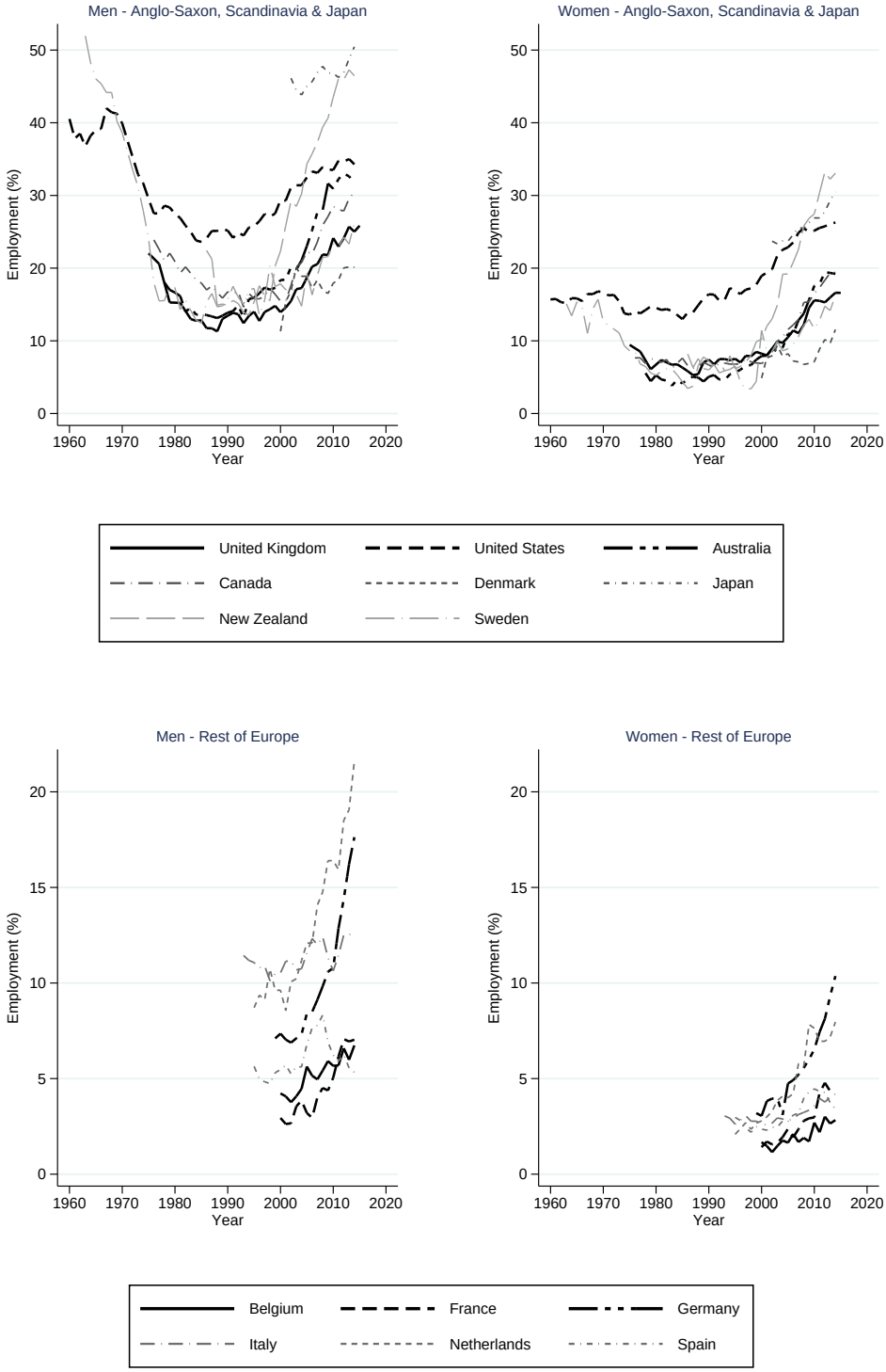
Source: Authors' calculations using data from the OECD and the UK Labour Force Survey.

Figure 2.2: Employment of those aged 60–64



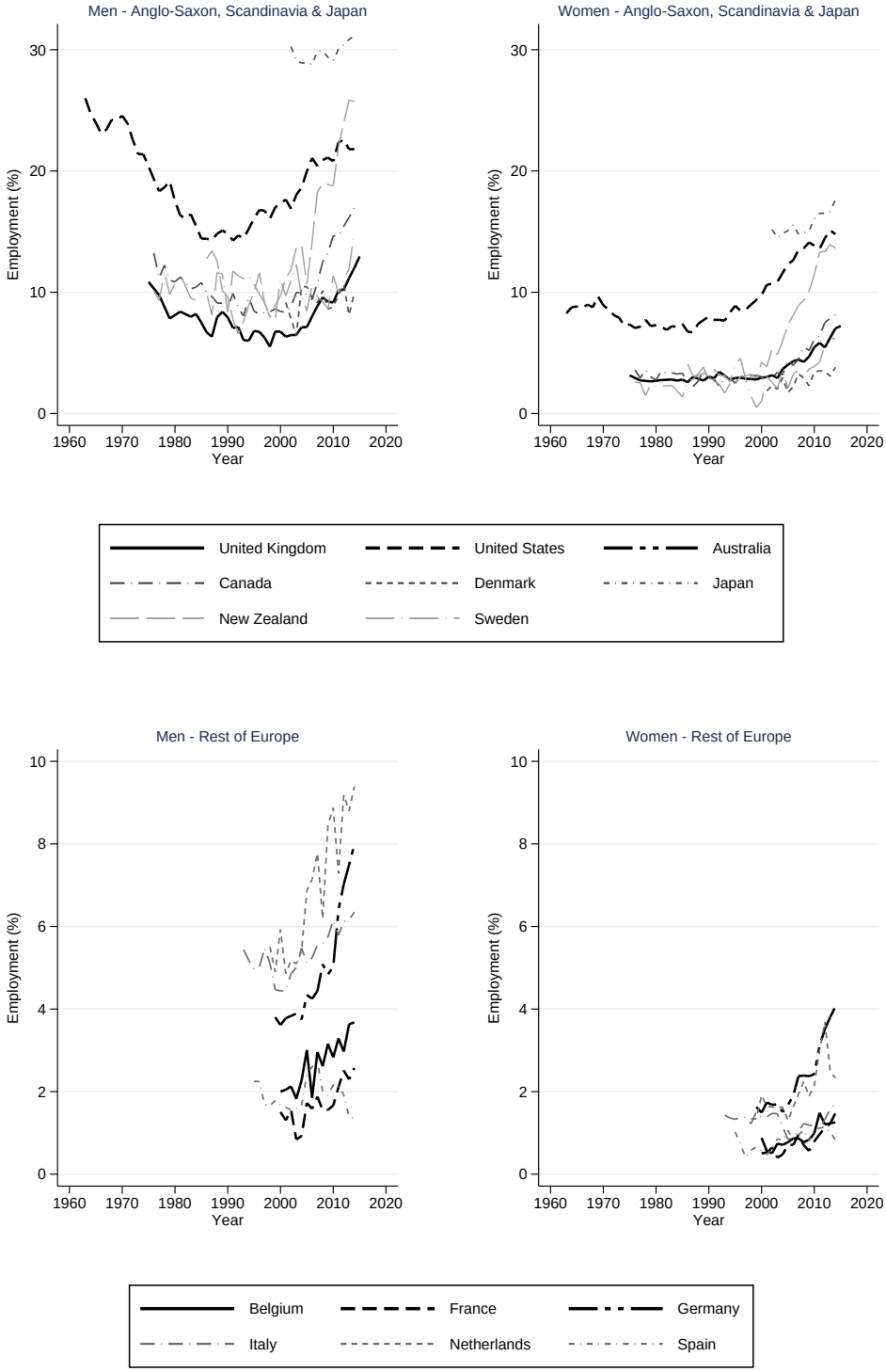
Source: As Figure 2.1.

Figure 2.3: Employment of those aged 65–69



Source: As Figure 2.1.

Figure 2.4: Employment of those aged 70–74



Source: As Figure 2.1.

Table 2.4: Changes in employment rate of 15- to 54-year-olds, 2007 to 2013

Country	Change in employment rate, 2007 to 2013			Employment	Employment
	Men	Women	All	rate in 2007	rate in 2013
Germany	1.6	4.3	2.9	73.0	75.9
Japan	-0.8	2.9	1.0	72.0	73.1
Sweden	-1.1	0.0	-0.5	75.2	74.7
France	-2.7	-0.0	-1.3	69.8	68.5
United Kingdom	-2.7	-0.4	-1.5	74.1	72.6
Australia	-2.9	-0.8	-1.8	76.0	74.2
Netherlands	-5.3	0.4	-2.5	80.2	77.8
New Zealand	-4.2	-2.3	-3.2	75.7	72.5
United States	-5.5	-4.0	-4.8	73.1	68.3
Italy	-8.3	-2.0	-5.2	64.2	59.0
Denmark	-7.8	-5.2	-6.5	81.5	75.0
Spain	-18.5	-7.1	-13.0	70.5	57.5

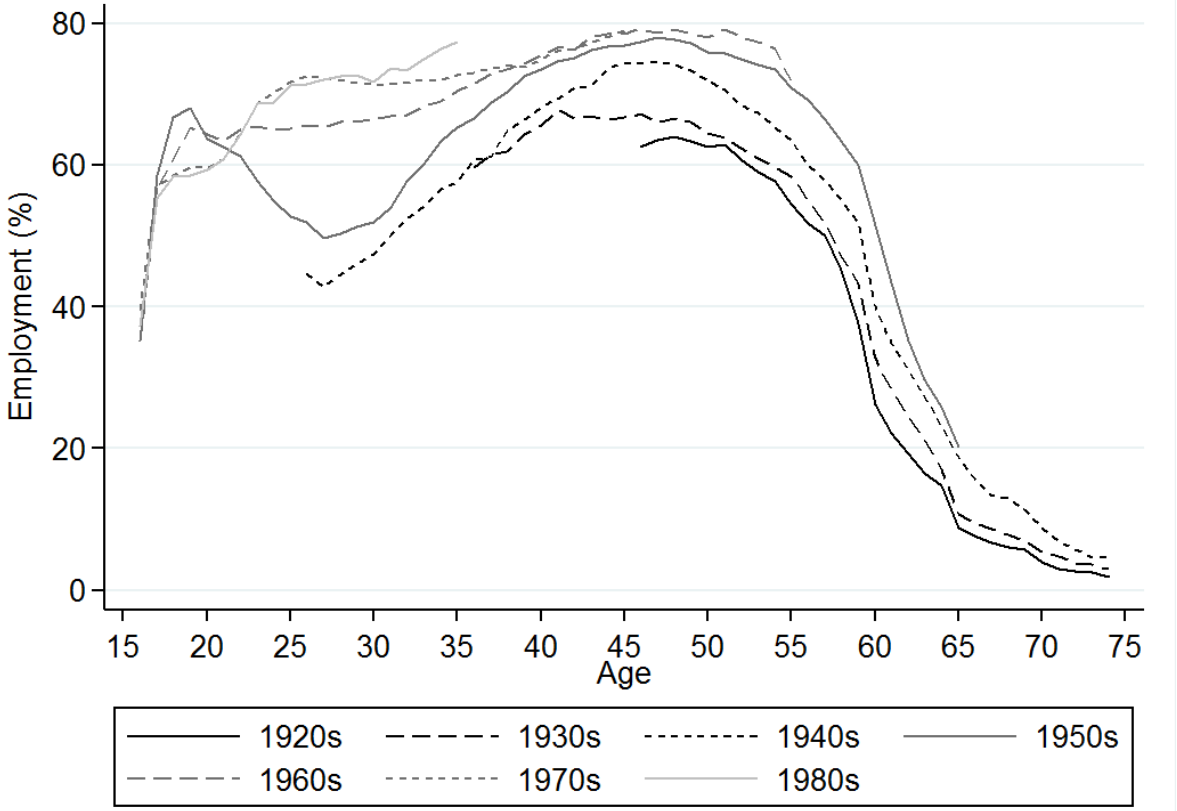
Note and source: As Table 2.1.

women have followed remarkably similar patterns in many developed countries. For example, as Figure 2.2 shows, between 1960 and the mid 1990s there was a steady decline in employment rates of men in their early 60s in many developed economies.

For men, the declines were larger in some countries than in others: the employment rate of men aged 60–64 in the Netherlands dropped from 72.3% to 20.5% (or 51.8 percentage points) between 1971 and 1995, while in the US the drop over the same period was 20.2 percentage points. Since the mid 1990s, employment rates of older men have started to increase again in virtually all developed countries. Though the magnitudes of the decline and the following increase differ across countries, the regularity of the patterns is striking.

Trends in employment of women during the post-war period have been rather different from those of men. Employment rates of older women have increased steadily and significantly across all developed countries over the last few decades. Rising labor force attachment of successive cohorts of women at all ages dominates the picture. For example, as Figure 2.5 suggests, in the UK rising employment rates at older ages reflect the fact that successive cohorts of women have been more likely to be in paid work at younger ages too. There was a particularly sharp increase in employment rates of women in their 30s and 40s between those born in the 1920s and those born in the 1960s. The fact that employment rates ceased to increase further between those born in the 1960s and those born in the 1970s might suggest that

Figure 2.5: Employment rates of successive cohorts of women in the UK



Source: Figure 2.7 of Chandler and Tetlow (2014b).

the rapid rise in older women's employment rates that has been seen over recent decades in the UK might slow down as these later cohorts age.

These cohort trends in female employment began at different points in different countries. In particular, as Figures 2.1 and 2.2 show, the rise in older women's employment rates began later in Italy and Spain than it did in Australia, Canada, the US, and many northern European countries.

In the 1970s, employment rates of older women were well below those of men in developed countries. However, steady increases in employment rates of women over the following four decades, coupled with declines in employment of older men up to 1995, mean that employment rates of older women are now much closer to those of men. Among women aged 55–59, employment rates in northern European countries, the US, and Canada are virtually the same as those among men of the same age. For example, in Sweden in 2014, 79.9% of women aged 55–59 were in paid work, compared with 84.0% of men. However, the gaps remain larger in

southern European countries: in Italy in 2014, just 48.6% of women aged 55–59 were working, compared with 72.4% of men.

The facts described above suggest that the factors driving employment among older groups may be different from the factors affecting younger groups, but they also suggest that there may be common factors underlying the similar trends among the old in different countries. There are many possible explanations for these trends, which we explore in Sections 2.3–2.6.

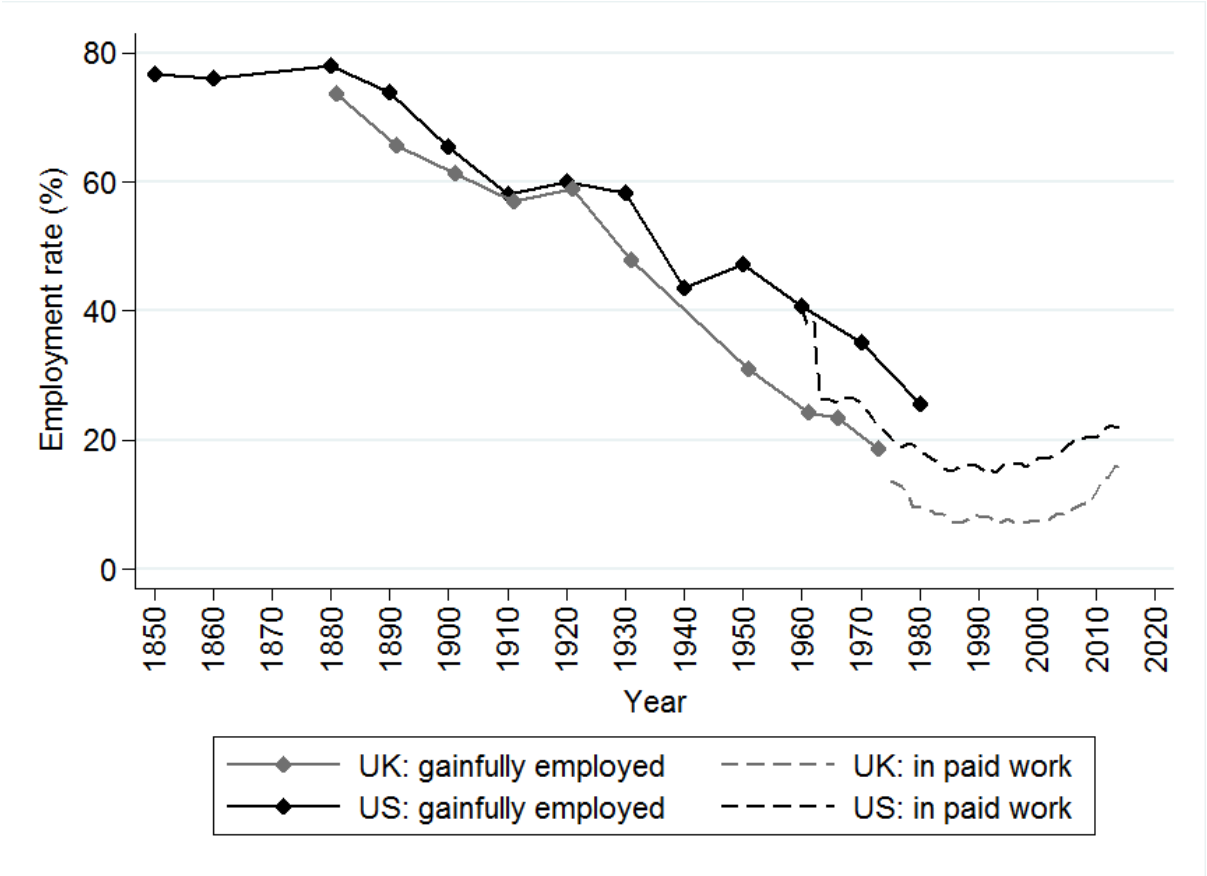
2.2.2 Historical Context

The concept of retirement as a significant period of leisure at the end of life is a relatively recent phenomenon. As Figure 2.6 shows, in the late 19th century, over three-quarters of all men aged 65 and over in the US were engaged in gainful employment. This fraction declined steadily over the following century, reaching an employment rate of less than one-fifth by the mid 1990s. Very similar patterns were seen in the UK and other European countries over the same period (Costa, 1998).

In the 19th and early 20th centuries, policymakers envisaged retirement as reflecting the point at which older workers (principally men) became incapable of working sufficiently productively. The public pension schemes that were established across much of the developed world at around this time were introduced with the intention that the state should insure individuals against the risk that they would live beyond the point at which they could contribute productively in the labor market. For example, as Costa (1998) summarizes, the statistician Frederick Hoffman argued in 1906 that a country's productive potential could be maximized if people ceased working at age 65; in a similar vein, the economist (and eventual architect of the UK's post-war welfare state) William Beveridge argued in 1909 that older workers lacked the adaptability to cope with rapid technological change.

Germany, under Otto von Bismarck, was the first country to introduce an old-age social insurance program, which came into force in 1889. This pension was founded on the principle that, as Kaiser Wilhelm I wrote to the German Parliament in 1881, 'those who are disabled from work by age and invalidity have a well-grounded claim to care from the state'. Reflecting this notion of a pension insuring against disability for work, the eligibility age was initially set

Figure 2.6: Employment rate of men aged 65+ in the UK and the US



Source: Data for the UK from Matthews et al. (1982) and the Labour Force Survey. Data for the US from Moen (1987) and OECD.

at 70.

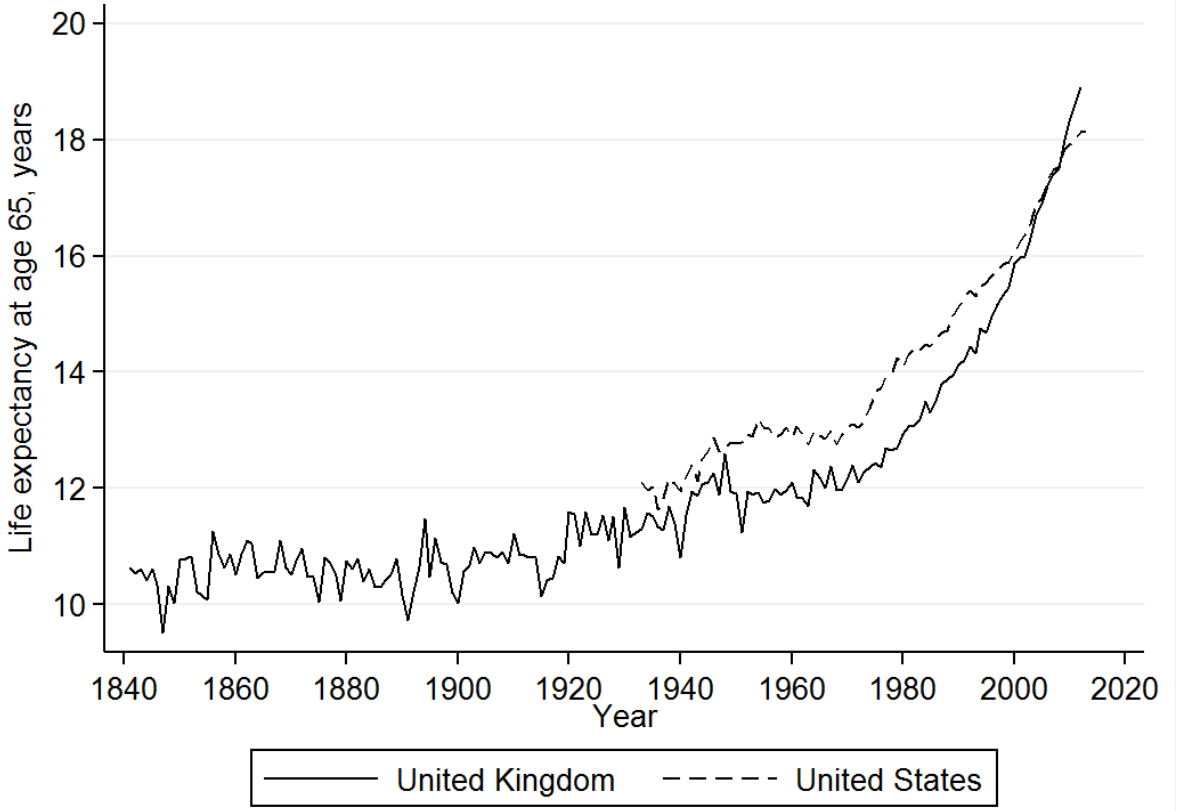
The same eligibility age was adopted by the British, in 1909, when they too introduced an old age pension. For those who were reaching pension age in the UK system's first year of operation, life expectancy at birth had been just 40 years for men and 43 years for women. Only one-in-four of those born in 1838 in the UK would actually have been alive to receive a pension.[2]

It was only somewhat later that pension eligibility ages were reduced to 65, which subsequently became widely accepted as an appropriate age to retire in many countries. The pension eligibility age was reduced to 65 in 1916 in Germany and in 1925 in the UK, and it was 65 from the inception of Social Security in 1935 in the US.[3]

[2]In contrast, over four-in-five of the men born in 1943 and the women born in 1948 (who reached the eligibility age for public pensions in 2008) were still alive. Source: Department for Work and Pensions (2008).

[3]Age 65 had also been used by the Pensions Bureau in the US as the age of pension eligibility for Union army veterans from 1890 onwards (Costa, 1998).

Figure 2.7: Life expectancy of men at age 65 in the UK and the US



Source: UK data from the Office for National Statistics. US data from the Human Mortality Database.

When the pension age was set at 65 in the UK, in 1925, life expectancy for men at that age was 11.2 years (as Figure 2.7 shows). This figure had changed little over the preceding 80 years. However, over the following 90 years (and particularly after 1960), it was to increase rapidly, reaching 18.9 years by 2012. This, coupled with the sharp fall in employment rates of older men described in section 2.2.1, led to a rapid expansion of the period spent in 'retirement'.

The same coincidence of rising life expectancy and falling employment rates led to similar expansions in the prevalence and length of retirement across most developed countries after the Second World War. Most people in developed countries now expect to have a period of leisure at the end of their lives, with the date of their exit from employment determined not only by declining productivity and capacity to work but also by other factors such as their access to publicly and privately provided pensions.

2.2.3 Trends in Hours of Work

As Figures 2.8 and 2.9 show, the pattern of part-time work follows a U shape over the life cycle, at least in the US and the UK. Part-time work in the US is very common at young ages, as many young people attend school and work at the same time. But part-time work is very common at older ages in the US as well: about 40% of working men and 60% of working ages 65-70 women are part-time. Part-time work amongst older workers is even more common in the UK. Part of this increase late in life is related to the trend towards higher self-employment in the late 60s. Many workers are part-time self-employed individuals after age 65. However, conditioning on being an employee, part-time work rises after age 65 too.

We do not show part-time rates in France above age 64, because so few French people work after age 65. However, the U-shaped profile in France does seem to be less pronounced.

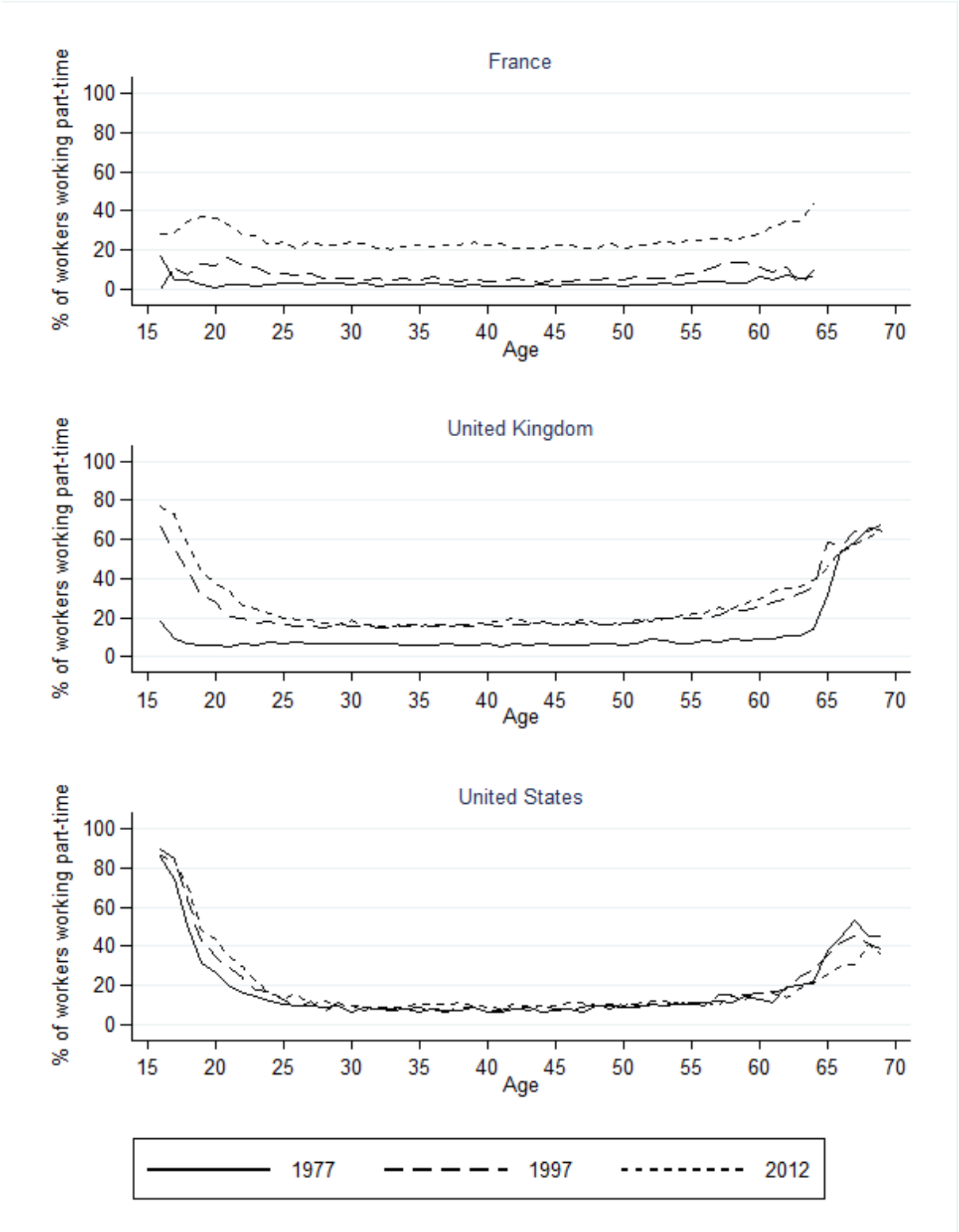
Figures 2.8 and 2.9 also show that part-time work was more common in 2012 than in 1977, especially in France but in the UK too. This trend, however, occurs at all ages. Part-time work after age 65 was common in the US and the UK in 1977.

2.2.4 Trends in Self-Employment

Self-employment constitutes only a small share of total employment across the population as a whole in most developed countries. However, among older workers, it is a much more significant phenomenon. As Figures 2.10 and 2.11 suggest, the fraction of workers who are self-employed rises sharply with age in France, the UK and the US. For example, in France in 2012, fewer than one-in-ten male workers aged under 30 were self-employed, compared with around one-in-three workers aged 60–64.

There are a number of reasons why self-employment may play a greater role among older people than among younger people. First, historically, employers in many countries have imposed mandatory retirement ages (determined either by government or by company-specific policies). As a result, older people who wished to work beyond that age often had to turn to self-employment instead. Mandatory retirement ages were common across developed countries in the early 1990s but many countries have made them illegal in recent years – for example, Australia, Canada, New Zealand, and the UK (Wood et al., 2010). Second, self-employment

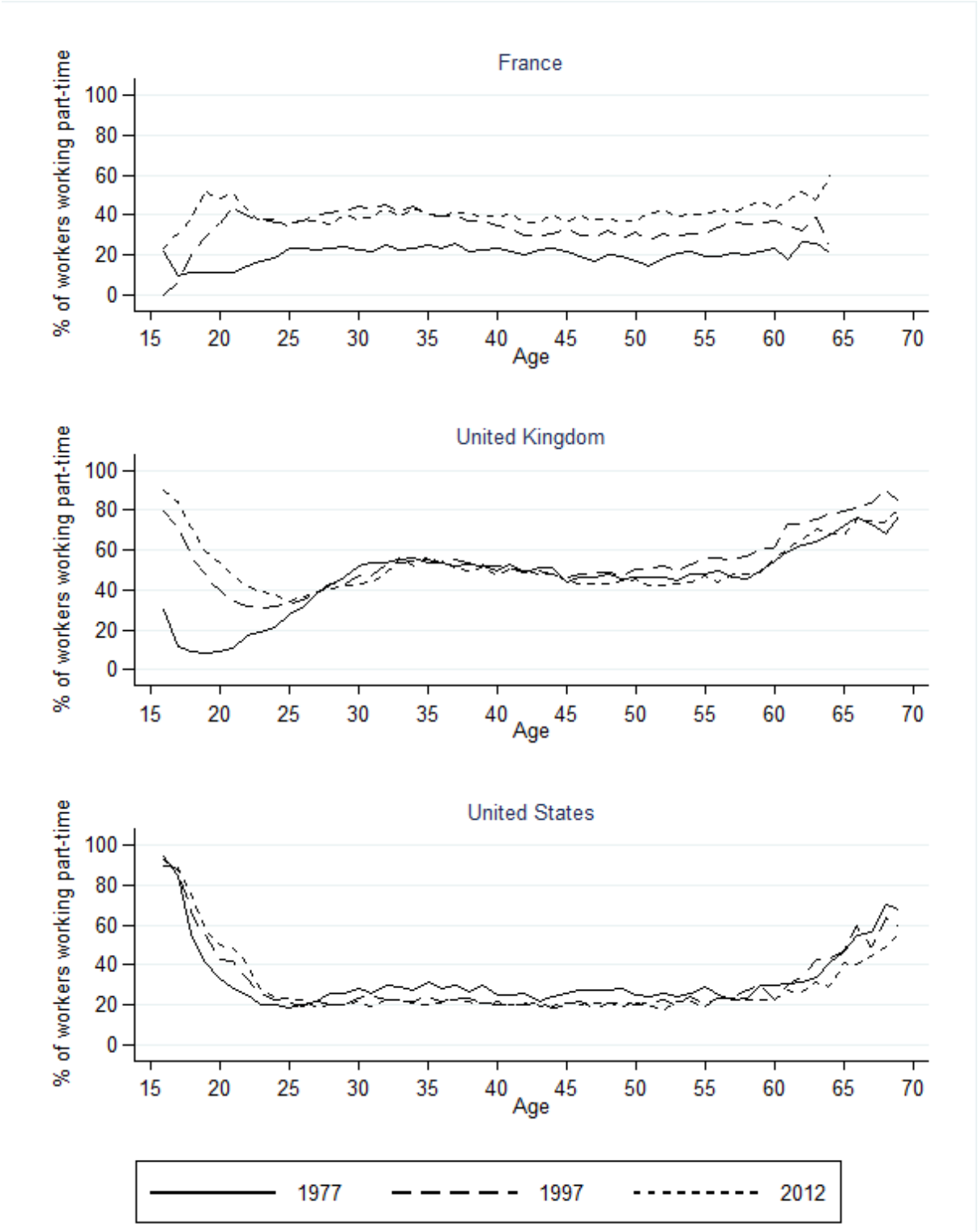
Figure 2.8: Prevalence of part-time working among male workers



Note: Part-time work is defined as working no more than 1,500 hours a year.

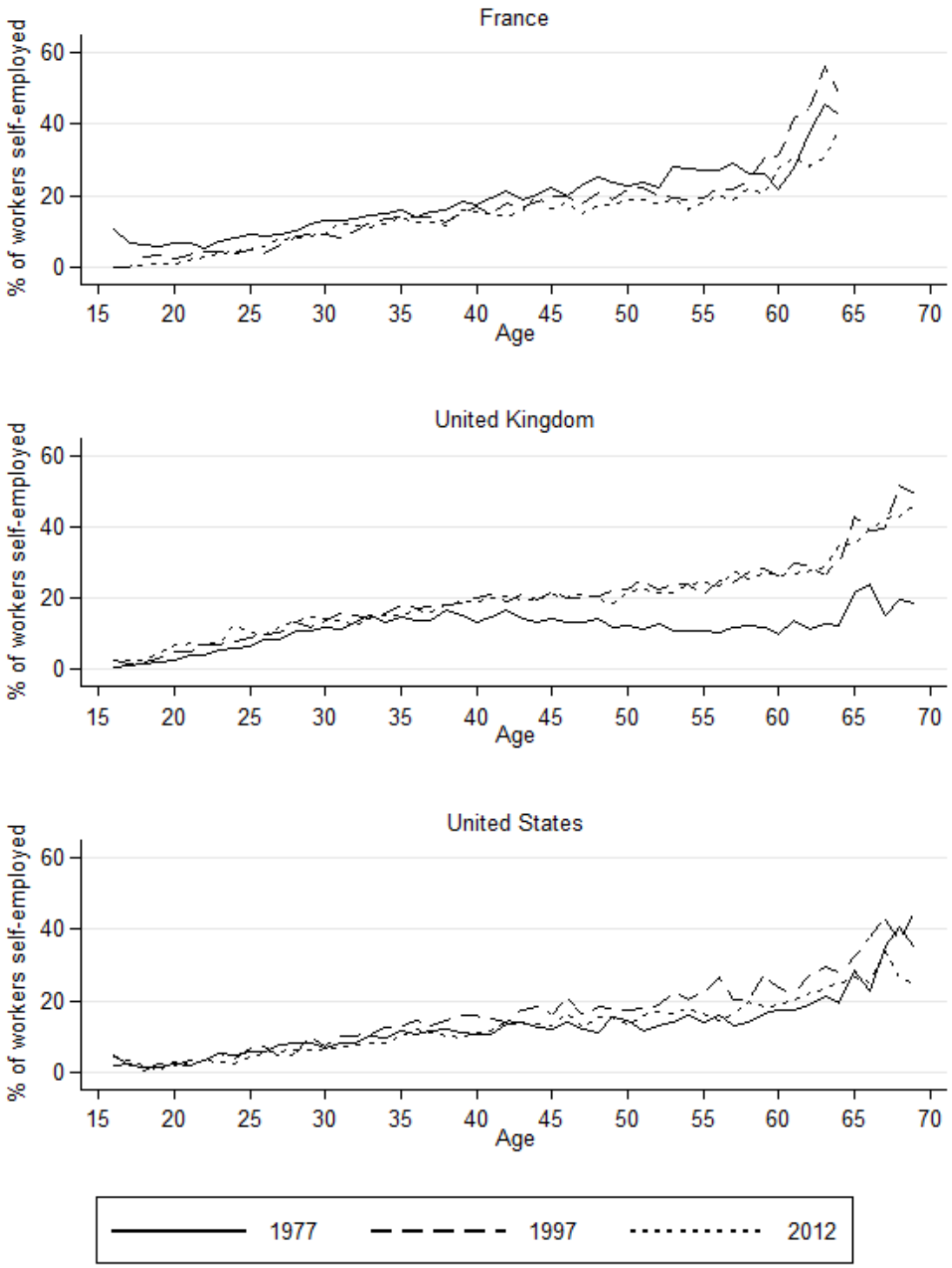
Source: Authors' calculations using Enquête Emploi for France, the Labour Force Survey for the UK, and the Current Population Survey for the US.

Figure 2.9: Prevalence of part-time working among female workers



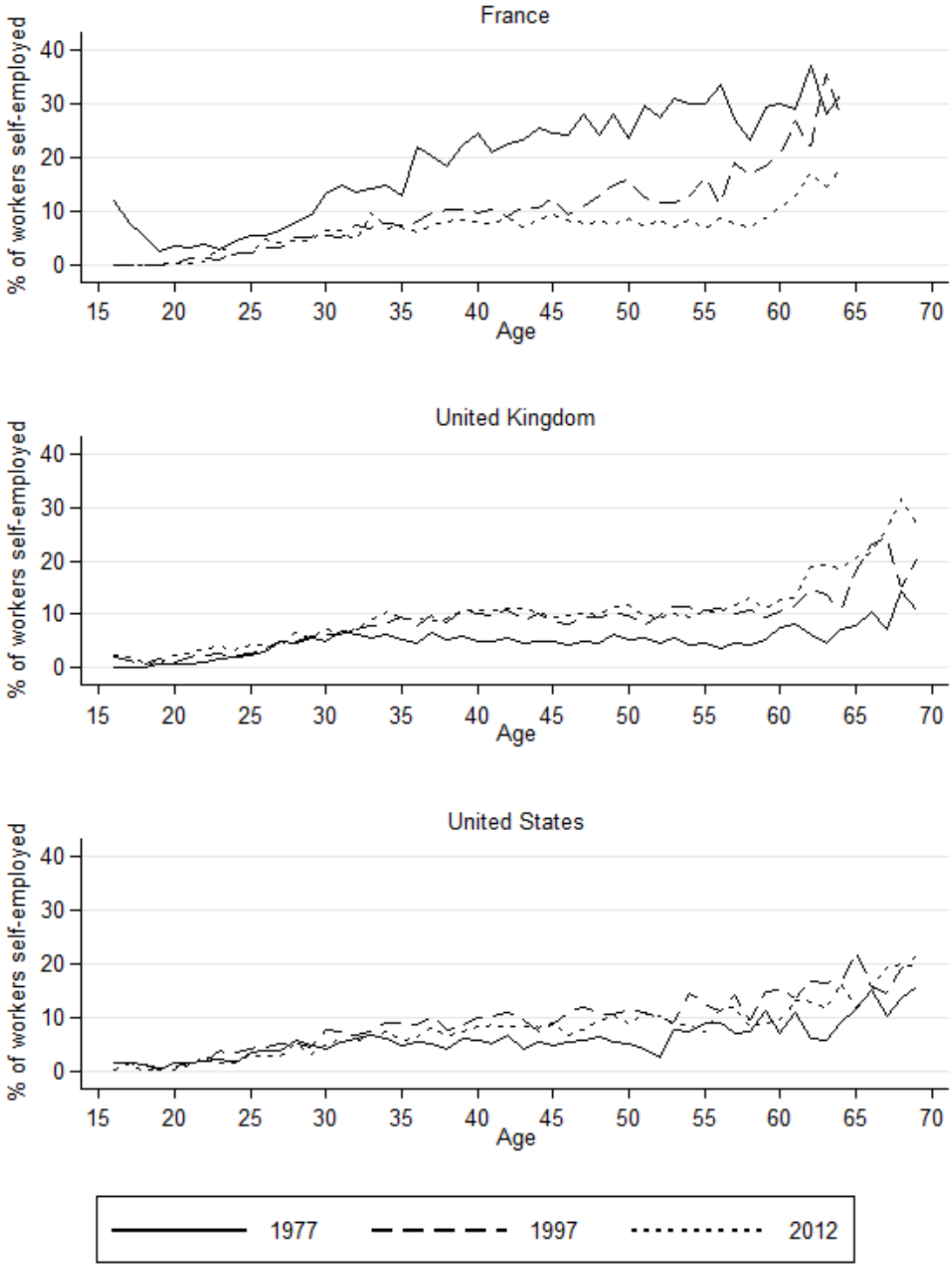
Note and source: As Figure 2.8.

Figure 2.10: Prevalence of self-employment among male workers



Source: Authors' calculations using Enquête Emploi for France, the Labour Force Survey for the UK, and the Current Population Survey for the US.

Figure 2.11: Prevalence of self-employment among female workers



Source: As Figure 2.10.

may allow greater scope for flexibility in hours and conditions of employment (Banks et al., 2012).

2.3 The Retirement Decision

2.3.1 The Life-Cycle Profile of Hours and Employment

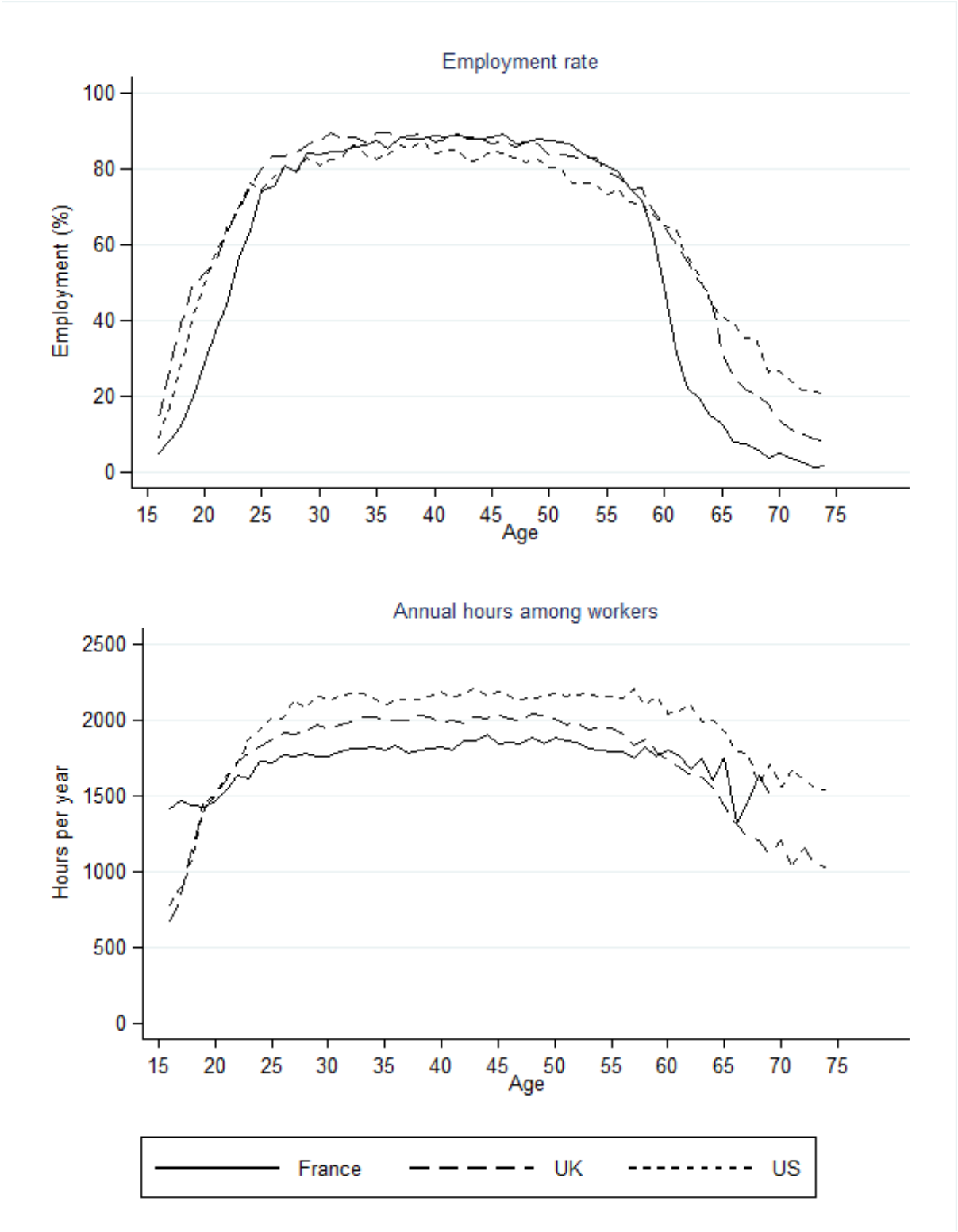
Before turning to examine factors that influence individuals' retirement decisions (in Section 2.4), it is important to start by characterizing the nature of the retirement process in developed countries. For much of the post-Second-World-War period, retirement has been an abrupt transition for many workers. That is, it typically manifests as a sharp change from working many hours a week to not working at all, rather than workers gradually reducing their hours from full-time to not working.

Figures 2.12 and 2.13 show how employment rates and hours of work among the employed differed with age in France, the UK, and the US in 2012 (for men and women, respectively).[4] In all three countries, employment rates drop sharply at older ages. While the average hours of work per year among those who are employed also decline slightly with age (particularly from age 60 onwards), hours of work still remain reasonably high at older ages. For example, in the US, workers on average work over 1,500 hours a year (equivalent to more than 31 hours a week for 48 weeks a year) even in their early 70s. This suggests that many people make a sharp transition in hours of work at the point of retirement.

The ages at which hours and labor force participation rates decline most rapidly differ across countries. Employment rates decline at a younger age in France than in the UK, which in turn sees an earlier decline in employment than the US. As we will discuss, the declines in each country typically coincide with the ages at which there are large pension and other policy-related disincentives to work and also coincide with the age at which wages decline.

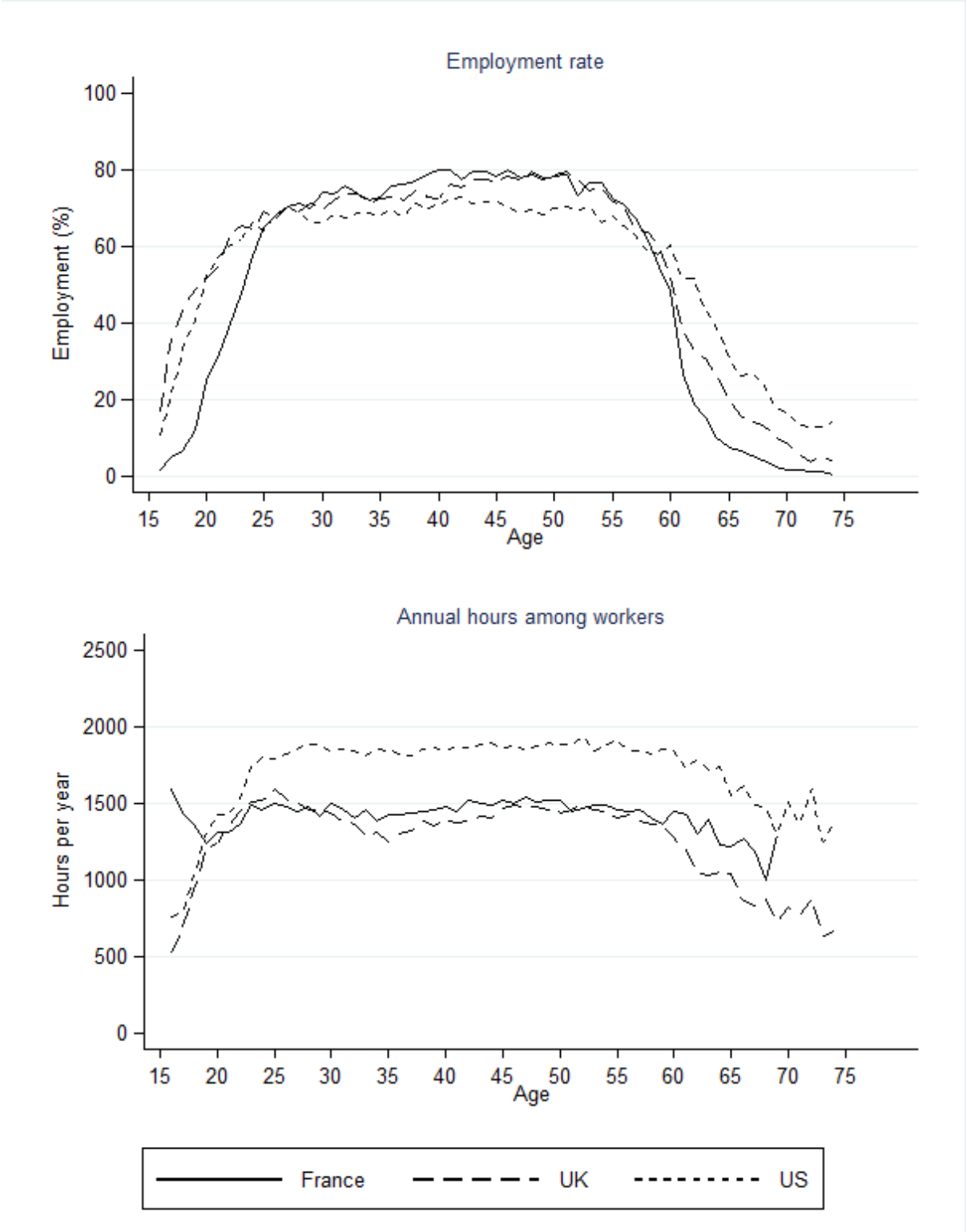
[4]These figures use updated data similar to those presented by Blundell et al. (2013). We are very grateful to Antoine Bozio for providing access to their data to allow us to produce these figures.

Figure 2.12: Employment rates and hours of work, by age: men in France, the UK, and the US



Figures for hours of work at ages 70–74 in France are excluded due to small sample sizes. Source: Blundell et al. (2013), updated using data from Enquête Emploi (France), the Labour Force Survey (UK), and the Current Population Survey (US).

Figure 2.13: Employment rates and hours of work, by age: women in France, the UK, and the US



Note and source: as in figure 2.12.

2.3.2 The Distribution of Hours Worked near Retirement Age

Several papers have noted that a common retirement transition is from full-time work to no work at all. This is an observation that is consistent with the more general finding that much of the variability of labor supply is on the margin of whether or not to work, rather than in the number of hours conditional on working (see, for example, Chang and Kim (2006), Ljungqvist and Sargent (2006), Rogerson and Wallenius (2009), Chetty et al. (2011), Erosa et al. (2014), and Ljungqvist and Sargent (2014)).

Much of the literature on the labor supply response to tax reforms has considered only the decision of whether or not to work, sometimes called the 'extensive margin'. Other papers assume that everyone works until a fixed and exogenous retirement age and focus on the number of hours worked by workers, sometimes called the 'intensive margin'. Figures 2.12 and 2.13 show that – even though both margins are important – most changes in life-cycle labor supply occur along the extensive margin. For example, while in the US participation rates drop dramatically between ages 62 and 65, hours worked among those in employment drop much more modestly. Similarly, employment rates in France drop sharply at age 60, while hours of work among those in work decline only slightly at this age.

Table 2.5 shows the distribution of hours worked by older men and women in France, the UK and the US. The table reveals that in all countries, even at ages 60–64, most working men are working over 1,500 hours per year, which would correspond to 30 hours per week for 50 weeks per year. This finding is corroborated by other studies. Rupert and Zanella (2015) show the density of hours worked at different points in the life cycle in the US. They show that part-time work is rare until ages 64–68. Similarly, for the UK, Chandler and Tetlow (2014a) show that fewer than one-in-ten men in their early 50s work part-time (defined in their analysis as fewer than 30 hours a week), but this rises to over half among employed men in their late 60s. Part-time work is more prevalent among women but, as Figure 2.13 suggests, this is true at all ages (particularly in France and the UK).

Using data from the Current Population Survey, the Panel Study of Income Dynamics, and the Health and Retirement Study, Fan (2015) shows that about 75% of all men who exit the labor force at older ages were working at least 35 hours per week in the year prior to

Table 2.5: Distribution of hours worked, by country, age, and sex (2012)

	Men		Women	
	Ages 50–54	Ages 60–64	Ages 50–54	Ages 60–64
France				
0 hours	25.2	77.5	35.5	80.3
1–500 hours	0.6	0.9	2.1	1.8
501–1,000 hours	2.1	1.7	5.9	2.4
1,001–1,500 hours	5.8	2.1	11.0	3.2
1,501–2,000 hours	26.1	6.3	25.9	6.1
2,001–2,500 hours	23.5	5.4	13.8	3.9
2,501+ hours	16.7	6.0	5.9	2.3
United Kingdom				
0 hours	24.5	53.0	32.8	70.1
1–500 hours	0.9	2.0	2.8	4.0
501–1,000 hours	2.5	4.0	8.4	6.6
1,001–1,500 hours	4.4	5.9	13.2	6.8
1,501–2,000 hours	19.0	12.1	24.3	7.3
2,001–2,500 hours	30.0	15.1	13.1	3.6
2,501+ hours	18.6	7.9	5.4	1.6
United States				
0 hours	22.9	44.7	32.7	52.6
1–500 hours	1.2	1.4	1.9	1.8
501–1,000 hours	1.6	2.5	3.1	3.7
1,001–1,500 hours	3.4	4.1	6.5	5.9
1,501–2,000 hours	7.1	6.4	12.0	9.2
2,001–2,500 hours	42.1	28.3	34.9	21.8
2,501+ hours	21.7	12.7	8.7	4.9

Source: as in figure 2.12.

retirement. Blau and Shvydko (2011) and Rogerson and Wallenius (2013a) report similar facts. Using data from the English Longitudinal Study of Ageing, Chandler and Tetlow (2014b) show that, of those who moved from full-time work into retirement between 2002–03 and 2012–13, 68% of men and 60% of women moved straight from full-time work to retirement, without experiencing an intervening period of part-time work, self-employment, or unemployment.

However, this does not mean that most individuals make the transition from a full-time career job to permanent non-work. Ruhm (1990) shows that less than two-fifths of household heads retire directly from career jobs, over half partially retire at some point in their working lives, and a quarter re-enter the labor force after initially retiring. Maestas (2010) shows that nearly 50% of retirees follow a non-traditional retirement path that involves partial retirement or unretirement, and at least 26% of retirees later unretire.

2.3.3 Potential Explanations for the Abruptness of Retirement

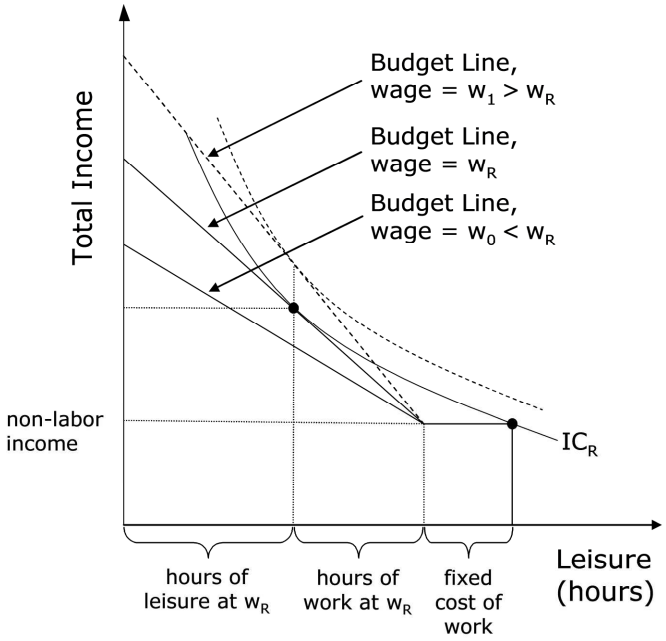
Why does there appear to be so little labor supply variability along the hours of work margin? Perhaps the most important reason is that there are fixed costs to working. It takes time to commute to work. Estimates of mean commuting time in several countries range from about 7% to 10% of market work time (Juster and Stafford, 1991). Furthermore, work involves extra monetary costs, such as food at restaurants and work clothes.

Spending falls on average by about 20% at retirement in Britain (Banks et al., 1998), and similar declines in spending have been documented in other countries as well. Part of this fall comes from declines in transportation and food bought in restaurants, suggesting that working imposes fixed costs on workers.[5]

There might also be fixed costs of work on the part of employers. Employers might incur fixed costs to recruit, hire, and train employees, and they might have to pay fixed administrative costs to keep records on each worker. Desk and office space is costly as well. Because these fixed costs must be spread over fewer hours of work for part-time employees, firms are likely

[5]This decline in spending does not necessarily represent a decline in retirees' standard of living. Aguiar and Hurst (2005) have argued that, even though spending on food declines after retirement, the nutritional quality of the food actually rises as individuals replace the fast food they ate when working with more nutritious home-cooked meals. However, Banks et al. (1998) and others have shown that the declines do not seem to be entirely explained by work-related expenses.

Figure 2.14: The labor supply decision with fixed costs of working



to pay lower wages to part-time workers. For example, Aaronson and French (2004) find that a part-time worker makes about 25% less per hour than a full-time worker, which is similar to what is found by Gustman and Steinmeier (1986) and others. Rogerson and Wallenius (2009) stress the importance of this issue in their analysis of participation and life-cycle labor supply.

To illustrate how fixed costs of work affect individuals' decisions about whether to work or not, Figure 2.14 shows the labor–leisure tradeoff that arises (in a static model) when there are fixed costs of working. The vertical axis shows the individual's total income; the horizontal axis shows hours of time, which are divided between leisure and work. The indifference curve IC_R (which passes through the point where no labor is supplied) shows that at the reservation wage, w_R, the individual is indifferent between working 0 hours and the amount of hours of work at w_R. If the wage falls below w_R, the individual will not work. If the wage rises, the individual will work for sure and, moreover, work a large number of hours. For those who are almost indifferent between working and not, small changes in the wage can induce large changes in hours. However, once wages are high enough to justify working, further wage increases will cause much smaller increases in hours. As an example, in Figure 2.14, raising the wage from w_R to w_1 yields higher utility but leaves hours of work unchanged.

French (2005) and French and Jones (2011) find that, in order to fit the decline in hours

of work seen among older workers in practice, fixed costs must be high. Depending on the specification, a fixed annual cost of work is estimated at 240–1,313 hours per year by French (2005) and at 826 hours per year by French and Jones (2011). Most of these estimates are much higher than the estimates of commuting times in Juster and Stafford (1991), for example. The lower estimates in French (2005) are the estimates that account for a part-time wage penalty: both part-time wage penalties and fixed costs of work imply that it is not advantageous for an individual to work part-time. Rogerson and Wallenius (2013b) show that either fixed costs must be large or labor supply very elastic (with an intertemporal elasticity of substitution of labor supply in the range of 0.75) in order to explain the abruptness of retirement.

The importance of participation decisions in determining labor supply and the apparent importance of fixed costs in affecting participation lead us to believe that labor supply elasticities are not constant over the life cycle. Instead, they are likely higher at ages when individuals are nearest to the participation margin. Given that the decision to retire by definition implies that the participation margin has been crossed, it is almost surely the case that older workers are nearer the participation margin than younger workers, whose participation varies much less. It is thus plausible that labor supply elasticities are higher at older ages. Many empirical studies confirm this, as we discuss in Section 2.5.3.

However, fixed costs of work are not the only potential explanation for the abruptness of the hours decline at retirement. For example, Fan et al. (2015) develop a retirement model with endogenous human capital accumulation. In such a model, because human capital depreciates, individuals have an incentive to cluster their hours in a small number of years. Reductions in work hours lead to reductions in future wages. Thus individuals have an incentive to keep work hours high until retirement.[6]

There are also more institutional reasons for remaining in the labor market. For example, in the US, many individuals work for firms that provide defined benefit pensions, where the value of the pension benefit is a function of final salary, amongst other variables. Thus, in such schemes in the US, a decline in work hours would lead to lower earnings and thus pension

[6]Fan (2015) integrates time non-separabilities in preferences for labor supply. He shows that these non-separabilities can create work habits that create a tendency for either high hours of work or no work at all.

benefits.[7] Fan (2015) shows that those with pension benefits are more likely to make a discrete jump from full-time work to non-work than those without a pension.

There might also be firm-based constraints. For whatever reason (such as coordination of work schedules), many firms do not let workers reduce their hours at a fixed wage schedule. Consistent with this view, Hurd (1996) shows that the share of the population who are self-employed (who are less likely to face these constraints) rises with age. The self-employed also tend to retire much more gradually than those employed by others. Banks et al. (2012) also find that – in both England and the US – reductions in hours of work are more common among those who change jobs or who move into self-employment than among those who remain employed in the same job with the same employer. This suggests that there is some rigidity in the employment contracts offered by employers to existing employees. Beffy et al. (2014) formulate and estimate a model with restricted hours choices.

Figures 2.8 and 2.9 show that many people who are working at older ages are working part-time. However, in most developed countries, it is still common for people to experience a sharp reduction in hours worked at the point of retirement, rather than gradually reducing their hours of work to zero. The next section discusses the key factors that have been highlighted by the literature as being important determinants of when people retire.

2.4 Retirement Incentives

There are many factors that are likely to incentivize individuals to continue or to cease working at older ages. In this section, we review the main factors that have been identified as being important, describing why these factors might matter in theory and reviewing the reduced form evidence on their importance in practice. Section 2.5 then shows how these factors can be incorporated into structural models of life-cycle consumption and labor supply and assesses the structural evidence on the quantitative importance of these factors. Our focus in both sections is on factors affecting the supply of labor among older workers. We do not devote much attention

[7] In the UK, in most defined benefit schemes, pension benefits are a function of final salary calculated on a 'full-time equivalent' basis. Consequently, periods of part-time work at the end of a career may have a less detrimental effect on a scheme member's pension than is the case in the US. However, there may still be a disincentive to move into part-time work if a scheme member would experience a reduction in hourly pay from doing so.

to factors potentially affecting the demand for older workers. Our focus on the supply side is in part motivated by the evidence presented in Section 2.2, which suggests that trends in employment of older workers have been rather similar across a large number of countries over recent decades, despite the fact that labor market institutions (such as the nature of employment contracts) are very different in these countries. This suggests that supply-side factors may be the most important.

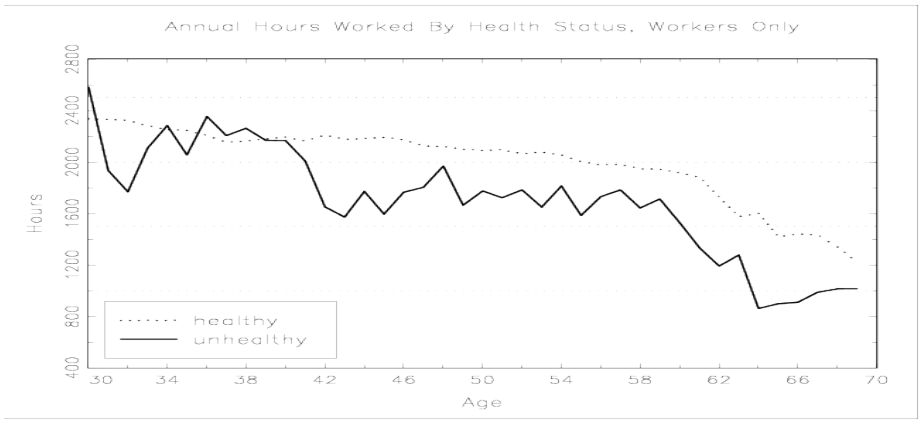
2.4.1 Declining Health

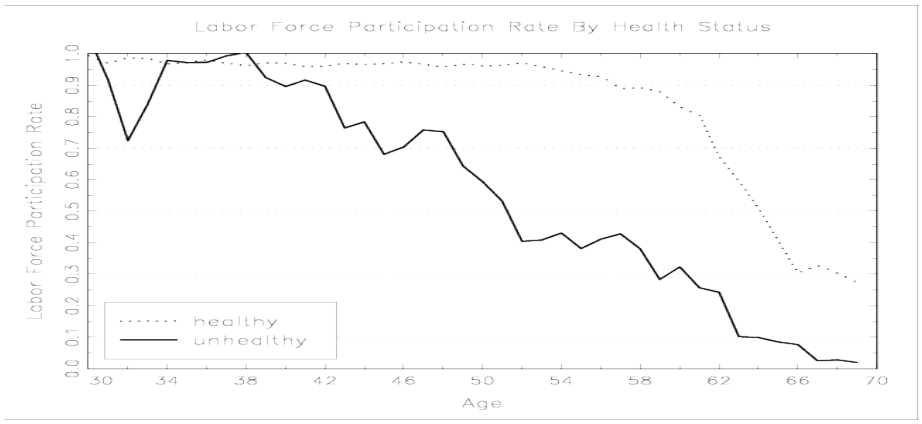
Both health and employment decline as people get older. For this reason, it seems natural to suspect that health declines are one cause of exits from work. There are several reasons why we might expect health to impact retirement behavior. First, declining health makes work less pleasant. Second, it can reduce an individual's productivity and thus the individual's wage. Third, health shocks might reduce life expectancy and thus the amount of savings that an individual needs for retirement. Finally, declining health means that an individual often becomes eligible for benefits from firm- or government-based disability programs, which often stipulate that the individual cannot work while drawing disability benefits.

French (2005) shows the life-cycle pattern of hours in the US for those in good and bad health, using data from the Panel Study of Income Dynamics (PSID). The PSID is a panel data set, covering 1968 to the present, which allows us to track individuals over extended periods. Using a fixed effects procedure that accounts for measurement error in health status, discussed in greater detail in French (2005), Figure 2.15 shows how wages and hours change for the same men over the course of their lives – distinguishing between those in good and bad health. The top panel of the figure shows the life-cycle profiles of hours worked, conditional on working. Hours begin to decline rapidly after age 59 but this is true of those in good health as well as those in bad health. The bottom panel of Figure 2.15 shows life-cycle profiles for employment. Health appears to affect employment rates more than hours worked. Nonetheless, the effect of health on employment rates is modest.

The fraction of individuals who report bad health rises from 20% at age 55 to 37% by age 70. French (2005) shows that this decline in health would, with the participation profiles shown

Figure 2.15: Life-cycle profiles for hours and employment for men in the US





Source: French (2005).

in Figure 2.15, lead to a 7 percentage point drop in the employment rate, and would thus explain a small share of the drop in participation rates from 87% to 13% between ages 55 and 70.

Disentangling the different channels by which health impacts retirement is difficult. Much of the literature focuses on the simpler questions of whether health impacts retirement decisions and of quantitatively how important these impacts are. The literature tends to find that health is an important predictor of retirement. However, most studies find that declining health can only explain a modest share of the decline in employment after age 50.

The estimates shown above are some of the higher estimates within the literature. O'Donnell et al. (2015) and French and Jones (2016) provide a range of the recent estimates within the literature and also review some of the same measurement issues we discuss below.

Measurement Issues

The literature measuring the effect of health on labor supply, starting with Bound (1991) and Stern (1989), has focused on two main issues in interpreting the effect of subjective and objective health measures on labor supply. The first of these is measurement error, which can take multiple forms. One problem is that most data sets have only limited health measures, and thus may only capture one dimension of health. This issue is especially important when considering the effect of objective measures on labor supply. For example, even if studies conclude that certain conditions – say, diabetes – have no significant effect on labor supply, we cannot conclude that health more broadly is unimportant for labor supply, since other (unmeasured) health conditions could still impact on labor supply behavior.

Many large surveys – such as the Health and Retirement Study (HRS), the English Longitudinal Study of Ageing (ELSA), the Survey of Health, Ageing and Retirement in Europe (SHARE) and related surveys – now contain a battery of subjective and objective health measures. These are designed to capture the variety of factors that might be important in understanding older people's behavior. These data have greatly expanded the opportunities to conduct empirical research on this question (Gustman and Steinmeier, 2014).

However, even with very detailed and wide-ranging measures of health, problems can arise in estimating how health affects employment. People may, for example, errantly misreport their

health status because they misinterpret a question, or interpret the question differently from others. For example, Kapteyn et al. (2007) show that differences in reported work disability between the Dutch and the Americans largely stem from the fact that Dutch respondents have a lower threshold in reporting whether they have a work disability than American respondents. Most likely, measurement error bias leads to an attenuation of the estimated effect of health on labor supply.

The second main issue that arises in interpreting the effect of subjective and objective health measures on labor supply is that estimates of the effect of health status on labor supply potentially suffer from 'justification bias', as those who are not working might claim to be unhealthy in order to justify their work status (see, for example, Butler et al. (1987)). This would likely lead to an overstatement of the effect of health on labor supply.

In most studies, the estimated effect of health on labor supply is found to be larger when using subjective measures than when using objective ones. These differences in estimates could be attributable to either measurement error in the objective measures or justification bias in the subjective measures. Bound (1991) and subsequent papers have found that these differences can be large, and using subjective measures can yield estimates of the effect of health that are several times or more larger than objective measures.

Finally, the relationship between health and employment could be driven by factors other than health causing employment. It could be that past employment (which is highly correlated with current health) increases economic resources, which in turn causes better health. Alternatively, it could be that health and employment are both caused by other factors earlier in life. For example, income in childhood predicts both income and health as an adult, presumably because the family has more resources to invest in health and human capital of the child. These factors are likely to give rise to persistent heterogeneity, biasing up the effect of health on employment.

A popular approach to addressing this problem is to use first differences or fixed effects estimation procedures. These procedures focus on how changes in health impact changes in employment. Blundell et al. (2016b) show that first differences and fixed effects deliver estimates that are several times smaller than OLS. On the surface of it, this may suggest that the

usual OLS estimates overstate the effect of health. However, as Blundell et al. (2016a) show, first-differences is likely to exasserbate issues of measurement error. Furthermore, they (and Bound et al. (1999)) show that not only is current health important, but lagged health is important also. First differences will only capture the effect of changes in current health, not lagged health. Furthermore Blundell et al. (2016a) point out that if lagged health is important for employment, OLS estimates may understate the effect of health on employment also if lagged health is not captured in the OLS regression.

Key Findings

Bound (1991) suggests using objective health measures (which are arguably free of justification bias, but suffer from measurement error) to instrument for more subjective measures. He shows that this procedure produces estimates that are close to simply using subjective health measures. This suggests that, for the subjective health measures, the effects of measurement error and justification bias roughly offset. Kreider and Pepper (2007) and Blundell et al. (2016a) come to similar conclusions. For example, Blundell et al. (2016a) find that declining health, measured using a battery of subjective health measures, can explain 11% of the fall in employment of low-education men in England between ages 55 and 70. However, when instrumenting for subjective health using more objective measures, health can explain 14% of the fall.

Gustman and Steinmeier (2014) find that health is an important factor in driving early retirement. They find that average retirement ages in the US are about one year younger than they would be if everyone were in good health.

However, using both cross-sectional and time-series data from 12 developed countries, Wise (2016) presents two types of evidence to make the case that declines in health cannot explain either the sharp drops in employment that still occur at older ages or the steady declines in employment at older ages that occurred up to the mid 1990s. First, the papers in Wise (2016) show that the trends in 'health' (as measured by one-year mortality probabilities) of older men across many developed countries are very different from the trends in employment. Steady declines in mortality rates since the mid 1970s were accompanied first by declining employment rates and then (from the mid 1990s onwards) by steadily rising employment. Second, the papers

compare employment rates of older people with those of similarly healthy younger people – using the detailed health measures from the HRS, ELSA and SHARE (described above) to define health. Evidence from all 12 countries suggests that health does decline on average across successively older age groups but that the declines seen are far from sufficient to explain the large differences in employment rates by age.

Trends in Health

Recent results from Vos et al. (2015) suggest improvements in health amongst the aged. Life expectancy is rising among the elderly, and the Global Burden of Disease Study suggests that much of the rise in life expectancy represents an increase in healthy life expectancy.

Summary

Taken together, the literature suggests that falling health is an important determinant of retirement and – as we discuss in Section 2.5 – it is a feature that is worth capturing in a retirement model. Recent and projected future trends of improving health among older people might also suggest that employment rates of older people will continue to increase in future. However, the available evidence clearly suggests that the great majority of variation in retirement is not explained by health.

2.4.2 Substitution Effects, Wealth Effects, and Liquidity Effects

There are many financial incentives for retirement that individuals face, coming from declining wages, public and private pensions, other government programs, and (in some countries, notably the US) health insurance. They can create incentives that affect retirement decisions for three main reasons.

- **Substitution Effects**. Changes in wage opportunities as people age, as well as the operation of the tax, benefit, and pension systems in a country, can affect the relative attractiveness of working versus not working at different ages. For example, public pension schemes in many countries generate high implicit tax rates on labor income after a certain age. These encourage households to work less when old. Similarly, if individuals'

productivity declines as they age, they may be able to command higher wages at younger ages than at older ages and so find it less attractive to work as they get older.

- **Wealth Effects**. All public pension schemes have an insurance aspect, which implies redistribution between individuals. Moreover, most public pension plans are pay-as-you-go systems, where taxes collected from the working young are used to finance current retirees' benefits. Even if a system lacks an insurance aspect, the actuarial value of a retiree's benefits rarely equals the actuarial value of the taxes she paid while working. Public pensions can therefore increase (decrease) a household's lifetime wealth, allowing it to finance its retirement with fewer (more) years of work. The redistribution/insurance aspect of pension schemes is particularly large for those with low income.

- **Liquidity Effects.** Public pension benefits tend to be illiquid: that is, households cannot borrow against future benefits. As a result, many households cannot finance their retirement until pension benefits become available. If public pensions crowd out private savings that would otherwise have been more liquid, they may delay retirement.

Understanding the quantitative importance of substitution effects, wealth effects, and liquidity effects is difficult because pension schemes are complex and individuals are likely to be affected by incentives from many different public programs and private pension schemes at the same time. Furthermore, each program induces substitution effects, wealth effects, and liquidity effects, making it difficult to disentangle the relative importance of each effect. In the following subsections, we examine the main factors and institutional features that result in important financial incentives to remain in or leave work at older ages. In each case, we describe how the financial incentives might operate in theory and then summarize the empirical evidence.

2.4.3 Retirement Incentives from Falling Wages

One often-discussed fact is that wages follow a hump shape over the life cycle: wages rise at younger ages and fall near retirement age. Falling wages are a potentially powerful retirement incentive that individuals face. A number of reasons have been put forward for why people

might face lower wages as they get older (Weiss, 1986). If health affects productivity, then declines in health with age – discussed in Section 2.4.1 – could result in declining productivity and thus declining wages with age. The human capital model (Mincer, 1974; Becker, 1975) suggests that wages vary over the life cycle because of differences in investment in depreciable human capital. This theory postulates that older people will perceive less benefit from investing in their human capital – because they have fewer years remaining to reap the rewards – and so their human capital (and thus the wage that employers will pay them) will decline more rapidly than for younger workers.

However, while there are numerous theoretical reasons why we might expect to see wages falling as people get older, the empirical evidence on this is not conclusive.

Measurement Issues

Measuring the extent to which wage offers fall with age near retirement appears superficially to be a simple question. However, for several reasons, measurement of whether wage offers fall with age is a challenging task.

First, cross-sectional comparisons of wages of the old with those of the young compare older individuals born in earlier years with younger individuals born more recently. Since younger people born more recently have higher lifetime wages than older people born long ago, failure to account for this problem likely leads to an understatement of wage growth with age. This problem can be solved by tracking wage growth of birth cohorts, and how wages change with age. The best papers in the literature address this important issue.

A second and more difficult problem is that we do not observe the wages of those who do not work. Those exiting the labor market may be earning more or less than those who remain in the labor market. If high-wage people are more likely to remain in the labor market to old age while low-wage people retire early, then estimates of wage growth will come from comparisons of all potential workers when young with only high-wage individuals when old. This will likely lead us to overstate wage growth when old. If the reverse is true, we would understate wage growth when old.

To help understand this issue, consider the following model of wages, where the logarithm

of wages, $\ln W_t$, is a function of age, t, plus an autoregressive component of wages, ω_t:

$$\ln W_{it} = W(t) + \omega_{it} \tag{1}$$

$W(t)$ is the age-specific component to wages that we wish to recover, and the idiosyncratic component of wages is ω_{it}. The selection problem is that wages are observed for workers but not for non-workers.

French (2005) and French and Jones (2011) attempt to address this problem using a fixed effects estimator. The idea here is to decompose the idiosyncratic component of wages ω_{it} into a permanent person-specific component α_i (which is potentially correlated with employment) and a stochastic component u_{it}:

$$\omega_{it} = \alpha_i + u_{it} \tag{2}$$

α_i summarizes time-invariant factors (such as education and ability) and u_{it} is the part that is orthogonal to α_i by construction.

The fixed effect (α_i) can be eliminated using first differences or a fixed effects estimator. However, first differencing or fixed effects on Equation (1) will not eliminate the average change in u_{it} in a given year. The average value of u_{it} might not be equal to 0 if those who received a bad wage shock dropped out of the labor market, for example. Therefore, using fixed effects estimation or first differencing to estimate Equation (1) will not on its own be sufficient to identify the object of interest, which is the relationship between age and wage offers, $W(t)$. Formally, even if

$$E[\ln W_{it} - \ln W_{it-1}] = [W(t) - W(t-1)] + E[(\alpha_i + u_{it}) - (\alpha_i + u_{it-1})] = 0 \tag{3}$$

amongst all (whether in work or not), most likely the expected change amongst those continu-

ously working is not 0:

$$
\begin{aligned}
&E[\ln W_{it} - \ln W_{it} | \text{working at } t \text{ and } t-1] \qquad (4)\\
&= [W(t) - W(t-1)] + E[(\alpha_i + u_{it}) - (\alpha_i + u_{it-1}) | \text{working at } t \text{ and } t-1]\\
&= [W(t) - W(t-1)] + E[u_{it} - u_{it-1} | \text{working at } t \text{ and } t-1] \neq 0
\end{aligned}
$$

Thus, first differencing eliminates the fixed effect α_i but does not address the fact that those who work in periods t and $t-1$ are a selected sample.

Because the fixed effects estimator is identified using growth rates for wages and not levels of wages, composition bias – the problem that persistently high-wage and low-wage individuals drop out of the labor market at different times – is not a problem if wage growth rates for workers and non-workers are the same. However, if individuals leave the market because of a sudden wage drop, such as from job loss, then wage growth for workers will likely be greater than wage growth for non-workers. This problem will likely bias wage growth upward, thus understating the amount of wage declines late in life. French (2005) and French and Jones (2011) estimate structural life-cycle models with realistic wage shocks estimated from the data. Consistent with intuition, they find that the fixed effects estimator modestly understates the extent to which wages decline late in life.

A third issue is whether measured wage differences between old and young individuals reflect only the potential productivity of these individuals or whether they also pick up (potentially unobserved) characteristics of the types of jobs they each do. Although declining productivity is one potential explanation for declining wages, (unobserved) differences in the types of jobs that older and younger people choose to do could provide an alternative explanation. For example, some of the measured declines in wages with age appear to come from people switching from higher-paying full-time jobs to lower-paying, less strenuous part-time jobs (Johnson and Neumark, 1996; Haider and Loughran, 2010).

Aaronson and French (2004) show that taking a part-time job causes individuals to receive a lower offered wage. They estimate this using arguably exogenous variation in hours caused by the Social Security rules. The Social Security rules provide incentives to reduce work hours

exactly at ages 62 and 65. It is exactly at these ages that we observe the sharpest decline in wages. Thus the decline in wages may merely reflect a transition from full-time jobs to part-time jobs. Other papers have also made the point that part-time workers earn lower wages than full-time workers.

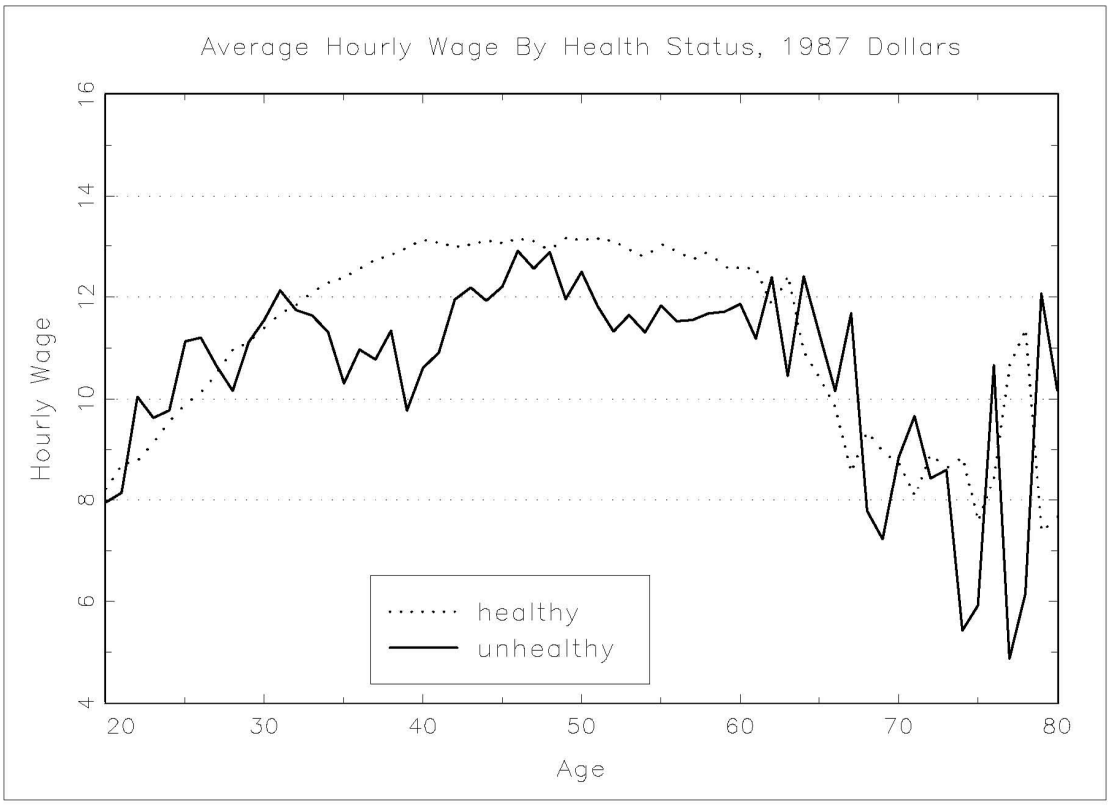
If the decline in wages represents a decline in productivity, then declining wages near retirement provide an incentive to work more when young and less when old. However, the other explanations for why wages decline near retirement often imply that there is no strong work disincentive to retire at older ages.

Key Findings

Some papers find that wages fall rapidly near retirement age, whereas other papers find that wages do not fall near retirement age. This is true even when using similar methods and data. For example, French (2005) uses data from the Panel Study of Income Dynamics (PSID) with a fixed effects estimator and finds that wages fall with age after age 60 in the US. Figure 2.16, taken from French (2005), shows predicted wages, conditional on health and age, using these procedures when including a full set of age dummy variables and age dummy variables interacted with health status. Fan et al. (2015) use Survey of Income and Program Participation (SIPP) and Current Population Survey (CPS) data and find that wages fall in the US when not accounting for fixed effects, but do not fall when accounting for fixed effects. Casanova (2013) uses data from the HRS and finds that – after using a fixed effects estimator with an additional selection correction to address transitory shocks and controlling for part-time employment status – wages do not fall.

It is unclear what drives these discrepancies in the estimates described above. Some recent papers have noted that, over recent years, the negative relationship between age and wages towards the end of working life appears to have weakened and that wages of older workers have been growing more rapidly than those of younger workers. Rupert and Zanella (2015) use data from the PSID and the CPS to measure how wages change near retirement for different cohorts of individuals. They find that cohorts born before the Second World War (who entered the labor market before the 1960s) experienced a decline in wages towards the end of working

Figure 2.16: Life-cycle profiles for wages for men in the US



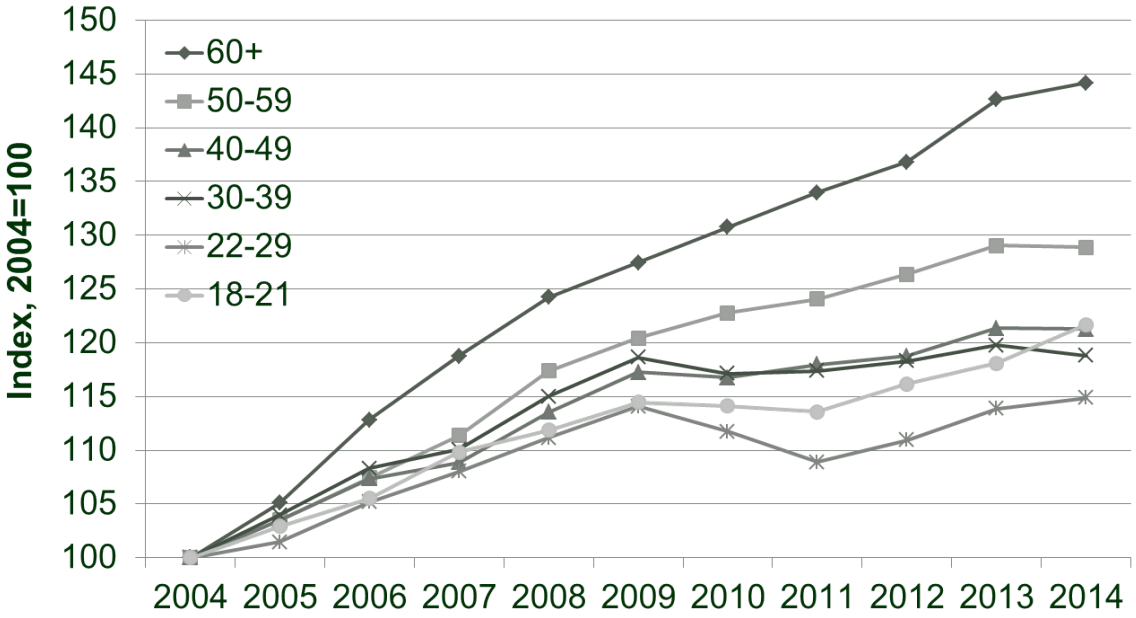
Source: French (2005).

life. In contrast, those born during or after the Second World War appear to have experienced no such fall in wages as they have aged.

Consistent with this, Aaronson and French (2004) find, using fixed effects estimators, that wages decline between ages 60 and 65 by approximately 4% per year in the PSID data over the period 1968–97, 3% per year in the HRS data covering the 1992–2000 period, and only 1% per year in the matched March and Outgoing Rotation Group samples from the CPS starting in 1979. Thus whether wages fall or not in the US appears to vary with sample period and data set.

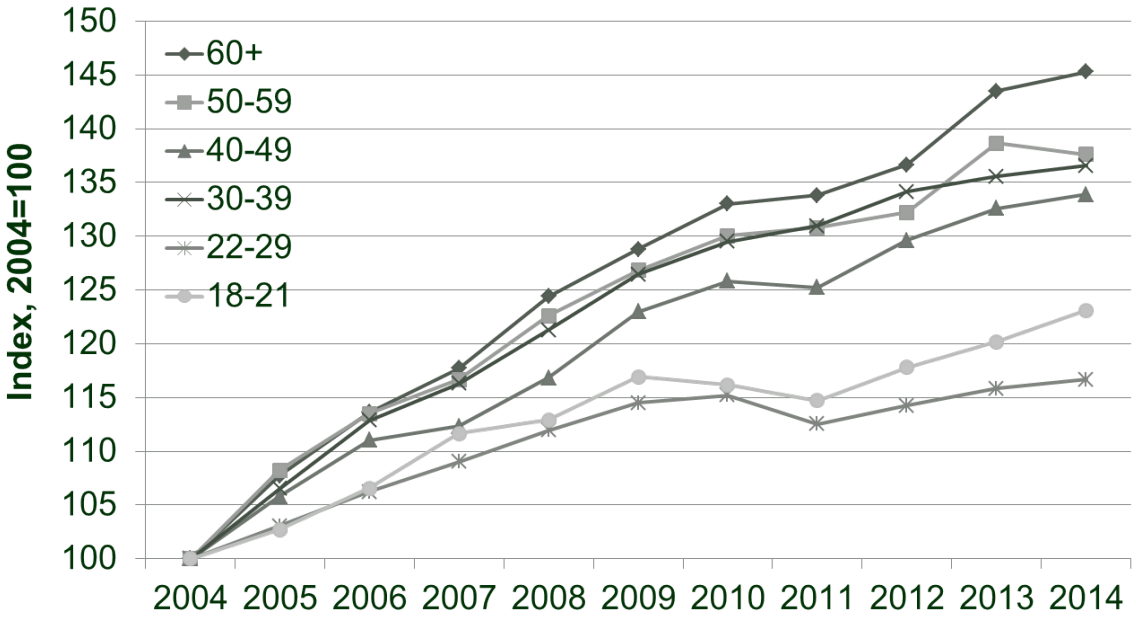
Figures 2.17 and 2.18 show data on wages for the UK, relative to the base year of 2004. They show that older workers have fared comparatively well in recent years, certainly compared with young workers. This may suggest that – if declining wages used to act as an incentive for older people to leave work – this incentive has perhaps weakened in more recent years.

Figure 2.17: Growth in median gross hourly wages for men in the UK



Source: Authors' calculations using the Annual Survey of Hours and Earnings.

Figure 2.18: Growth in median gross hourly wages for women in the UK



Source: As Figure 2.17.

2.4.4 Retirement Incentives from Public Pensions

Public pension schemes likely affect employment patterns of older people across many developed countries. As we discussed in Section 2.2, public pension schemes were introduced in many developed countries from the late 19th century onwards. These were originally intended to provide an income to the minority of people who survived to very old age but were unable to continue working. However, as life expectancies increased, more and more people reached the eligibility ages – increasing the importance of these schemes in affecting incentives to work.

Common Features of Public Pension Schemes across Countries

Although the precise details of public pension schemes differ across countries, many of them have common features. We begin by describing these.

For most developed countries, public pension schemes are defined benefit (DB) in nature – that is, pension benefits are a function of the age at which the individual begins drawing benefits and of earnings when working (as well as other factors, such as date of birth and marital status). Although a number of countries, such as Italy and Sweden, have now moved towards defined contribution (or notional defined contribution) systems, we focus in this section on features of DB schemes. This is because DB schemes can have strong effects on incentives to leave work at older ages, which are typically not present in defined contribution schemes.

Public pension programs in most countries impose an early and/or normal 'retirement' age. These are, respectively, the earliest age at which an individual can receive any income from a public pension scheme and the earliest age at which an individual can receive an unreduced pension. Although these are typically referred to as 'retirement' ages, in some countries' public pension systems these ages simply relate to the date at which pension income may be claimed and have a weak or non-existent relationship to employment. In many countries, individuals can draw benefits and work at the same time with little tax penalty. The effect of the public pension scheme on individuals' incentives to participate in paid work typically changes at the early and normal retirement ages.

This happens for a number of reasons, some of which relate to other common features of public pension schemes. First, public pension schemes are typically 'contributory' – that is, by

continuing to work and contribute to the system, individuals can accrue entitlement to a higher future pension income. There is typically a greater incentive to continue working while it is still possible to accrue additional rights. In many countries, the ability to accrue additional rights ceases at the normal retirement age.

Second, employment incentives can be affected by whether or not the public pension system offers any adjustment to pension benefits for early/late claiming (i.e. before/after the normal retirement age). If benefits are adjusted, this can increase the incentive to delay claiming (and possibly also the incentive to carry on working).

Finally, in many countries, pensioners will have their benefits reduced if they have income from earnings, often referred to as an 'earnings test'. This reduces the incentive to engage in paid work once a person is in receipt of her public pension income.

A further common feature of public pension programs is that individuals are unable to borrow against future public pension income. This can induce liquidity constraints on individuals' behavior, particularly in countries where (or for individuals for whom) public pension programs constitute a very large share of retirement saving.

We discuss these incentives with reference to the specific case of the US Social Security system. We then discuss important differences between the workings of a number of European public pension schemes and the US one. Table P provides a summary of public pension scheme rules in a number of countries. We discuss some of these in the text below.

Table P: A summary of country-specific public pension scheme rules

Country	Early retirement age (ERA)	Normal retirement age (NRA)	Increase in pension rights if continue working beyond ERA/NRA?	Deferral rate / actuarial adjustment?	Earnings test?	Generosity
Australia	65 (increasing to 67, 2017–23).	n/a	No: pension is non-contributory, eligibility based on being resident for 10+ consecutive years.	No	Pension is means tested against any income above AUD 4,200/7,500 p.a. (singles/couples); 50% withdrawal rate.	Benchmarked to 28%/42% of male total average weekly earnings (singles/couples).
Belgium[1]	Until 2012: 60 (subject to 35 years' contributions). Gradually rising to age 63 in 2019 (with 42 years' contributions).	M: 65. W: increased from 60 to 65, 1997–2008. M&W: to be increased to 66 in 2025 and 67 in 2030.	Only if it boosts best 45 years' earnings.	No penalty for claiming before NRA. No bonus for deferring beyond NRA.	Yes. From 2016, earnings test does not apply to those aged 65+ or those with 45+ years' contributions before NRA.	75% of average lifetime earnings for one-earner couples, 60% for singles. (Floors and ceilings also apply – benefits are becoming increasingly flat-rate.)
Canada	60	65	Yes, until age 70.	Until 2011:[2] 0.5% per month. From 2014: 0.7% boost for claim after NRA. From 2017: 0.6% reduction for claim before NRA.	Until 2011, necessary to have a period of at least 1 month without earnings to claim public pension.	Replaces up to 25% of average lifetime earnings up to a cap. Average calculated between ages 18 and 65/70. Maximum monthly benefit CAD$1,021.50 (2013).
Denmark	Can claim post-employment wage (*efterløn*) from ERA. 1979–2014: 60. 2014–17: increased to 62. 2017–23: increased to 64. 2023 onwards: increasing with longevity projections.	*Efterløn* ceases and *folkepension* starts from NRA. 1979–2004: 67. 2004–06: reduced to 65. 2014–17: increasing to 67. 2023 onwards: increasing with longevity projections.	Entitlement is residence based (maximum 40 years).	Between ERA and NRA: more than actuarially fair. Beyond NRA: actuarially fair (using official life tables). Maximum 120 months beyond NRA. Must work 83+ hours per month to defer.	*Efterløn* and *folkepension* benefits are earnings tested.	*Folkepension*: DKK 12,462 per month for a single person (2016); compares with median equivalized monthly disposable income of DKK 19,000 (2014).
France	60 (with 41 years' contributions). 2010–16: increased to 62.	65 (to get full rate without meeting contributory conditions). 2010–16: increased to 67.	Yes, even after NRA.	5% p.a. penalty for claiming before NRA. 5% p.a. bonus for delaying claim (maximum 5 years post-NRA).	No, provided do not work for same employer as before claiming pension.	Replaces 50% of best 25 years' earnings. (Additional mandatory pension benefits increase this to around 75%.)
Germany	63 if have 35 years' contributions. Until 2012: 60 (W) if had 15 years' contributions with 10 after age 40.	Until 2012: 65. 2012–29: increasing to 67.	Yes: yearly pension rights increase with each year of service as long as no benefits have been claimed (amount depends on relative income position).	Since 1997, 3.6% p.a. if claim before NRA. 6% bonus for deferring beyond NRA.	Only for those between ERA and NRA. Pension fully withdrawn if earn above €450 per month.	Earnings related. Current pensioner with 45 years' service at average wage receives pension worth 44.4% of current economy-wide average earnings (2014).
Italy[3]	From 2002: 57 with 35 years' contributions; any age with 37 years' contributions. Gradually increased from 2011 to 60 with 36 years' contributions; any age with 40 years' contributions. Contribution condition rising to 46 years (M) / 45 years (W) by 2050.	From 2000: 60 (W) and 65 (M) (with 20 years' contributions). M and W: increasing to 66 years and 7 months by 2018. Eligibility age now linked to changes in life expectancy – expected to increase to 69 years and 9 months (M/W) by 2050.	Yes. *If had more than 18 years' contributions by end of 1995:* – up to 2012, can increase average wage of last 5/10 years, and increases number of years' contributions (if <40); – from 2012 onwards, increases DC part of pension. *If less than 18 years' contributions by end of 1995:* Increases contributions that form basis for computing DC part of pension; also increases transformation coefficient in calculating	For DB benefits since 2011: 1% p.a. between ages 60 and 62; 2% p.a. before age 60.	No	DB system: designed to guarantee a replacement rate of about 80% with 40 years' contributions (a bit lower for very high earners and higher for very low earners); pro-rated for <40 years' contributions. DC system: lower replacement rate.

[1]There are three main public pension schemes in Belgium – for private sector wage-earners, public sector employees, and the self-employed. We describe here the scheme for wage-earners, which has by far the largest coverage. The public sector scheme is more generous; it is essentially a defined benefit pension that depends on the average of the last five years' wage. The self-employed scheme is less generous than the scheme for wage-earners.

[2] Changes to Canadian upward adjustment are being phased in over a three-year period from 1 January 2011 and changes to downward adjustment are being phased in over a five-year period from 1 January 2012.

[3] Reforms legislated in 1995 are set to replace the defined benefit pension with a notional defined contribution (NDC) system. Those who started work after 1995 (i.e. retiring from 2032 onwards) will receive benefits solely from the NDC system. Cohorts retiring before then will receive benefits that are a mixture of the NDC system and the previous defined benefit system. All new accruals from 2012 onwards are to the NDC system.

			DC entitlement.			
Japan	Flat-rate benefit (M): increased from 60 to 65, 2001–13. Flat-rate benefit (W): increased from 60 to 65, 2006–18. Earnings-related benefit (M): increasing from 60 to 65, 2013–25. Earnings-related benefit (W): increasing from 60 to 65, 2018–30.	n/a	Yes, until age 70 – if it increases career-average monthly earnings, which are calculated over full years of contributions.	8.4% per year after age 65.	Yes, up to age 69; threshold differs for ages 60–64 and 65–69; marginal withdrawal rate is 50%.	Flat-rate benefit: if have 40+ years' contributions; ¥780,100 (2016), equivalent to around 18% of average earnings. Earnings-related benefit: 7.125/1000th of career-average monthly earnings for each month of contributions.
Netherlands	Until 2013: 65.[4] 2013–18: increasing to 66. 2018–21: increasing to 67.	n/a	No	None	No	Flat-rate benefit equal to half the minimum wage (after tax) or 70% of minimum wage for single people living alone. Subject to being resident for 50 years prior to ERA; otherwise pro-rated.
New Zealand	65	n/a	No: pension is non-contributory, eligibility based on being resident for 10+ years of working life (including 5+ years since age 50).	n/a	No	Flat-rate pension replaces about 25% of average full-time earnings for 60- to 64-year-olds or 60% of earnings for full-time minimum-wage worker.
Spain[5]	Before 2002: 60. From 2002: 61.	Until 2011: 65. From 2011: 67.	Yes, subject to maximum 35 years' contributions.	8% p.a. reduction for claiming before NRA. 2–3% p.a. bonus for deferring beyond NRA.	Until 2013: work and pension were incompatible except under the partial retirement program, which allowed workers in big firms to cut hours to 75–85% from ERA if their employer hired a replacement.	Receive nothing if <15 years' contributions. Benefits depend on last 15 years' earnings. Each year's contributions worth about 2–3% of previous earnings. Minimum benefit approximately equal to minimum wage; maximum benefit equal to 4–5 times minimum wage.
Sweden[6]	61	65	Yes, if improves best 15 years' earnings.	0.5% per month reduction for claiming before NRA. 0.7% per month increase for delaying beyond NRA (up to age 70).	No	Basic pension (residence based) plus income-related supplementary pension (based on 15 best years' earnings, up to a cap).
United Kingdom	M: 65 (increasing to 66, 2018–20). W: increasing from 60 to 66, 2010–20. M&W: increasing to 67 between 2024 and 2026.	n/a	Yes – more rapid if have fewer than 30 years' contributions.	10.4% p.a. from ERA. From April 2016: 5.4%.	No (abolished 1989).	Up to 20% of average lifetime earnings up to a cap.
United States	62	Up to 2002: 65. 2003–09: increased to 66. 2021–27: increasing to 67.	Yes – if it increases AIME (i.e. average income over the best 35 years in the labor market).	Prior to NRA: 5.0%–6.7%. NRA up to age 70: increased from 3% in 1989 to 8% from 2009. Age 70+: 0%.	Yes for those between ERA and NRA. Abolished for those over NRA in 2000.	Replaces approximately 40% of previous earnings for the median worker, with lower benefits (but higher replacement rates) for low-income workers.

Source: Wise (2016); OECD (2015).

[4] For the Netherlands, this is the statutory retirement age, at which most labor contracts are terminated and unemployment, disability, and other assistance benefits also cease.

[5] A major reform was legislated in Spain in 2013 to reduce the long-run costs of the pension system. In particular, this reform introduced a new element (known as the sustainability factor) to the calculation of pension benefits such that these will now depend on expected longevity. The intention is that pensioners (with the same employment history, retiring at the same age) should all expect to receive the same total pension benefit over their lifetimes and so cohorts with longer life expectancy will receive lower annual pension payments than cohorts with shorter life expectancy. This effectively converts the DB pension system into a DC-like system. Other features of the system (such as normal retirement age) remain the same.

[6] Sweden has been introducing a radical reform of its public pension since 2001, replacing its defined benefit pay-as-you-go public pension with a new system that is a mixture of a notional defined contribution pay-as-you-go pension and a fully funded defined contribution pension with individual accounts. Those born before 1938 receive a pension entirely under the old system; those born from 1954 onwards receive a pension entirely from the new system. The new system will therefore be fully implemented by the early 2020s. The table summarizes the old defined benefit system. The new system has no normal retirement age, but the earliest age at which individuals can claim their pension remains age 61.

A Detailed Example: Public Pension Programs in the US

The American public pension program is a pay-as-you-go pension scheme called Social Security. On average, Social Security replaces about 40% of pre-retirement earnings; the replacement rate is higher for those with low lifetime income.

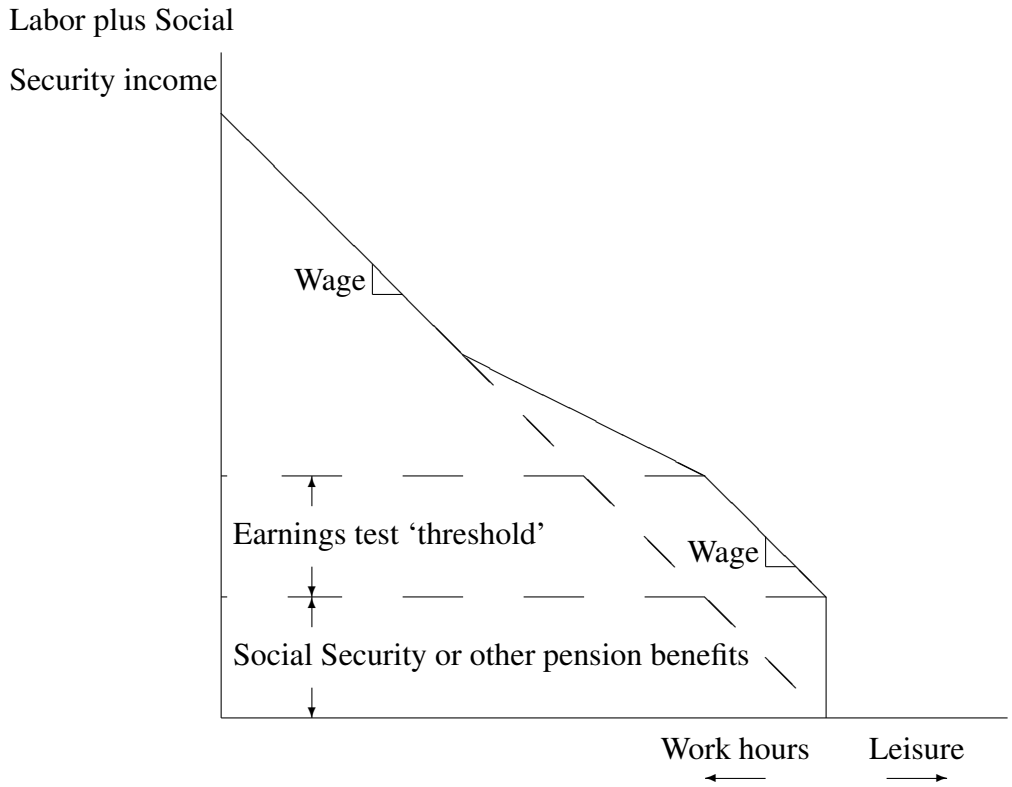
Private pensions, which are discussed in more detail in Section 2.4.5, also replace a large share of pre-retirement earnings. Private pension replacement rates tend to be higher for those with relatively high lifetime income. Gustman and Steinmeier (1999) and Scholz et al. (2006) both found that mean private pension wealth and mean Social Security wealth (that is, the expected discounted value of the pension benefits) at the end of working life are just over $100,000 each in 1992 dollars, although median private pension wealth is much smaller than median Social Security wealth.

Social Security distorts labor supply in four ways. First, Social Security benefits depend on total contributions to the system during the worker's 35 highest-earning years. Once a worker has paid into the Social Security system for 35 years, additional years of work increase her benefits only if earnings in those years exceed earnings from earlier years. Thus an important work incentive may disappear after 35 years in the labor force.

Second, Social Security is financed by a payroll tax of 5.3% on both workers and firms (so the total tax is 10.6%). In addition, workers and firms each pay a 0.9% tax for disability insurance and 1.45% for Medicare, resulting in a 7.65% tax on both workers and firms. These taxes reduce the after-tax wage and thus the incentive to work. Although tax payments into the Social Security system usually lead to higher benefits, the links are indirect and variable. For example, tax payments made by younger workers translate into higher benefits only after they retire, a substantial delay; tax payments made by older workers translate into higher benefits much more quickly. In short, the net tax rate imposed by Social Security is higher for younger workers and higher earners (see, for example, Feldstein and Samwick (1992)).

Third, until recently, the basic benefit formula encouraged workers to claim benefits by age 65. The age at which the individual applies for Social Security affects the size of the annual benefit. Most individuals can begin drawing benefits at age 62. Between 62 and the normal retirement age (which, as Table P describes, was 65 until 2002 and is currently 66), benefits are

Figure 2.19: The earnings test



reduced by 5.0-6.7% for every year before the normal retirement age that benefits are drawn. This is roughly actuarially fair for single men: that is, the reduction in the annual benefit is offset by the additional years of benefits. However, until recently, the annual benefit increase from waiting past the normal retirement age was small. For those retiring in the 1980s, delaying benefits past 65 increased the annual benefit by only 3% for each year of delay. This was much less than actuarially fair and provided strong incentives to draw benefits by age 65.

Fourth, until 2000, individuals drawing benefits faced the Social Security earnings test, which discouraged work. The earnings test was essentially a tax on earnings above a certain threshold. Between the early and normal retirement ages, benefits were reduced by $1 for every $2 in income above the threshold level ($9,600 in 1999); between the normal retirement age and 70, benefits were reduced by $1 for every $3 in income above the threshold level ($15,500 in 1999). Figure 2.19 shows how the earnings test affects the budget constraint that older people used to face in the US. Benefits lost through the earnings test did increase future benefits, but these adjustments were relatively modest after age 65.

Relatedly, those who draw benefits and work at the same time usually earn enough that

their benefits become taxable. Thus, in addition to the loss of benefits through the earnings test, any benefits above a threshold are taxed, essentially meaning that benefits are taxed twice, each time at a high rate (Jones and Li, 2016).

As a result, until recently, the Social Security system provided strong incentives to begin drawing benefits by age 65. When coupled with the earnings test, it also yielded strong incentives to leave the labor market by age 65. Recent rule changes, however, have eliminated most of these incentives. Under current rules, annual benefits now increase by 8% for each year that benefits are delayed past the normal retirement age, up until age 70. Furthermore, the earnings test was repealed in 2000 for those above the normal retirement age.

It is important to note that the basic benefit formula does not apply to all workers; there is a lot of variation in how benefits accrue by age, and thus potentially a great deal of variation in retirement incentives. For example, Coile and Gruber (2004) point out that, for married men, Social Security accrual is large and positive between ages 62 and 65, because Social Security provides a widow's benefit. Although men tend to die early (which would tend to provide an incentive to claim benefits as early as possible), their wives typically live much longer, which provides an incentive to draw benefits late. In addition, the standard benefit rules do not necessarily apply to individuals with low labor earnings. These individuals can receive a minimum benefit called Supplemental Security Income (SSI), which is available from age 65. Delaying receipt of SSI does not increase the future level of SSI; therefore, low-income workers still face a strong incentive to apply for benefits at age 65.

Many workers exit the labor market at the early retirement age (62), even though actuarial calculations suggest that there are no incentives to draw benefits before age 65. One possible explanation for this behavior is liquidity constraints. It is illegal to borrow against Social Security benefits. Therefore, if individuals have no other source of private assets to fund early retirement, they must wait to retire until they are eligible to receive Social Security benefits. In practice, many people younger than age 62 in the US have few liquid assets, suggesting liquidity constraints could be important.

Public Pension Programs in Other Developed Countries

In this subsection, we briefly discuss a number of other developed countries' public pension plans. Summaries of individual countries can be found in Table P. Further details can be found in Gruber and Wise (2007) and Wise (2016).

In many ways, other countries' plans are similar to the US Social Security program. The plans typically have a normal retirement age, and delaying benefit receipt past this age tends to be actuarially unfair. Some plans have an earnings test, above which benefits are taxed at a high rate. Moreover, in many countries, individuals draw private as well as government pensions. There are several dimensions, however, along which other countries' pension plans have traditionally differed from those in the US. These features tend to induce earlier retirement than in the US.

First, many but not all European schemes have had normal pension ages that are earlier than in the US. In 2014, the average normal pension age across OECD countries was 64.0 years for men and 63.1 years for women (Organisation for Economic Co-operation and Development, 2015), whereas it was 66 in the US. However, there is considerable variation across countries. The lowest early retirement ages in the OECD are 58.0 years for women in Turkey and 58.7 years for men in Slovenia. The highest normal retirement age in the OECD is 67 for men and women in Norway and Iceland. Many developed countries are in the process of increasing their early and normal retirement ages. As Table P describes, Denmark, France, Germany, the Netherlands, and the UK are all in the process of increasing (or have recently increased) the early and/or normal pension ages in their public pension schemes.

Interestingly, many countries do not have separate early and normal retirement ages. For example, in the UK, the 'state pension age' serves as the early retirement age but in fact there is no 'normal' retirement age. The 'state pension age' is the only focal age in the UK state pension system. The same is true in Australia, the Netherlands, and New Zealand.

A number of other countries' pension programs – similar to Social Security in the US – provide benefits that are related to previous earnings. This is the case in, for example, France, Germany, and Japan. It was also the case in Italy and Sweden until radical reforms were implemented. However, a growing number of pension systems in other developed countries

now provide only a flat-rate benefit, which offers a higher level of earnings replacement to low earners than to high earners – meaning that the public pension system is likely to have a sharper effect on incentives to work for low earners than for higher earners. Australia, Denmark, the Netherlands, and New Zealand all have public pension systems that provide a flat-rate benefit (subject to an individual meeting certain residence/contribution conditions). New accruals to the UK public pension are also now flat-rate, although past accruals remain somewhat earnings-related.[8]

European public pension schemes tend to be more generous than their American counterparts. European pensions typically provide higher replacement rates (Duval (2003), figure 2). For example, public pensions in Spain replace on average 80% of pre-retirement income, whereas it is closer to 40% for the US. European pension schemes also tend to provide a more generous pension to lower earners. The Netherlands, Spain, and the UK all have a minimum benefit level that is higher than in the US.

Historically, many European systems raised annual benefits little, if at all, for those who chose to delay claiming benefits past the normal retirement age. This was the case in Germany until 1997 and remains the case in Spain. Workers who delayed retirement for one year past the normal retirement age simply lost one year of benefits. However, an increasing number of countries have started to impose some sort of actuarial adjustment, although the levels of these vary significantly. As Table P describes, at one extreme, Australia and the Netherlands continue to offer no increase in future benefit income to those who delay claiming. This (coupled with the earnings test imposed in both countries, described below) likely provides a strong incentive for older people not to work once they reach the normal retirement age. At the other extreme, until April 2016, the UK offered individuals a 10.4% increase in benefits for each year that they delayed claiming beyond the state pension age. This has now been reduced to 5.4% – closer to the rates offered in Canada and Sweden (both 8.4%) and Germany (6%).

Relatedly, when individuals draw benefits, they often face an 'earnings test' on benefits, described above for the US case. In many countries, these earnings tests impose a strong implicit tax on benefits. For example, in Australia, pension benefits are withdrawn at a rate

[8]See Crawford et al. (2013) for a description of recent reforms to the UK state pension system.

of 0.5 AUD for every 1 AUD of earnings above an earnings threshold. However, a number of countries that used to impose such earnings tests have now abolished them. The UK did this in 1989: Disney and Smith (2002) find that the abolition of the earnings test had a significant effect on increasing employment rates among older men.

Duval (2003) calculates the decrease in lifetime benefits and additional payroll taxes that workers incur when they delay claiming their public pensions. Expressing these losses as income tax rates, he finds that implicit tax rates are high in most continental European countries, compared with Japan, Korea, and English-speaking and Nordic countries.

In addition to the provisions of public pension programs, a number of European countries also have unemployment and disability benefit programs that effectively offer a route to early retirement. Disability programs are discussed in Section 2.4.6. In many European countries, unemployment programs also act effectively as early retirement programs (with limited conditionality). Table UI provides a summary of various countries' unemployment programs.

Table UI: Country-specific unemployment insurance (UI) programs and older workers

Country	Summary
Australia	Available before pension age. Means tested. Must be capable of undertaking and actively seeking work, be prepared to enter into an employment pathway plan, and meet activity-test requirements. Very low replacement rate.
Belgium	Unemployment Insurance (UI): pays 65% of previous net wage for first 3 months, then reduces to 60% for 9 months; thereafter reduces to 55% if single and 40% if the spouse has earnings. Prior to 2015, those aged 50+ received a higher rate of unemployment benefit. (Floors and ceilings apply to benefit levels, which depend on career length, UI duration, and family composition.) Conventional Early Retirement: also allows early exit; similar to UI but additional payment from employer that adds half gap between UI benefit and previous earnings; available from age 58 with sufficient years of contributions. Unlike UI, benefits are not dependent on claim duration or family composition. (Rolls into regular pension at age 60 – or earlier in certain professions.)
Canada	Available at any age for up to 45 weeks. Minimum contribution requirement depends on regional unemployment rate. Requires active job search. Replaces up to 55% of previous earnings, up to a cap.
Denmark	Post-employment wage program *(efterløn)*. Requires voluntary UI contributions for 30 out of the last 35 years. No job search requirement for those 60<=age<67 (1979–2004), falling to 60<=age<65 (2004–06), increasing to 62<=age<67 (2014–17), increasing to 64<=age<67 (2017–23), increasing with longevity projections thereafter. Compensation is up to 80% of former earnings with a (low) ceiling of DKK 836 per day in 2016. (This compares with mean hourly private sector wage of 270 DKK for 50- to 54-year-olds in 2014.)
France	Available between age 50 and ERA. Replacement rate declines with prior earnings – minimum wage workers get 75% replacement; 57% replacement at 1.8 times minimum wage; maximum eligible earnings of €12,872 per month, implies maximum benefit of €7,337 per month. Must have worked 122 days in last 36 months. Maximum duration equal to number of weeks' contributions made in last 36 months. Moved onto old age pension at ERA.
Germany	UB1 pays 60% of previous net earnings (67% for households with children) for 12–24 months; UB2 then pays flat-rate €382 (2013) a month (plus housing and heating costs) thereafter until become eligible for pension. Old-age pension for the unemployed available from age 60 (cohorts 1937–41) – rising to age 63 (cohorts 1949–51) – if have made 15 years' contributions, including 8 in the last 10 years; cohorts born before 1952 must have been unemployed for at least 52 weeks, abolished for later cohorts.
Italy	*Up to 2013:* Available to all insured workers who involuntarily lost their job. Workers must have paid at least 1 year of unemployment contributions in the last 2 years before losing their job. In addition, the worker should have paid at least 1 week of unemployment contribution at least 2 years before the beginning of unemployment. Benefit available for 8 months for those below age 50 and for 12 months for those above age 50. Generosity: equal to 60% of the average wage for the first 6 months, 50% for the following 2 months, and 40% for the remaining period. *Since 2013:* Available to all eligible workers who involuntarily lost their job. Workers must have paid at least 1 year of unemployment contributions in the last 2 years before losing their job. In addition, the worker should have paid at least 1 week of unemployment contribution at least 2 years before the beginning of unemployment. Benefit available for 8 months (10 months in 2015) to those younger than 50 and 12 months for those aged 50–55; for those aged 56+, available for 12 months (2013), 14 months (2014), and 16 months (2015). Generosity: in the first 6 months, 75% of the average wage over the last 2 years (up to a ceiling[1])+ 25% of the difference between the average wage and the ceiling; for months 7–12, benefit is reduced by 15%; after 12 months, benefit is reduced by another 15%.
Japan	Available before ERA; contributory, non-means-tested earnings-related benefit; available for 90–360 days depending on prior length of contributions to employment insurance and the reason for separation in the previous job; amount of benefit depends on age, years of contributions, and pre-unemployment wage (e.g. those aged 60–64 who have contributed for 20 years or more receive 45–80% of pre-unemployment wage); requires active job search.
Netherlands	Available up to EPA (see Table 1). Maximum claim period depends on prior contributions but, for most claiming after age 60, benefits used to last to EPA. Currently, maximum duration is 38 months, being gradually reduced to 24 months by 2019. Benefits equal to 70% of previous earnings (up to a cap); higher benefit (75% replacement) for first 2 months. Active job search is required.
New Zealand	Available before pension age. Non-contributory, means tested. Must actively seek work and accept any offer of suitable employment. May be withheld for up to 13 weeks in cases of voluntary unemployment or the failure to meet employment-related obligations. Not paid if unemployment was voluntary or due to dismissal for serious misconduct or industrial dispute. Low replacement rate.
Spain	Contributory benefit: 70% of previous 180 days' wages for 6 months; 60% (reduced to 50% in 2012) thereafter. Minimum benefit is 80% of minimum wage; maximum benefit is 175% of minimum wage (for those without dependent children). Maximum period of receipt is 2 years or one-third of accumulated job tenure, whichever is shorter. After this period, receive flat-rate benefit equal to 80% of minimum wage if family income below 75% of minimum wage; for those aged 52+, this is payable until reach NRA.
Sweden	Available until age 65. Must be actively seeking work. Flat-rate benefit (320 SEK per day if previously worked full-time, otherwise pro-rated). Around 90% of workers also covered by additional voluntary earnings-related benefit – for those who choose to contribute to such a scheme and have been employed for at least a month: must have been member for 12 months and worked for at least 6 months in last year (for at least 80 hours per month), receive benefit worth 80% of previous earnings for 200 days (capped at 680 SEK per day), then 70% for 100 days (again capped at 680 SEK per day); those with children under 18 receive 70% for total of 250 days; thereafter moved onto labor market program.
United Kingdom	Available before state pension age; contributory, non-means-tested benefits only available for 6 months; non-contributory, means-tested benefit (paid at same rate) available thereafter; both require active job search; flat-rate benefit – provides very low level of earnings replacement for mid/high earners.
United States	Available at any age (though benefit amount reduced if also receive public pension income); contributory, non-means-tested benefits only available for 6 months. Requires active job search. Benefits replace approximately 50% of earnings when working; lower benefits (but higher replacement rates) for low-income workers.

Note: This table summarizes unemployment insurance available to older people, which in many countries acts as an alternative route into early retirement. The table summarizes the scheme rules that were prevalent during the last 10 years. The rules applying to younger individuals may differ.
Source: Wise (2016).

[1] The ceiling was €1,192.98 for 2014 and €1,195.37 for 2015.

Social insurance programs in continental Europe tend to provide more generous pathways to early retirement than those in most English-speaking countries. Duval (2003) (endnote 24) finds that unemployment benefits can finance early retirement in Belgium, Finland, France, Germany, the Netherlands, Portugal, and Spain. In the Netherlands, for example, as Table UI shows, unemployment benefits replace around 70% of previous earnings, while this can be up to 80% in Denmark. Such unemployment programs can imply a high marginal tax rate on earnings for older people and so discourage work at older ages.

In contrast, UK unemployment benefits replace a relatively small fraction of pre-unemployment income (similar to the US), and expire after six months. Unemployment benefits in Australia and New Zealand are entirely means tested – meaning that those with other sources of income or assets may not qualify at all. In all of these countries, claimants are required actively to search for work in order to remain eligible for benefits.

There are also other differences between the US and other developed countries in terms of other taxes and programs faced by the elderly, including differences in payroll taxes. For example, in some European countries (such as the UK), unlike the US, payroll taxes are lower for the elderly than for younger workers.

However, the US and many other developed countries are similar in providing a more generous means-tested safety net to the elderly than to those of working age.

Key Findings

Importance of earnings tests

Figure 2.19 showed how an earnings test for receipt of a public pension would affect the budget constraint that older workers face. Depending on the shape of individuals' indifference curves between consumption and leisure, the wages older people can earn, and how quickly pension benefits are withdrawn as earnings rise, economic theory suggests that earnings tests could have significant effects on employment rates of older workers.

A number of papers have attempted to estimate the effect of earnings tests on labor supply. Some papers have done this by exploiting the kinks in the budget constraint, while others have examined the impact of removing or changing these tests in certain countries.

Evidence from a number of countries suggests that earnings tests have been important in affecting labor supply, particularly of older men. The earliest evidence on the incentive effect of the earnings test in the US came from Blinder et al. (1981). Friedberg (2000) documents bunching at the kinks in the budget constraint caused by the earnings test, and Haider and Loughran (2010) document even greater bunching, in response to reforms of the earnings test in 1983 and 2000, when administrative data are used. Gelber et al. (2013) use a 'bunching analysis' to show that earnings of older people in the US responded significantly when the earnings threshold was changed. Song and Manchester (2007), also examining the 2000 abolition of the Social Security earnings test, conclude that the effect on earnings between the median and the 80th percentiles was large and significant.

Baker and Benjamin (1999) show that the removal of the earnings test in Canada was associated with an immediate increase in hours of work. Disney and Smith (2002), using evidence for up to five years after the removal of the earnings test in the UK in 1989, show that the earnings test had a large effect on reducing employment rates among older men in Britain before it was abolished. They find that removing the earnings test increased work hours of older men by around 4 hours per week, with a smaller effect for women. Likewise, removal of earnings tests (in combination with changes in actuarial adjustments) in Norway after 2011 had large impacts on employment (Brinch et al., 2016).

The evidence from Japan, however, is more mixed. Using a difference-in-differences approach, Abe (1998) and Ohtake and Yamaga (2003) find that the reforms to the earnings test in 1989 and 1995 (respectively) had only limited effect. On the other hand, using direct reports from a survey about whether individuals are discouraged from working by the earnings test, Shimizutani (2012) finds that the earnings test does have a discouraging effect. It is worth noting, however, that (as Figures 2.1–2.4 showed) employment rates of older Japanese men are above those seen in the other countries, despite the fact that Japan imposes a harsher earnings test than many other countries do.

Effect of actuarial adjustments

A number of countries offer actuarial adjustments for delayed claiming of public pension benefits. Several countries have recently introduced these or made their existing provisions

more generous in an attempt to encourage labor supply among older people.

There is some empirical evidence available on how these actuarial adjustments affect behavior. In particular, a number of papers have examined the effect of changes to the Delayed Retirement Credit (DRC) in US Social Security. Applying a difference-in-differences methodology to data from the Survey of Income and Program Participation, Pingle (2006) examines whether employment of 65- to 70-year-old men responded to increases in the DRC that were legislated in 1983 and gradually implemented over the following 20 years. These reforms increased the bonus offered for each year of deferment from 3% to 8%. He concludes that there was a significant positive effect on employment.

On the other hand, descriptive evidence from the UK suggests that actuarial adjustments there (where they are not coupled with an earnings test) have little effect on the timing of pension claims. For example, Crawford and Tetlow (2010) find that only 2–3% of people aged between the state pension age and 75 had chosen to defer their state pension. This is despite the fact that the deferral rate offered (10.4% per year) was more than actuarially fair and relatively generous compared with rates offered in other countries (as Table P shows).

Effect of changing early and normal retirement ages

Early and normal retirement ages can affect employment behavior for a number of reasons, including those just discussed: that is, the effect of liquidity constraints before benefit eligibility, actuarial adjustments, and earnings tests on pension income.

In addition, other changes to tax and benefit systems that happen around the normal or early retirement age may also affect employment. For example, as we discuss in Section 2.4.7, the fact that individuals also become eligible for Medicare in the US from age 65 may mean there is a reduced incentive to remain in work beyond that age, which is not a direct result of the Social Security rules. Similarly, as Cribb et al. (2013) describe for the UK, payroll taxes are lower and means-tested benefits more generous for those aged above the state pension age in the UK, which affects the marginal financial incentives to work that individuals face before and after that age. Along similar lines, the Netherlands tax code now directly depends on age: those at older ages receive a tax credit that encourages work (Euwals et al., 2009).

Another possible explanation for why early and normal retirement ages affect the timing

of retirement is that they act as a focal point, perhaps inducing some sort of social norm or providing some form of signal about the 'appropriate' age for retirement. We discuss this issue further in Section 2.4.8.

Gruber and Wise (2004) surveyed evidence on 11 developed countries and highlighted the fact that labor force exits are concentrated around legislated early and normal retirement ages and are potentially larger than can be explained by the pure financial incentives associated with retiring at these ages.

Most of the early papers that attempted to simulate the impact of moving these early and normal retirement ages on labor force participation relied on using out-of-sample predictions. Papers simulating changes in early and normal retirement ages in the US suggested quite large effects on retirement ages (Fields and Mitchell, 1984; Gustman and Steinmeier, 1985; Rust and Phelan, 1997; Coile and Gruber, 2000; French, 2005). For the UK, Blundell and Emmerson (2007) estimate that a three-year increase in the early retirement age for both men and women (and assuming that DB occupational pension schemes respond with a three-year increase in their normal pension ages as well) would increase retirement ages by between 0.4 and 1.8 years, depending on the specification used.

The results of ex-post evaluations, which typically pick up the short-run effect of changes in early and normal retirement ages, suggest even larger effects than were suggested by ex-ante simulation exercises. One of the first papers to examine ex post the impact of a change in early retirement ages was Burtless and Moffitt (1984). They showed that in 1960, when the earliest age an American man could draw benefits was the normal retirement age of 65, there was a large spike in exits for men at age 65, with no jumps at other ages. It was only after the introduction of the early retirement age of 62 in 1961 that a spike in job exit rates at 62 emerged. Börsch-Supan and Schnabel (1999), who looked at evidence from the reduction in the earliest age of pension receipt in Germany from 65 to 63 in 1972, concluded that the reform resulted in a significant downward shift in retirement ages. More recently, there have been a growing number of reforms around the world that have increased early retirement ages.

Staubli and Zweimüller (2013) use administrative data to examine an increase in the early retirement age in Austria. They find that a one-year increase in the early retirement age led to an

increase in employment rates of 9.75 percentage points for affected men and of 11 percentage points for affected women, with increases in unemployment rates of a similar size. Manoli and Weber (2012) study the same Austrian reforms and find large delays in job exits and pension claiming caused by the increase in the early retirement age.

Atalay and Barrett (2015) examine the effect of an increase in the earliest age at which women can access the Australian Age Pension. They find, using cross-sectional survey data, that a one-year increase in the eligibility age induced a 12–19 percentage point increase in female labor supply.

Using household survey data, Cribb et al. (2013) find that the increase in the female state pension age in the UK from 60 to 61 increased the employment rate of 60-year-old women significantly, by 7.3 percentage points. They also provide evidence that the policy led to increases in the employment rate of husbands of affected women too, suggesting that the policy has spillover effects within families; we return to discuss inter-family dependencies in Section 2.6.

A number of papers have also sought to evaluate the impact of changing normal retirement ages on employment of older people. Pingle (2006) and Mastrobuoni (2009) evaluate the effect of the increase in normal retirement age in the US that occurred for those born from 1938 onwards. Exploiting a difference-in-differences approach – to compare those just too old to have been affected with those first affected – these papers find significant immediate effects on the employment of workers aged between 60 and 64.

Hanel and Riphahn (2012) and Lalive and Staubli (2015) evaluate the effect of the 1991 reform of the Swiss mandatory retirement insurance program, which raised the normal retirement age for women from 62 to 64. They too find that the increased normal retirement age led to an increase in employment. Lalive and Staubli (2015) find that retirement ages increased by six months for each one year increase in the normal retirement age, while Hanel and Riphahn (2012) find that the size of the effect differed across education groups, with the strongest response being among the low educated.

One limitation of these types of evaluations, which estimate the reduced form impact of changing the early or normal retirement age in a particular country, is that the results depend to

some extent on the exact details of the pension system in place. As a result, it can be difficult to unpack which of the possible mechanisms discussed above are most important.

Benefit generosity

To the extent that government retirement programs induce early retirement, the more generous the program, the larger the inducement to retire early. Conditional on the level of contributions made, a more generous program induces a larger wealth effect.

Some of the most compelling evidence on the impact of benefit generosity on employment comes from examining the US 'notch' cohort born in the period 1917–22, whose benefits were lower than those born before.

Krueger and Pischke (1992) and Snyder and Evans (2006) investigate labor supply patterns of this group, both using data from the Current Population Survey (CPS). Despite using the same data, Krueger and Pischke find no evidence of disemployment effects from larger benefits, whereas Snyder and Evans find considerable disemployment effects.

The CPS data suffer in this context from not cleanly identifying year of birth – only age at interview. Both papers assume that year of birth is equal to the survey year, less age, less 1. However, because the survey is conducted in mid March, this will misallocate about 20% of individuals. Krueger and Pischke (1992) do not attempt to compensate for this. Snyder and Evans (2006) assign a treatment weight of 0.2 to those who they calculate were born in 1916.

The other difference between Krueger and Pischke (1992) and Snyder and Evans (2006) is in the sample they use. Krueger and Pischke include all individuals aged between 60 and 68 observed in the data from 1976 to 1988, whereas Snyder and Evans use a balanced panel of cohorts (those born between 1913 and 1920), who are observed in the CPS data from 1976 onwards, when aged between 62 and 70. The changes made by Snyder and Evans likely represent improvements in methodology, although the differences in estimates given relatively modest differences in method do suggest that neither set of estimates should be taken as definitive.

The policy reform that induced the 'notch' cohort provides a good source of exogenous variation in Social Security wealth, making it a useful and unusual situation in which to examine wealth effects. However, as Snyder and Evans (2006) note, most of those born after the notch did not realize the impact of the law changes until after they had retired. Consequently, evidence

from this 'experiment' could underestimate the true size of wealth effects on retirement.

Trends in Public Pension Incentives

Partly in response to the low levels of labor supply amongst those aged over 55, in recent years many governments have changed the rules of their social insurance programs. Reforms have further been precipitated by concerns about the long-term financial sustainability of some countries' systems, particularly in the aftermath of the 2008 financial crisis (Organisation for Economic Co-operation and Development, 2015).

Over the last two decades, we have seen a number of similar reforms implemented across a range of developed countries. First, a number of countries have removed (or made less harsh) the earnings test on receipt of public pensions. The UK did this in 1989, the US (for those above the normal retirement age) in 2000, and Canada in 2011. Second, many countries have also increased their early or normal retirement ages. For example, the US increased the normal retirement age from 65 to 66 in the early and Denmark increased it from 2004. Both of these types of changes are likely to have increased incentives to work at older ages.

Further increases in early and/or normal retirement ages are also planned elsewhere, which could delay retirement through a number of mechanisms. Australia, Belgium, Canada, Denmark, France, Italy, the Netherlands, the UK, and the US are all planning to increase their early and/or normal retirement ages over the coming years. For example, the UK has legislated to increase the state pension age to 66 for both men and women by 2020 and to 68 by the middle of the century.

Many countries have also reduced the generosity of pension benefits by changing the indexation of benefits, where the index maps past earnings into current benefits. Such reforms impose a wealth loss on future pensioners, which again will tend to encourage people to work more (and possibly to retire later). Belgium and Italy, for example, have both reduced the generosity of benefit indexation in recent years. Other countries, such as Canada and Spain, have introduced new mechanisms to link benefit indexation more closely to the contributions being made to the system, to improve financial sustainability. One exception to this pattern is the UK, where pension benefit indexation was made more generous in 2011.

A third set of reforms has been to increase mandatory contribution rates for public pension schemes and/or to increase taxes more generally. For example, Canada increased the contribution rate for the Quebec Pension Plan from 9.9% in 2011 to 10.8% in 2017. In France, employee and employer contributions will increase by 0.3 percentage points in 2017. The effect of these types of reforms on employment is ambiguous. On the one hand, the substitution effect will tend to make work less attractive. On the other hand, these measures reduce individuals' lifetime wealth, which will tend to increase labor supply.

A fourth set of common reforms has focused on increasing the replacement rate available to the lowest earners in order to reduce poverty among this group. These reforms will tend to reduce the incentive to work, particularly for those with low earning capacity.

Overall, reforms over the last few decades appear to have significantly increased the labor supply of older individuals and may continue to do so over the coming years.

2.4.5 Retirement Incentives from Private Pensions

In addition to public pension schemes, private pensions – particularly those provided by employers – play a significant role in some countries. This is particularly the case in the UK and the US, though these schemes have played a far more limited role (and in some cases no role) in continental Europe.

Evidence from the Health and Retirement Study suggests that the pension wealth of those retired in the US today is almost as important as Social Security wealth, and most of the pension wealth of those who have retired to date came from DB pensions (Gustman et al., 2010).

Defined Benefit Pensions

Historically, many firms in the UK and the US have provided DB pensions. DB pension plans in the private sector work in a similar way to public DB pension schemes and often provide incentives to leave the labor market at specific ages. Benefits are typically a function of earnings on the job, years of service at the job, and age. They also usually have an early retirement age (typically 55, 60, or 62), before which benefits cannot be drawn, and a normal retirement age (often 65). It is typically the case that, if individuals claim their pension before the normal

retirement age, they will face some reduction to their annual pension benefits. However, after the normal retirement age, there is often no actuarial increase for delayed claiming. As a result, benefit accrual typically becomes negative after the normal retirement age, inducing individuals to claim their pension benefits at this age (if not before).

A further incentive to retire was provided by the fact that, for a long time, it was illegal in many countries to continue working for an employer while also claiming pension benefits from them. This has changed recently in some countries – for example, this provision was relaxed in October 2006 in the UK. These incentives to claim a pension tended to translate into incentives to exit work at the same time.

Although they are now declining in prevalence among younger workers, DB pension plans have over recent decades created strong incentives that have influenced at least a significant minority of retirements. The incentives from DB plans vary sharply from individual to individual, depending not only on variation in plan provisions, but also in some cases on the date at which someone was hired by the firm. This variation has provided an opportunity to identify the importance of different pension incentives for retirement behavior as it has allowed analysts to exploit this heterogeneity between otherwise very similar individuals.

Defined benefit pension plans are an important factor in understanding the course of retirements to date, particularly in the UK and the US. In the UK, for example, those covered by an occupational DB pension have been able to opt out of the public pension system, meaning their retirement behavior is driven largely by incentives in their DB pension scheme rather than by the public system. The retirement incentives from DB pensions have been shown to be very strong and to have exerted an enormous influence on retirements that have taken place to date (Kotlikoff and Smith, 1983; Kotlikoff and Wise, 1985, 1987, 1989; Lumsdaine et al., 1990, 1994, 1996; Asch et al., 2005).

The development of surveys such as the Health and Retirement Study in the US (since 1992) and the English Longitudinal Study of Ageing (since 2002), which collect detailed information on individuals' pension plans (Gustman et al., 2010), has allowed researchers to account for heterogeneity in the marginal incentives provided by pension plans more accurately for wider populations (see, for example, Blau and Gilleskie (2008)). The papers in Wise (2016) use these

sorts of detailed microdata to estimate responses to financial incentives from different types of pension programs across 12 countries.

However, individual heterogeneity in plan details also poses challenges for some analyses, as ignoring the heterogeneity can lead to specification error. Studies of retirement that have ignored DB plans or not modeled them in detail may have generated biased conclusions about the influence of included factors on retirement and about the influence of related policies. Often due to a lack of data, rather than modeling individuals' occupational pension incentives in detail, many papers have assumed some typical scheme or incentives (Blundell et al., 2002; Blau and Goodstein, 2010). To the extent that doing so merely introduces measurement error, it may reduce the precision with which other coefficients in the models are estimated. However, if the mismeasured pension incentives correlate with other factors that have been included in the model, the coefficients on other variables could be biased. There are reasons to believe this could be an important concern. In particular, many occupational schemes have the same normal retirement age – and thus similar peaks in incentives – to those generated by public pension schemes.

Some authors have attempted to avoid this specification error by limiting their analysis to populations that are not covered by these types of private pension plans. For example, Benitez-Silva et al. (1999) and Benitez-Silva et al. (2004) limit their sample to exclude those who are covered by a private pension. Van der Klaauw and Wolpin (2008) exclude those who have a DB plan on their current job or who had a defined contribution plan at any time. Bound et al. (2010) assume, counterfactually, that all defined contribution assets and non-pension wealth are paid out as an annuity. The major limitation of this approach is that the results may not be generalizable to a wider population.

Trends in Private Pension Incentives

Defined benefit pensions have declined in popularity in recent years, increasingly being replaced by defined contribution pension schemes. One reason for this is that unforeseen increases in life expectancies have increased the cost of the schemes dramatically. Changes to laws governing DB schemes have also been important in increasing the cost of these schemes

– and thus reducing their attractiveness to employers – in the UK. For example, since 1997, employers have been required to provide inflation uprating of benefits in payment, which had not previously been mandatory.

Until recently, about 50% of all jobs in America had DB pensions. However, for younger workers, DB pension plans have been largely replaced with defined contribution plans. The most common type in the US is known as a 401(k). Defined contribution pension plans are mostly just subsidized savings plans. These plans do not provide strong incentives to exit the labor market and therefore the role of pension plans in driving retirement behavior is likely to decline in future. Just as public pensions are discarding early retirement incentives, private pensions are discarding early retirement incentives as well.

For those DB schemes that still exist, there have been other changes to plan rules that are also likely to affect behavior. In the US, employers are now required to offer continued accrual for those who remain in the scheme past age 65. In the UK, there has been a tendency to increase the normal pension age in many plans, particularly in the public sector.

This trend of changing plan rules and moving away from DB schemes altogether has had an important effect on trends in retirement. These changes are likely to continue affecting behavior for many years to come as later cohorts are more likely than earlier cohorts to have been affected by the changes.

It can be difficult to disentangle the effect of trends in private pensions on retirement from the influence of other changes that have gone on at the same time. Anderson et al. (1999) provide evidence on the impact of changes in pensions and Social Security in the 1970s and 1980s in the US and Gustman and Steinmeier (2009) examine more recent data.

2.4.6 Retirement Incentives from Disability Insurance

Another potentially important retirement incentive in the US is the Disability Insurance program. If an individual is determined to be disabled, her benefits replace about 50% of her income when she was working. Qualifying for Disability Insurance is difficult. Except in extreme cases (such as blindness or multiple sclerosis), the application process takes multiple years (French and Song, 2014). Nonetheless, the fraction of US workers receiving Disability

Insurance has grown rapidly in recent years (Autor and Duggan, 2006).

The eligibility criteria for many European disability insurance programs are often less stringent than those in the US (see Table DI). For example, in the Netherlands in 1996, 34% of all men and 14% of all women aged 60–64 were drawing disability benefits (De Vos and Kapteyn, 2004), whereas the corresponding rate for the US was 12% for men and 9% for women. In the Netherlands, screening standards have been tightened for disability benefits in more recent years, reducing inflows into the system.

Table DI: Country-specific disability insurance (DI) programs

Country	Summary	Disability test	% of men aged 60–64 receiving DI
Australia	Available before pension age. Non-contributory, means-tested (unless blind) income replacement benefit. Value equivalent to Age Pension (see Table 1). Must have actively participated in a program of support (tailored to level of impairment) for at least 18 months within the 3 years prior to claiming. Supplement paid to recipients of the disability pension to assist with general living expenses, such as utilities, telephone, and pharmaceuticals. Supplementary non-contributory scheme (National Disability Insurance Scheme) to be rolled out by 2018–19 to cover specific disability costs.	Permanently blind or have a severe physical, intellectual, or psychiatric impairment, be unable to work at least 15 hours a week for at least the minimum wage, and be unable to be retrained for such work for at least 2 years due to the impairment.	14.5% (2013) – men 13.3% (2013) – women
Belgium	Contributory condition: must have worked at least 120 days full-time (or 400 hours if part-time) in previous 6 months. Benefit level: 65% of reference wage if have dependants, 55% for singles, 40% for cohabitees. (Rolls into OAP at NRA.)	Loss of earnings capacity of 66% over a year, as assessed by a medical doctor, using a general medical assessment of work capacity that does not take into account the capacity to do the previous job.	
Canada	Can qualify for C/QPP before normal pension eligibility age if become disabled and have contributed for at least 4 of 6 years before onset of disability. Converts to ordinary pension at age 65.	Severe and prolonged medical condition.	7.0% (2009)
Denmark	Available up to *folkepension* age (see notes on NRA in Table 1). Same level of basic benefit as UI/*efterløn* ceiling (i.e. the public benefit is not related to previous earnings) + some specific needs supplements.	Permanent social and/or health impairments that reduce work capacity for any job by over 50%. Assessed by regional hospital physician, municipal social worker, and/or psychologist. Administered by municipalities.	12.3% (2008)
France	Before age 60: between 30% and 50% of average of last 10 years' earnings, depending on severity of disability. From age 60: people treated as full-rate pensioners, even if do not fulfill normal contribution conditions.	Before age 60: two-thirds disablement (compared with a fully-functioning individual). After age 60: 50% disablement. Assessment is carried out by a team of medical experts appointed by the local administration.	5.9% (ages 55–59, 2007)
Germany	Requires 5 years' contributions, including 3 in the last 5 years. Paid at same rate as old-age pension. Credits are given towards the old-age pension for years between disablement and the lower age threshold (60 until 2012, increasing to 2024 in 2024). Amount received is subject to deductions for claiming before the NRA – 3.6% per year between lower (as above) and upper (63 until 2012, rising to 65 by 2024) age thresholds. Thresholds (60, 63) remain fixed permanent for applicants with 40 years' compulsory contributions.	Capacity to do any job limited to less than 3 hours per day (less than 6 hours for partial DI). Exceptions for those born before 1961 who fulfill special conditions for an occupational disability pension – to get full pension, must be incapable of working 6+ hours per day in their occupation. Medical assessment of capacity carried out by a medical expert on behalf of the pension administration; final decision on applications made by the pension administration.	11.5% (ages 55–59, 2009)
Italy	Require at least 5 years of social security contributions, including at least 3 in the 5 years before claiming. Converted automatically into old-age pension at NRA.	Capacity to carry out own occupation reduced by at least two-thirds, defined by a medical test. Eligibility assessed by a physician from the National Institute of Social Security every 3 years.	
Japan	*Flat-rate benefit* Grade 1: full amount of flat-rate benefit of public pension × 1.25 (¥975,125 (2016), about 23% of average earnings) Grade 2: full amount of flat-rate benefit of public pension (¥780,100 (2016)) For both: additional payments if have children *In addition, employees (but not self-employed) receive an earnings-related benefit* Grade 1: earnings-related benefit × 1.25 Grade 2: earnings-related benefit For both grades 1 and 2: additional payments if have a spouse Grade 3: max{earnings-related benefit, ¥585,100 (2016)}	Grade 1: inability to perform activities of daily living, ADLs (e.g. complete blindness, severe disability affecting both hands) Grade 2: severe limitations in performing ADLs (e.g. any severe disability affecting either hand) Grade 3: difficulties with ADLs, less severe than Grade 2	
Netherlands	Available up to EPA (see Table 1). Receive at least 70% of last wage from employer (up to a cap) for first 2 years; reintegration programs during this time to encourage return to work. When the loss of earnings capacity is more than 80% and probability of ever being able to work again is low, benefit is 75% (up to cap) until EPA. In other cases (35–80% loss of earnings capacity), benefit level falls after a period; % reduction and length of time after which this happens depend on age and/or length of previous employment.	Must have lost at least 35% of earnings capacity to qualify for some benefit (over 80% for full benefit). Strict screening of disability and loss of earnings capacity by medical and labor market professionals.	12.1% (2010)
New Zealand	Non-contributory, means-tested benefit. Assistance benefits (when assessed disability is likely to last at least 6 months and incurs regular, ongoing costs because of disability that are not fully covered by another agency).	Permanently and severely restricted in capacity to work because of a health condition, injury, or disability. Must have a condition affecting capacity to work for more than 2 years, or have life expectancy of less than 2 years and be unable to regularly work 15+ hours a week, or be totally blind.	6.2% (men and women, 2016)
Spain	Contributory benefits: lower contributory condition if disability results from accident (especially if from work-related accident or illness), as opposed to ordinary illness. Benefits are earnings-related; exact amount depends on level of disability and age of onset. Those aged 55+ with disability in category (ii) receive higher payment if it is deemed they would have difficulty finding work due to limited education or local labor market conditions. Non-contributory benefits: means tested; average payment around €400; not eligible if income exceeds around €4,750 (for a single person in 2010). Converted to old-age pension at age 65.	Four degrees of disability: i. Permanent limited (at least 33%) disability for usual job (one-off payment). ii. Cannot do fundamental tasks in usual job but capable of doing other jobs. iii. Unable to do any job. iv. Requires assistance of a third person to carry out essential activities of daily living. Assessed by national social security agency on basis of medical notes.	12.0% (2012)
Sweden	Until 2003, able to access the old-age pension without actuarial reduction. Since 2003, benefits equal to 64% of 3 highest years' earnings in 5 years before labor force exit. (Transferred to pension system at age 65.)	Permanent inability to do any job.	16.6% (2012)
United Kingdom	Flat-rate benefit – low level of earnings replacement for mid/high earners.	Capacity to do any job, assessed by a government-appointed agent. Points awarded for a wide variety of potential disabilities – eligible if have sufficient points.	13.7% (2012)
United States	Benefits are an increasing function of earnings when working. Calculation of disability benefits is similar to calculation of retirement benefits, the main difference being that there is an adjustment to disability benefits for missing working years.	Individuals must have an impairment, either medical, psychological, or psychiatric in nature, that keeps them from being able to do their past job or engage in substantial gainful activity (essentially, being able to earn $15,000 per year) for a period of at least 12 months or until death.	16.3% (2009)

Note: This table summarizes the scheme rules that were prevalent during the last 10 years. The rules applying to younger individuals may differ.

Source: Wise (2016). Figures for the fraction of those receiving disability insurance in Canada, Denmark, France, Germany, the Netherlands, Spain, the UK, and the US come from figure I.1 of Wise (2016). Figures for Australia are derived from data from the Australian Department of Social Security and the Australian Demographic Service. Figure for New Zealand is calculated from data from the Ministry for Social Protection and Statistics New Zealand.

Figure 2.20: Job exit rates, by health insurance type

Source: French and Jones (2011).

2.4.7 Retirement Incentives from Health Insurance

In the US, the provision of health insurance is potentially also an important driver of labor supply decisions. The US government provides Medicare, which is nearly universal health insurance coverage, beginning at age 65. Medicare provides an important retirement incentive because many individuals younger than 65 obtain group health insurance only while they continue to work. Thus, those individuals potentially work not only for the labor income from work, but also for the health insurance benefit. However, once individuals become eligible for Medicare at age 65, the health insurance incentive for work largely vanishes.

Consistent with this view, those who would lose their health insurance when retired tend to remain at their jobs about six months longer than those who can maintain their post-retirement coverage. This was documented by Madrian (1994), Rust and Phelan (1997), and Blau and Gilleskie (2001), amongst others. Rust and Phelan (1997) and French and Jones (2011) show that the differences in employment among health insurance types is largely explained by a large

share of individuals whose health insurance is tied to their jobs waiting until age 65 to exit the labor market, the age at which these individuals are eligible for Medicare. Figure 2.20, taken from French and Jones (2011), shows that those whose health insurance is tied to their jobs have high job exit rates at age 65, whereas those with access to post-retirement 'retiree' coverage tend to leave at 62.

2.4.8 Expectations, Salience, and Focal Points

All of the above channels rely on individuals understanding how the system affects them and acting accordingly. Many of the incentives described above are complex. An active literature has tried to measure how well people understand these budget sets. For example, Gustman and Steinmeier (2004) show that people know the value of their pension and Social Security wealth only poorly, although Rohwedder and Kleinjans (2006) show that their level of knowledge rises near retirement. More generally, Lusardi and Mitchell (2007) show that financial knowledge is limited.

There is some evidence that, in practice, individuals respond strongly to what they believe the rules of the system are, even if they are misinformed (Chan and Stevens, 2004; Bottazzi et al., 2006; Coppola and Wilke, 2014). Moreover, there is evidence that individuals change their behavior in response to receiving correct information about public pension rules. Liebman and Luttmer (2011) run an experiment providing individuals with information on life expectancy and Social Security rules in the US and find that labor force participation is 4 percentage points higher among the treated group than among the control group one year later.

Early and normal retirement ages may also affect behavior in a number of ways outside of the direct financial incentives discussed above. They may provide a focal point for decision-making and/or shape social norms about what is the appropriate retirement age. If early and normal retirement ages in public pension schemes induce a social norm about the appropriate retirement age, and if that social norm takes some time to become established, the long-run effects of increasing retirement ages could be larger than the short-run effects suggested by the papers discussed in Section 2.4.4.

In practice, it is often difficult to unpack which mechanisms are important, as numerous

changes to financial incentives occur at the same time around early and normal retirement ages. However, some have attempted to do so. For example, Behaghel and Blau (2012) conclude that the strong employment reaction to increases in the normal retirement age in the US reflected loss aversion with reference dependence – that is, if people start by assuming that the normal retirement age is when they will retire, they then worry about ending up worse off if they deviate from this behavior. To the extent that people do not fully understand the Social Security rules, they fear making themselves worse off by deviating from what they see as being the 'normal' retirement age.

2.5 Models of the Retirement Decision

Reduced form evidence strongly suggests that many of the mechanisms that might be expected to affect retirement – such as declining health, liquidity constraints, and financial incentives – do indeed influence behavior. However, these factors interact with each other in potentially complicated ways and many public policies work through more than one of these channels. Reduced form papers on their own, therefore, do not tell us much about the mechanisms through which policies or other changes in the economic environment affect retirement behavior.

Structural models provide an alternative approach. Unlike much of the reduced form evidence, structural models can, in principle, accommodate the greater complexity of real-world policies and help us to understand the mechanisms by which they affect behavior. However, until recently, few models had made good progress in being able to capture this complexity.

2.5.1 Early Structural Models

The considerable policy relevance of retirement and the forward-looking nature of the retirement problem mean that structural modeling of the retirement decision has a long and rich history. Early work focused on carefully modeling the budget sets created by public and private pensions, and measuring the labor supply responses to kinks in the budget set (for example, Gustman and Steinmeier (1986) and Burtless (1986)). The early structural models differed from one another (and also made important departures from reality) in three important ways: first, in

the assumptions made about certainty; second, in the assumptions made about borrowing and lending constraints; and third, in the assumptions made about the choice of retirement options open to people.

Gustman and Steinmeier (1986) and Burtless (1986) abstracted from uncertainty and assumed that households can perfectly smooth consumption by borrowing and lending without limit. However, such models were unable to match two facts observed in practice: first, that a large share of the US population begin drawing benefits at the first age they are eligible (i.e. at age 62), despite the fact that Social Security is actuarially fair towards delayed benefit receipt; and second, that, for those with employer-provided health insurance, the availability of Medicare at age 65 seems to influence the timing of retirement.

Building on Rust (1989), Rust and Phelan (1997) devised a dynamic programming model that made the diametrically opposed assumptions about borrowing – i.e. individuals could not save and thus could not finance early retirement or self-insure against medical and other risks through savings. They also allowed for realistic uncertainty. This meant they could replicate the two key facts mentioned above. The earlier certainty models with no borrowing constraints suggested that there was no incentive to draw at age 62. But the inability to borrow against future benefits (which Rust and Phelan incorporated) would imply that people might leave the labor market at the first age they were eligible. Furthermore, by allowing for uncertainty, Rust and Phelan could better consider risk and the insurance value of Medicare health insurance for the elderly.

Most of the early papers modeled only the decision of when to stop working and not, for example, the choice of hours of work. As the evidence in Section 2.2 suggests, this captured many of the important patterns of exit from work for men at that time. Gustman and Steinmeier (1986) allowed somewhat greater richness in their description of retirement by also allowing for part-time work to capture 'bridge jobs' and for the gradual transition to retirement that a significant number of people experience.

Other early structural models incorporated some other extensions to allow for greater realism. For example, Berkovec and Stern (1991) estimate a retirement model that allows for job-specific match effects.

In parallel to the development of these dynamic programming models, Stock and Wise (1990) devised 'option value' models, which are simple models designed to capture the forward-looking nature of pension schemes, without incorporating the full dynamic decision-making process. These option value models, and how they compare with the full dynamic programming approach, are discussed in Section 2.5.7.

2.5.2 A Structural Model with Savings and Uncertainty

More recent structural models have combined the strengths of a number of the earlier papers and exploited improvements in computing power to produce more realistic models of retirement behavior. French (2005) allowed for both savings and uncertainty, and thus nested some of the key features in previous papers. For this reason, we will use his framework in this section to show how structural models can be used to analyze the effect of the incentives, constraints, and uncertainties that individuals face.

In this model, a single person can choose consumption, work hours (including the labor force participation decision), and whether or not to apply for pension benefits. He is allowed to save but not borrow against future labor, private pension, or public pension (Social Security) income. When making these decisions, he is faced with several forms of uncertainty: survival uncertainty, health uncertainty, and wage uncertainty.

A version of this model has been estimated in French (2005) and has been found to fit the data well. This model has now been extended in multiple papers, but is sufficiently parsimonious that many key retirement incentives that individuals face are relatively clear.

Consider a household head seeking to maximize his expected discounted lifetime utility at age t, $t = 30, 31, ..., 95$ (where the subjective discount factor is β). Each period that he lives, the individual derives utility from consumption, C_t, and hours of leisure, L_t. The within-period utility function is of the form shown in Equation (5).

$$U(C_t, L_t) = \frac{1}{1-\nu}\left(C_t^{\gamma} L_t^{1-\gamma}\right)^{1-\nu}. \tag{5}$$

The quantity of leisure is given by Equation (6).

$$L_t = L - H_t - \phi_P P_t - \phi_M M_t, \tag{6}$$

where L is the individual's total annual time endowment. Participation in the labor force is denoted by P_t, a 0–1 indicator equal to 1 when hours worked, H_t, are positive. The fixed cost of work, ϕ_P, is treated as a loss of leisure. Including fixed costs helps us capture the empirical regularity that annual hours of work are clustered around 2,000 hours and 0 hours, as seen in Table 2.5. The quantity of leisure also depends on an individual's health (or medical) status through the 0–1 indicator M_t, which equals 1 when his health is bad – in other words, there is a fixed cost of being in poor health.

Workers alive at age t survive to age $t+1$ with probability s_{t+1}. Workers who die value bequests of assets, A_t, according to the function $b(A_t)$ shown in Equation (7).

$$b(A_t) = \theta_B \frac{\left(A_t + \kappa\right)^{(1-\nu)\gamma}}{1-\nu}, \tag{7}$$

where θ_B and κ are parameters that allow for a flexible bequest motive.

Given the objective function, individuals face several constraints. The probability of surviving to next period depends upon previous health status M_t and age:

$$s_{M,t+1} = prob(alive_{t+1}|alive_t, M_t, t+1). \tag{8}$$

Next year's health status, $prob(M_{t+1}|M_t, t+1)$, depends on current health status and age. Health status follows a two-state transition matrix at each age with a typical element given by Equation (9).

$$\pi_{bad,bad,t+1} = prob(M_{t+1} = bad|M_t = bad, t+1). \tag{9}$$

The logarithm of wages at time t, $\ln W_t$, is a function of hours worked, age, and health status, plus an autoregressive component of wages, ω_t:

$$\ln W_t = \alpha \ln H_t + W(M_t, t) + \omega_t, \tag{10}$$

where the function $W(M_t, t)$ is the one that fits the wage profile in Figure 2.16, controlling for

hours worked as in Figure 2.15, and the idiosyncratic component of wages, ω_t, is an AR(1). By assumption, the individual is uncertain about future realizations of the AR(1) component of wages.

To allow for insurance through spousal income, spousal income ys_t is allowed to depend upon the individual's wage and age:

$$ys_t = ys(W_t, t). \tag{11}$$

The final constraint is the asset accumulation equation:

$$A_{t+1} = A_t + Y_t - C_t, \quad A_{t+1} \geq 0, \tag{12}$$

where Y_t is post-tax income from labor income from both self and spouse, interest on assets, and pension benefits (public and private). These private and public pension benefits capture the key features described in Sections 2.4.4 and 2.4.5.

Optimal decisions for consumption, hours and whether to apply for benefits (defined as B_t) depend on the state variables, denoted $X_t = (A_t, W_t, B_t, M_t, AIME_t)$,[9] (where $AIME_t$ is average earnings up to that point) the data-generating process for the state variables, and preferences, denoted $\theta = (\gamma, \nu, \phi_P, \theta_B, \phi_H, L, \beta)$. The value function is the solution to

$$V_t(A_t, W_t, B_t, M_t, AIME_t) = \max_{C_t, H_t, B_t} \left\{ \frac{1}{1-\nu} \left(C_t^{\gamma}(L - H_t - \theta_P P_t - \phi M_t)^{1-\gamma} \right)^{1-\nu} + \right.$$
$$\left. \beta s_{M,t+1} E_t V_{t+1}(A_{t+1}, W_{t+1}, B_{t+1}, M_{t+1}, AIME_{t+1}) + \beta(1 - s_{M,t+1}) b(A_{t+1}) \right\}, \tag{13}$$

subject to the equations described above. The decision rules are solved recursively, starting at time T and working backwards. Since there is no closed form solution to the problem, the state variables are discretized into a finite number of points on a grid and the value function is evaluated at those points. The approach allows for heterogeneity in the state variables $(A_t, W_t, B_t, M_t, AIME_t)$, but not in other dimensions such as preferences. Different realiza-

[9] Pension wealth and spousal income depend on the other state variables and are thus not state variables themselves. Also, B_t as a state variable here refers to whether the individual has already applied for benefits.

tions of the stochastic shocks mean that wages and health status will differ across individuals, so there may be differences in consumption, labor supply, and benefit application decisions across individuals. However, given the same age, wage, health status, asset level, Social Security application status, and AIME, different individuals will make the same decisions. French and Jones (2011) extend to allow for preference heterogeneity as well.

2.5.3 Estimated Life-Cycle Labor Supply Elasticities

In estimating the type of model described above, the parameters are typically chosen in order to match certain variables to real-world data. For example, French (2005) estimates the model described above choosing parameters so that the model's predictions for hours worked by workers, labor force participation, and asset profiles match data from the US. The model matches the data extremely well.

Such a model can then be used to examine labor supply elasticities for different groups. In such a model, there is no analytical solution for the labor supply elasticities. Instead, they must be derived by simulating the model deviations in the wages available to individuals. For example, French and Jones (2012) first use the model described above to simulate average hours of work across all individuals. They then repeat the simulation with wages increased by 20% at certain ages, but being held at their baseline values at all other ages, and calculate how total hours of work change at each age. Comparing the hours of work simulated in the two cases then allows the authors to compute labor supply elasticities.

French (2005) shows that in this realistic environment, groups closer to the participation margin have higher labor supply elasticities, because of the fixed cost of work. Since those near retirement are nearer to the participation margin, the model can reconcile the low labor supply elasticities typically estimated for young workers with the large observed responses to changes in private and public pension rules.

Table 2.6 presents the labor supply elasticities calculated by French and Jones (2012). It shows that labor supply elasticities increase significantly over the life cycle. For temporary (one-year) wage changes, the elasticity rises from 0.36 at age 40 to 1.28 at age 60. When workers are young, the benefits of working are typically far above the fixed cost of working. Young

workers have few assets and work to build up a buffer stock of wealth (Benitez-Silva, 2000; Low, 2005; Pijoan-Mas, 2006). As a result, changes in wages do not change the participation decision and have little effect on labor supply. As workers near retirement, the benefits of work begin to shrink. Their wages begin to fall, their health worsens, and their wealth increases. Thus older workers are closer to the participation margin. Because those near the participation margin have more elastic labor supply, as workers approach retirement their labor supply elasticities rise.

Table 2.6: Labor Supply Responses to a 20% Increase in Wages

	Temporary wage change		Permanent wage change	
	At age 40	At age 60	At age 40	At age 60
		Labor supply elasticities		
In year of wage change	0.36	1.28	0.17	1.17
Over entire life	-0.01	0.01	0.11	0.14
In years prior to change	-0.01	-0.01	-0.21	-0.04
In years after the change	-0.03	-0.11	0.26	2.24
		Change in hours of work		
In year of wage change	155	377	74	346
Over entire life	-183	167	1,432	1,906
In years prior to change	-39	-111	-923	-519
In years after the change	-300	-99	2,281	2,079

Source: French and Jones (2012).

Table 2.5 and Figure 2.15 show why a labor supply elasticity that rises with age is consistent with the data. Table 2.5 shows that very few workers in the US work less than 1,500 hours a year; in the model, such behavior implies a significant fixed cost of work. Figure 2.15 shows that the labor market participation of healthy people is more or less constant until age 60, at which point it drops dramatically over just a few years. For the model to replicate these facts, reservation wages must rise and/or after-tax wages fall after age 60; with a fixed cost to work, these shifts move workers to the participation margin, where labor supply elasticities are higher.

Table 2.6 shows that, when wage changes are temporary, individuals are more willing to shift hours across the life cycle than to change total lifetime hours. For example, the elasticity of hours with respect to a transitory wage change is 0.36 at age 40. Because the wage is higher at age 40, agents work more hours at that age. However, hours after age 40 fall significantly,

so much so that total lifetime hours of work actually fall. Agents feel richer throughout their lives, and thus consume more of everything, including leisure.

Similarly, when future wage increases are anticipated, individuals will adjust current hours in response. Younger workers will need to work and save less when young, knowing they will work until an older age. A temporary wage increase at age 60 increases hours at age 60 by 377, but decreases hours prior to age 60 by 111. Total lifetime hours increase by only 167. Thus the labor supply response to a transitory wage change is not so much an increase in total lifetime hours as it is a reallocation of hours over the life cycle.

Finally, Table 2.6 shows that the contemporaneous hours response is smaller for permanent wage changes than for temporary ones. When a wage change is permanent, the scope for reallocating hours over the life cycle is smaller and the wealth effect, which reduces hours, is larger. The table shows that for a permanent wage change at age 40, the elasticity of hours at age 40 is 0.17; the corresponding elasticity for a temporary wage change was 0.36. Permanent wage changes also lead workers to reallocate their labor, as they shift hours from before the wage change to afterwards. It is still likely that total lifetime hours will rise in response to increased labor supply incentives when old. Table 2.6 shows that, when there is a permanent wage increase at age 60, total lifetime hours increase by 1,906. However, it also shows that the labor hours of younger workers fall by 519, partly offsetting the labor supply responses of older workers.

While these types of structural model focus on understanding retirement behavior, they also provide some of the only evidence available on how labor supply elasticities vary over the life cycle. Despite the fact that this is an issue of central importance for optimal taxation over the life cycle, there is relatively little other evidence on it. Imai and Keane (2004) argue that – because work at young ages increases future wages – the labor supply of young workers is not very sensitive to changes in their current wages, leading to elasticities that rise over the life cycle (also see Wallenius (2009)). Conversely, Gomme et al. (2005) find that at business-cycle frequencies, the elasticity of labor supply follows a U-shaped pattern over the life cycle – highest at young ages, then falling and rising slightly at older ages. Thus the other evidence is not definitive, but it suggests that labor supply elasticities rise at older ages.

Retirement Elasticities

Overall, direct evidence on labor supply elasticities around retirement age is scarce. This is likely related to two separate issues that we noted previously.

First, we should not view employment elasticities as structural. Employment elasticities are likely to be a function of the density of individuals who are near the employment margin. Given that the share of all workers near the employment margin likely rises with age, the elasticity should rise also. As noted previously, this is the line of reasoning underlying French (2005), who finds that intertemporal (Frisch) labor supply elasticities rise from around 0.36 at age 40 to 1.28 by age 60.

Second, the complex nature of pension schemes faced by the elderly means that estimating a labor supply elasticity is difficult. It is sometimes not clear whether the elasticity concept is with respect to the pre- or post-tax wage. Furthermore, applying for benefits often affects the after-tax wage individuals face, meaning that the elasticity is a function of choices. For these reasons, any estimate of a retirement elasticity should be interpreted with caution.

These issues are in addition to the standard issues of obtaining credible variation in wages that is independent of preferences.

Nevertheless, we think a short review is valuable. French (2005) finds a labor supply elasticity with respect to the pre-tax wage near retirement of 1.28. French and Jones (2011) extend French (2005) to have a more flexible structure of unobserved heterogeneity in the model and find that a total labor supply elasticity with respect to the wage is 0.49 at age 60. Manoli and Weber (2011) use a bunching style estimator to evaluate the employment response to severance payments and obtain estimates of 0.1–0.4. Kimball and Shapiro (2008) use survey evidence on how people would respond to a large wealth shock. Assuming that income and substitution effects offset, the survey evidence suggests a Frisch labor supply elasticity of around 1. Lastly, Imai and Keane (2004) estimate an intertemporal labor supply model with human capital accumulation and evaluate the intensive labor supply response to a wage change at different ages. By age 60, this elasticity rises to 2 in their estimated model.

In summary, although there is no consensus as to the substitutability of labor supply near retirement age, it appears that labor supply elasticities are higher at older ages. This is because

the decision to work becomes operative at these ages.

2.5.4 Policy Experiments

A significant benefit of developing structural models is that they can predict the effect of policy reforms that have not yet occurred. Table 2.7 presents findings from French (2005), who uses a structural model to assess how changes in the US Social Security rules would affect both consumption and labor supply over the entire life cycle. The first row of Table 2.7 shows predicted years worked, hours worked per year among workers, the present discounted value of labor income and consumption, and assets at age 62 for the cohort of men who neared retirement age in 1987, under the Social Security rules faced by these workers. The second row shows what would happen to their labor supply and savings if their benefits were cut by 20% and they anticipated these lower benefits.

Table 2.7: Policy experiments

	Years worked	Hours worked per year	PDV of labor income	PDV of consumption	Assets at age 62
1987 policies	32.60	2,097	$ 1,781	$ 1,583	$ 190
Reduce benefits	32.83	2,099	$ 1,789	$ 1,569	$ 200
Shift early retirement age to 63	32.62	2,096	$ 1,781	$ 1,584	$ 190
Eliminate earnings test, age 65+	33.62	2,085	$ 1,799	$ 1,594	$ 188

Note: PDV stands for present discounted value. Consumption, labor income, and assets are measured in thousands. Source: French (2005).

The second row of Table 2.7 shows that reducing Social Security benefits by 20% causes individuals to work more hours throughout their lives and increase their assets in order to offset reduced benefits. To understand the magnitude of these effects, note that the average present value of Social Security benefits at age 62 is about $132,000. Cutting benefits 20% thus reduces the present value of Social Security wealth by about $26,000. Individuals respond to this wealth loss by reducing both consumption and leisure – that is, by working and saving more. As a result, age-62 asset levels are around $10,000 greater when benefits are reduced. About two-thirds of this increase is from reduced consumption, while the other one-third is from increased labor supply. This highlights the importance of forward-looking behavior when considering effects of changing the Social Security rules.

Nevertheless, most of the effects are seen after age 62. Increased years in the labor market after age 62 replace $5,500 of the lost income. One reason for this is that most of the life-cycle variability in hours occurs at the participation margin at older ages, implying that the flexibility of labor supply is highest after age 62. A second reason is that reducing Social Security benefits also effectively reduces the Social Security earnings test, and thus reduces the tax imposed by the earnings test. If an individual receives no Social Security benefits, there are no Social Security benefits to be reduced by the earnings test. Therefore, the substitution effect associated with a benefit cut causes individuals to work more hours when eligible for Social Security benefits and fewer hours at younger ages.

In short, reducing Social Security benefits generates substitution and wealth effects that both encourage workers to supply more labor, especially after age 62. It is not immediately obvious which of these effects is stronger. French (2005) uses additional simulations to show, however, that the substitution effect is much stronger.

Another potential reform to the Social Security system is to shift the early retirement age from 62 to 63. Recall that increases in future benefits almost fully replace benefits lost through the earnings test at age 62. Therefore, if borrowing constraints do not bind, there should be little if any work disincentive imposed by Social Security at age 62, and thus there should be little if any effect of shifting the Social Security early retirement age to 63. French (2005) finds that very few individuals face borrowing constraints at age 62. Not surprisingly, the penultimate row of Table 2.7 shows that the effects of shifting the early Social Security retirement age to 63 are very small.

Finally, the last row of Table 2.7 shows results from eliminating the Social Security earnings test for individuals aged 65 and over. This has large effects. Years in the labor force rise from 32.60 to 33.62, a full year, in response to the abolition of the earnings test, although average hours worked by workers are largely unchanged. Given that eliminating the earnings test increases lifetime wealth, which decreases hours of work, the observed increase in labor supply is completely due to substitution effects.

This final experiment allows us to test the model's forecasting ability, because the earnings test was in fact abolished for individuals aged 65 and older in 2000. Given the value of structural

models as forecasting tools, it is reasonable to test their forecasting ability through out-of-sample validation exercises. The basic structure of a validation test is to estimate a model with data drawn from one observed policy regime and then use the model to predict outcomes in another observed policy regime (see, for example, Keane and Wolpin (2007) and the references therein).

The model used to produce Table 2.7 was estimated on a sample of individuals who faced the earnings test until age 70, so its predictions regarding the elimination of the earnings test are out-of-sample forecasts. The final row of Table 2.7 shows that the model predicts that once the earnings test is eliminated, labor force participation rates should rise sharply in the years that follow. As it turns out, labor force participation rates for men over 65 have risen rapidly over the last 20 years, from 16% in 1987 (the central year of analysis in French (2005)) to 18% in 2000, when the earnings test was repealed, to 22% in 2009. Admittedly, however, this comparison of labor supply in 1987 and 2009 might not cleanly identify the true effect of the repeal of the earnings test, because many other changes occurred between 1987 and 2000, when the earnings test was repealed.

In order to isolate the effect of the earnings test more cleanly, we consider a somewhat different validation exercise, using a different model that appears in French and Jones (2011). This model was estimated on a cohort of individuals who were aged 57–61 (with an average age of 59) in 1992, and thus faced the earnings test. The authors then tested the model by predicting the labor supply of individuals who were aged 51–55 (with an average age of 53) in 1992, and thus did not face the earnings test. In both cases, the model simulations were started in calendar year 1992, so individuals had only a limited time to respond to the changes. This exercise also differs from the exercise in Table 2.7 in that the simulations allow the in-sample and out-of-sample cohorts to differ in their initial endowments of financial, Social Security, and private pension wealth; in Table 2.7, the same people are subjected to different policy regimes. Table 2.8 presents the results from this out-of-sample comparison. The model predicts the observed increase in participation rates reasonably well. For example, it finds that the younger cohort, who did not face the earnings test, worked an additional 0.341 years between ages 60 and 67, whereas the model predicts an additional 0.447 years. The estimated increase in labor

supply at ages 62–67 is similar to the estimated increases in labor supply reported in Song and Manchester (2007).

Table 2.8: Participation rates by birth year cohort

	Data			Model		
	Age in 1992			Age in 1992		
	59	53	Difference†	59	53	Difference*
Age	(1)	(2)	(3)	(4)	(5)	(6)
60	0.657	0.692	0.035	0.650	0.706	0.056
61	0.636	0.642	0.006	0.622	0.677	0.055
62	0.530	0.545	0.014	0.513	0.570	0.057
63	0.467	0.508	0.041	0.456	0.490	0.035
64	0.408	0.471	0.063	0.413	0.449	0.037
65	0.358	0.424	0.066	0.378	0.459	0.082
66	0.326	0.382	0.057	0.350	0.430	0.080
67	0.314	0.374	0.060	0.339	0.386	0.047
Total, 60-67	3.696	4.037	0.341	3.721	4.168	0.447

† Column (3) = Column (2) − Column (1). * Column (6) = Column (5) − Column (4).
Source: French and Jones (2011).

2.5.5 Recent Structural Models

Recent research using structural models of retirement behavior has made progress in several dimensions. First, the more recent literature has allowed for additional sources of risk, such as wage, unemployment, health, and medical spending risk. Second, it has allowed for more realistic modeling of budget sets, such as the dynamic aspects of pension schemes, which often introduce non-convexities. Third, many of the recent papers also allow for both savings and the possibility that people cannot borrow. Fourth, recent research has allowed for more choices, such as the choice to apply for disability benefits. We describe some of these advances below and leave discussion of important advances on family labor supply to Section 2.6.

Liquidity Constraints

As mentioned above, many people exit the labor market at the first age they are eligible for benefits despite the fact that in many countries there is no actuarial incentive to draw benefits at the first possible age. Delaying benefits typically yields a larger annual payment and often a similar present discounted value of future payments.

A potential explanation for this behavior is the presence of liquidity constraints. In the US case, many people younger than 62 have few liquid assets and thus may not be able to finance exit from the labor market before that age. Using data from the Retirement History Survey, Kahn (1988) presents evidence that those with low asset levels have larger jumps in exit rates at age 62. Assuming that individuals have zero assets, Rust and Phelan (1997) use a dynamic programming model to show that the liquidity constraint can be quantitatively important for producing the observed jump in exit rates at age 62.

Gustman and Steinmeier (2005) and French (2005) endogenize savings and also liquidity constraints in a retirement model. Gustman and Steinmeier conclude that liquidity constraints are the key explanation for the spike in retirements at the early retirement age. French also finds that liquidity constraints are important for the age-62 jump, although he finds that the details of private pensions are more important for explaining the jump.

French and Jones (2011) update Kahn's (1988) analysis, showing differences in job exit rates (and employment rates) by asset grouping. They show that those with low assets have a higher jump in exit rates at age 62, although the difference is not big: employment rates drop sharply at 62 for all asset groupings.

Some have argued that the liquidity constraint argument is implausible because most people have positive assets near retirement age. French (2005) shows that about 80% of all men in their early 60s in the Panel Study of Income Dynamics have sufficient net worth assets to finance at least one year out of the labor force. However, there are at least two reasons that households with positive net worth may still act as if they are liquidity constrained.

First, many households may hold positive net worth to pay for contingencies such as unforeseen medical spending. In a model with uncertain medical spending, for example, many individuals may wish to hold onto a large amount of assets to insure themselves against catastrophic medical expenses. Thus even those with assets equal to a year's worth of earnings may behave as if they are liquidity constrained (French and Jones, 2011).

Second, many households, despite having high total net worth, have little in the way of liquid assets. For many households, most assets are tied up in illiquid assets such as housing, businesses, and autos. It is costly to refinance. Furthermore, lenders may be reluctant to lend

to the elderly who have low future earnings. To account for the illiquidity of these assets, Gustman and Steinmeier (2005) exclude housing from their measure of wealth when estimating a retirement model. They conclude that liquidity constraints are important for understanding the high job exit rates at age 62 in the US. Their approach makes the extreme assumption that households are completely unable to borrow against housing wealth. Presumably, households have at least some ability to liquidate or borrow against these assets. To address this issue, many models in the consumption literature now include both liquid and illiquid assets to study the spending response to income changes. For example, Kaplan and Violante (2014) develop a model with liquid and illiquid assets, where the illiquid asset has a higher return but there is a transaction cost to move money out of the illiquid asset. They find that, for a given level of total assets, spending behavior of some people with high total assets (but low liquid assets) mimics that of people who are liquidity constrained. For example, in their model, consumption is very sensitive to the timing of income. Aaronson et al. (2012) create a model with durable and non-durable goods. Households can borrow against durable goods, but face a collateral constraint. The authors show that in this framework, spending can also be extremely sensitive to the timing of income. Thus these papers show that models with both liquid and illiquid assets produce stronger effects of liquidity constraints than models with a single liquid asset. Presumably, this logic would carry over to models of spending and retirement. However, to the best of our knowledge, such a model has not been solved, so the quantitative effects of allowing for both liquid and illiquid assets is unclear.

Health

As pointed out in Section 2.4.1, there are several reasons why we might expect health to impact retirement behavior. First, declining health makes work less pleasant. Second, it can reduce an individual's productivity and thus the individual's wage. Third, health shocks might reduce life expectancy, and thus the amount of savings that an individual needs for retirement. Finally, declining health means that an individual often becomes eligible for benefits from firm- or government-based disability programs, which often stipulate that the individual cannot work while drawing these benefits. Without using the structure of a model, it is difficult to disentangle

the relative importance of these factors.

Most existing papers allow for only a subset of these channels. See, for example, French (2005) and Capatina (2015), who consider the first three channels but do not account for disability benefits. Capatina finds that the main channel by which health affects earnings is through its effect on productivity and in time lost in bad health.

Disability Insurance

As we brought up in Section 2.4.6, receipt of disability insurance is an important pathway to retirement. Modeling this pathway is difficult because in some ways receipt of benefits is uncertain, and disability itself is usually an unexpected health shock. The most common reasons for applying for benefits in the US are musculoskeletal (such as back) and mental health problems – problems that are difficult to diagnose. In many countries, such as the US, not everyone who applies for benefits receives them, and the process of receipt can take years. Furthermore, in order to be eligible for benefits, the individual must be out of the labor force, including when applying for benefits.

Bound et al. (2010) and Iskhakov (2010) model the health shocks people face over the life cycle in a detailed way, and how they impact eligibility for disability benefits. Low and Pistaferri (2010) and Benitez-Silva et al. (2013) add savings to the model so that self-insurance through savings can be considered as an alternative insurance mechanism to disability benefits. Kitao (2014) formulates a model with uncertain medical spending and disability, which is important because those eligible for disability benefits also become eligible for Medicare benefits in the US.

French and Song (2016) estimate a dynamic programming model of employment and the disability application process, matching the model predictions to administrative data on flows into the US disability program, appeal rates of those denied, and the labor supply of those allowed and denied benefits over the process of their applications. They account for the fact that many of those who apply for benefits are initially denied, but remain out of the labor force so that they can continue to appeal their rejection. They find that failure to account for these dynamic incentives would seriously understate the true work disincentive of disability

insurance.

An important limitation of these papers is that they tend to assume that retirement is exogenous. This limits our ability to consider how changes in disability policy affect retirement patterns. For example, we know that increases in the normal retirement age tend to increase entry into disability insurance. It would be useful to have a model to better assess the mechanisms behind these changes and to better assess the optimality of increasing the normal retirement age.

Medical Spending Risk

In the US context, a key risk is the possibility of facing high medical spending when uninsured. Gustman and Steinmeier (1994) modeled the level of medical spending in a certainty model, but Rust and Phelan (1997) were the first to consider medical spending risk as a driver of retirement.

Later analyses by, for example, Blau and Gilleskie (2006) and Blau and Gilleskie (2008) consider the importance of spouses and endogenous medical care, respectively. French and Jones (2011) endogenize savings. These studies find smaller effects of health insurance on retirement than Rust and Phelan (1997), possibly because they allow for more margins of substitutability (such as spousal insurance, ability to reduce medical spending, or dissavings). But they find bigger effects than the certainty model of Gustman and Steinmeier (1994). Furthermore, these papers are better able to match the basic reduced form facts than Gustman and Steinmeier (1994), such as the large reduced form estimates of the impact of health insurance on retirement described in Section 2.4.7, showing the importance of the risk of catastrophic medical expenses for understanding retirement.

French and Jones (2011) find that Medicare was about as important as Social Security in determining retirement for the cohort that turned 65 in the late 1990s. They find that raising the Medicare eligibility age from 65 to 67 leads individuals to work an additional 0.074 years over ages 60–69. In comparison, eliminating two years' worth of Social Security benefits increases years of work by 0.076 years. Van der Klaauw and Wolpin (2008) also consider the importance of spouses in a model with medical spending, focusing on low-income individuals who are not covered by private pension plans.

A number of recent papers have considered the potential impacts of the 'Obamacare' health care reform on retirement and other decisions. Pelgrin and St-Amour (2016) consider the many margins by which medical reforms might impact decision-making, including both the impact on uncertainty and the impact on human health capital investment. Fonseca et al. (2009) also add endogenous human health capital to the model with retirement. French et al. (2016) estimate a structural model that accounts for both Medicaid expansions and health insurance exchanges. Pashchenko and Porapakkarm (2013a) show that the Affordable Care Act (Obamacare) reforms likely increased aggregate welfare, although the key channel for this was through redistribution of resources to low-income individuals, rather than through the reduction of medical expense risk. Jung and Tran (2016) also find that the redistribution channel is key to the Obamacare reforms.

Hansen et al. (2014) consider a model where individuals can engage in 'Medicare buy-in', an idea advocated by leading Democrats, Al Gore and Hillary Clinton. Their calibrations suggest that adverse selection eliminates any market for a Medicare buy-in if it is offered as an unsubsidized option in individual private health insurance. They also evaluate the impacts of the reform if the market were subsidized.

Explaining Differences in Retirement across Countries and over Time

A key advantage of structural models is their ability to assess differences in retirement patterns across countries and over time.

As pointed out in Section 2.2, people are living longer. Furthermore, over the last two decades, people have begun to retire later. Because of the trend towards longer life expectancy, governments are increasing the age at which individuals can start to receive pension benefits.

Erosa et al. (2012) assess cross-country differences in retirement patterns and the quantitative importance of pension schemes for understanding these differences. Their findings support the view that government policies can go a long way towards accounting for the low labor supply late in the life cycle in European countries relative to the US, with social security rules accounting for the bulk of these effects.

Haan and Prowse (2014) show, in the case of Germany, that either an increase of 3.76

years in the pension age thresholds or a cut of 26.8% in the per-year value of public pension benefits would be sufficient to offset the fiscal consequences of the increase in life expectancy that is anticipated to occur over the next 40 years. They evaluate the extent to which such a reform would cause people to increase labor supply, postpone retirement, and accumulate more wealth as life expectancy increases. These behavioral responses partly mitigate the increases in pension costs associated with increases in life expectancy. The authors also compare the welfare implications of a variety of pension reforms that address the fiscal challenges presented by increasing life expectancy, such as combining adjustments in the full pensionable age with changes in annual pension benefits, minimum pension provisions, and early retirement rules.

Imrohoroglu and Kitao (2012) build a general equilibrium model with endogenous saving, labor force participation, work hours, and Social Security benefit claiming, in which overlapping generations of individuals face income, survival, and health expenditure risks in incomplete markets. Their results emphasize the importance of accounting for both savings and labor supply when considering reforms to the early and normal retirement ages in the US, and show that the gains to reform will increase as the population ages.

A reform of retirement ages can have a significant effect on the Social Security budget through changes in savings as well as benefit claiming and labor force participation. When the projected aging of the population is taken into account, the case for a reform that encourages labor force participation of the elderly becomes stronger.

Optimal Pensions Policy

Structural retirement models are critical for considering optimal pension design, since they can be used to assess the tradeoff of the welfare loss from the savings and labor supply distortions of pensions versus the insurance against longevity and other risks that individuals may face.

Goda et al. (2009), French and Jones (2012), and Laitner and Silverman (2012) point out that – to the extent that those nearing retirement have higher labor supply elasticities – the usual Ramsey rules suggest that taxes near retirement should be relatively low. Laitner and Silverman (2012) show, however, that policies that encourage delayed retirement by providing low implicit taxes on work at older ages mostly benefit high-income people, because high-

income people are the ones who work until older ages. This emphasizes the equity–efficiency tradeoff inherent in reducing effective taxes in old age. However, neither their paper, nor any of the other papers mentioned above, has a social welfare function. Thus they do not formally consider optimality.

In contrast, Sefton and Van De Ven (2009), Huggett and Parra (2010), and Golosov et al. (2013) model optimal pensions with simple behavioral models, but they include a social welfare function and do consider optimality.

O'Dea (2016) bridges these two literatures by including a social welfare function with a realistic model of savings, labor supply, and retirement, estimated using data from England. He considers the issue of optimal pension design and the tradeoff between different types of public pension scheme when risky assets are held in defined contribution plans. He finds that means-tested payments to the elderly in England are too low and that the tax treatment of private pensions is too generous.

Means testing (such as asset testing) for eligibility for many programs has recently become a bigger policy issue. Many social insurance programs are means tested, providing benefits to those who need them the most but at the same time potentially producing strong work and savings disincentives. For example, a significant fraction of medical spending in the US is covered by Medicaid, which is a means-tested health insurance program. In principle, means-tested health insurance, which is more targeted than universal coverage, can be very valuable. However, it also distorts incentives to work, save, and consume medical care.

Pashchenko and Porapakkarm (2013b, 2015) find that the work disincentives of Medicaid are significant and costly. Focusing on the elderly, De Nardi et al. (2011) estimate a rich structural model of saving and endogenous medical spending. They find that most individuals value the insurance provided by Medicaid at more than its actuarial cost. Braun et al. (2016) find that, in the presence of medical expense and lifespan risk, the benefits that retirees receive from means-tested programs such as Medicaid and Supplemental Security Income (a minimum pension benefit program) are large. In fact, increasing the size of this insurance by one-third benefits both the poor and the affluent, assuming the increase is financed by a payroll tax. To date, there is still relatively little structural work assessing the importance of means testing,

beyond the work mentioned above (although see Jimenez-Martin and Sanchez Martin (2007), who estimate the effect of minimum pensions for Spain, and Sefton et al. (2008), who do this for the UK).

2.5.6 Retirement and Financial Decision-Making

Retirement is also an issue important in financial decision-making. The ability to delay retirement is an important way to hedge medical spending, asset return, and other risks. This allows individuals to take on greater investment risks, for example (Gomes et al., 2008). See also Hubener et al. (2015) for a model with many risks.

2.5.7 Option Value Models

When individuals decide whether or not to continue working at older ages, they must solve an inherently forward-looking, dynamic problem. Many public and private pension schemes have highly non-linear patterns of accrual with age. Therefore, the relevant question for an older individual when deciding whether or not to work next year is not simply whether the additional benefit obtained in that year sufficiently outweighs the cost, but rather whether the future 'path' that it would put her on would be more attractive than the other paths that would remain open to her if she chose instead to keep working.

So far, this section has focused on structural models that have been used to estimate these forward-looking individual retirement decisions. As described above, such models fully specify the decision problem and uncertainty facing the individual and assume that – in deciding which options to choose – the individual solves this dynamic programming problem.

A second branch of the literature has instead followed the 'option value' approach suggested by Stock and Wise (1990). The option value model is similar in spirit to the full dynamic programming approach but involves a less complex decision rule.

The option value model assumes that, when making their decision about whether to retire this year or continue in paid work, individuals compare the value of retiring in the current period with the expected value of retiring at all possible dates in the future.

In the option value model, the value of retiring (where retiring means complete exit from

the labor market and receipt of benefits) in period r depends on the discounted utility that is expected from income up to the point of retirement plus the discounted utility from income received after retirement until death, as shown in Equation (14). Individuals have a probability of surviving from period t to period s ($\pi_{s,t}$), but die with certainty by age T. Discounted lifetime utility is

$$V_t(r) = \sum_{s=t}^{r-1} \beta^{s-t} \pi_{s,t} U_w(Y_s^w) + \sum_{s=r}^{T} \beta^{s-t} \pi_{s,t} U_r(Y_s^R). \tag{14}$$

The expected utility function allows for separate functions for utility derived from income received while working ($U_w(Y_s^w)$) and income received after retirement ($U_r(Y_s^R)$). A common formulation is that

$$U_w(Y_s^w) = (Y_s^w)^\gamma + \omega_t$$
$$U_r(Y_s^R) = (kY_s^w)^\gamma + \xi_t$$

where ω_t and ξ_t are independent of other variables and k and γ are the key utility function parameters of interest. In practice, measures of wealth and age dummy variables are typically added to the within-period utility function. The option value model evaluates the gain of retiring at age r rather than at age t:

$$G_t(r) = E_t V_t(r) - E_t V_t(t). \tag{15}$$

The individual will postpone retirement if there is an $r^* > t$ such that

$$G_t(r^*) = E_t V_t(r^*) - E_t V_t(t) > 0. \tag{16}$$

Under certain functional forms, the solution to Equation (16) yields a probit model, although in the original formulation of the model (Stock and Wise, 1990) the estimating equation is more complex. Belloni and Alessie (2013) describe in more detail when the probit formulation is appropriate.

This simplicity has led to the option value model being estimated in numerous countries and circumstances. For example, Coile and Gruber (2007) look at retirement in the US, Blundell et al. (2004) examine retirement of older men in the UK, Belloni and Alessie (2009, 2013)

examine retirement of men and women in Italy, and the papers included in Gruber and Wise (2004) apply this model to a further nine developed countries.

Because of its simpler structure, the option value model can incorporate some features of reality that are more difficult to incorporate in dynamic programming models. This was particularly advantageous when computing power was limited. For example, until recently, dynamic programming models did not incorporate separate defined benefit and defined contribution pension assets, despite the fact that these assets have very different characteristics (as described in Section 2.4.5). However, more recent advances in computing power have allowed the estimation of more complex models – for example, Blau (2016) and O'Dea (2016) incorporate separate defined benefit and defined contribution assets. Even here, however, dynamic programming models have a difficult time capturing all the heterogeneity in pensions. At each age, the dynamic programming model must consider all possible outcomes, whereas the option value model must only consider the expected outcome at each possible retirement age.

The key simplifying assumption in the 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 at each of the potential future ages. In contrast, the dynamic programming retirement decision is based on the maximum of retiring today versus the expected maximum of future options. The expected value of the maximum of a series of random variables will be greater than the maximum of the expected values. Thus, to the extent that this difference is large, the option value rule underestimates the value of postponing retirement.

An alternative to both the option value model and the dynamic programming model under uncertainty is to simplify the dynamic programming model by eliminating uncertainty. For example, the models of Gustman and Steinmeier (1986), Gustman and Steinmeier (2005) allow for detailed modeling of budget sets, but do not allow for uncertainty. The simpler certainty models of Gustman and Steinmeier have the benefit of being able to accommodate not only complex pension incentives but also multiple choices, such as part-time work and savings.

Early evaluations of option value models versus dynamic programming models focused on assessing whether evaluating the maximum of the expected values (as in the option value model) resulted in better or worse fits than evaluating the expected value of the maximum.

Lumsdaine et al. (1992) found that the option value model and two alternative dynamic programming models performed similarly well in predicting how individuals would respond to changes in the incentives facing members of a particular firm's pension plan in the early 1980s. Daula and Moffitt (1995) found that a model akin to the option value model fitted their data on exits from the military slightly better than their dynamic programming model did, though they argued that simulated behavior from their dynamic programming model was qualitatively more plausible than that implied by the option value type of model.

For the single choice of whether or not to leave a job with a relatively certain wage, with no major sources of uncertainty, the option value model appears to perform about as well as a similar dynamic programming model. Proponents of option value models point out that dynamic programming models assume that individuals have the capacity to solve these complex decision rules when making their choices, which seems extreme. Thus the gain from the full dynamic programming solution is modest.

However, there are certain issues that cannot fully be considered within the option value framework. First, the option value model can handle only a single decision (the decision to both exit the labor market and begin drawing benefits). However, in reality, there are multiple choices that are related to retirement. For example, many individuals use disability benefits as a pathway to retirement. This process involves first an application for benefits, whose outcome is uncertain. Disabled people's consumption could be financed by increased work of spouses, by part-time work, which is sometimes allowed in disability schemes, or by savings. The option value model cannot accommodate these issues, whereas the dynamic programming model can.

Furthermore, to evaluate any disability program, there should be some concept of insurance against shocks. The option value model, with no real concept of risk, cannot be used to contemplate insurance.

Thus whether there is an advantage to the additional complexity of dynamic programming is situation specific. If the question to be evaluated is the simple decision to retire from a stable job at a firm, the option value model works well. But the option value model works less well in environments that include uncertainty or multiple decisions.

2.5.8 Structural Models: Key Limitations and Challenges for the Future

This section of the paper has focused on some of the key findings of structural modeling in the last 20 years since the survey by Lumsdaine and Mitchell (1999). Over this period, structural models have made great progress in incorporating more realism in terms of both the budget sets and the shocks that people face. Despite this progress, structural models still have several extreme limitations. Most of these limitations are related to two issues.

The first issue is a computational issue known as 'Bellman's Curse of Dimensionality': the exponential rise in the amount of computer time required to solve a dynamic programming problem as its size (measured in terms of the number of possible values the key variables in the model– the 'state' and 'control' variables– can take on) increases, where an example of a 'state' variable might be assets, the wage, or health and an example of a 'control' variable might be work hours, consumption, or benefit receipt. Many of the models described in this section address this problem by using parallel processing on large computer clusters, efficient languages such as FORTRAN, C, C++, or NUMBA, and other recent advances in model solution techniques. Using these techniques can easily increase computational speed 1,000-fold. But because of Bellman's Curse, this is often only enough to add in an additional two state variables. For this reason, we are still only able to solve structural models with limited amounts of heterogeneity in reasonable amounts of time. However, as we have brought up in this chapter, there are many important issues when considering retirement. It is not obvious that omitting key variables that drive retirement is innocuous if the model is to be used for policy evaluation. Omitting key variables could potentially lead to overstatement of or understatement of retirement responses to different reforms. For this reason, capturing all variables is important. For example, French and Jones (2011) show that uncertainty and savings both have important consequences for evaluating the effect of health insurance and retirement.

The second issue is related to data and identification. Structural models need large amounts of data to credibly identify them. Furthermore, they are sensitive to which variables are added, the fashion in which they are added, and how unobservables (such as unobserved preference variation) are added to the model. Models that have different policy implications are often observationally indistinguishable in a given data set.

In particular, we describe four areas where the structural literature often falls short.

First, dynamic programming models cannot accommodate the great heterogeneity in pension types that exists within many developed countries. Many papers include at most one public pension. In the US, the UK, and many other countries, individuals rely on both government- and firm-based pensions. Although most people within most countries face a single government pension plan, different people within that country will face different firm-based pension plans. Different plans have different levels of generosity, different early and normal retirement ages, and many other differences as well. Dynamic programming models are not well suited to capturing this type of heterogeneity. Different papers use different solutions to this problem. Some solve it by using samples of individuals without a firm-based pension (for example, Rust and Phelan (1997), van der Klaauw and Wolpin (2008)). Others use a representative firm pension plan (Blau (2016), Blau (2016)) or a representative firm plan, conditional on observables (French and Jones (2011)). Certainty models and option value models, because of their simpler solution structure, can accommodate greater heterogeneity in pensions. However, they have the problem of not being able to accommodate uncertainty. Furthermore, option value models have the additional limitations discussed in section 2.5.7.

Second, most retirement models only allow for a limited number of pathways into retirement. As we have noted previously, multiple pathways are important in many countries. In many countries disability insurance and unemployment insurance are important pathways to retirement, yet most models do not allow for disability or unemployment insurance.

Third, most structural models only allow for limited preference heterogeneity. As we noted in section 2.5.5, discount factor heterogeneity may be important for understanding why many households have few liquid assets. Discount factor heterogeneity, in combination with low wealth, can drive liquidity constraints to bind. For this reason discount factor heterogeneity and liquidity constraints can explain why so many households exit the labor market at the first age they are eligible for benefits.

Finally, virtually all of the research discussed in this section have relied on rational expectations and exponential discounting. Yet much of the evidence in section 4.8 shows that individuals may not be fully informed of the Social Security rules, for example.

2.6 Families and Households

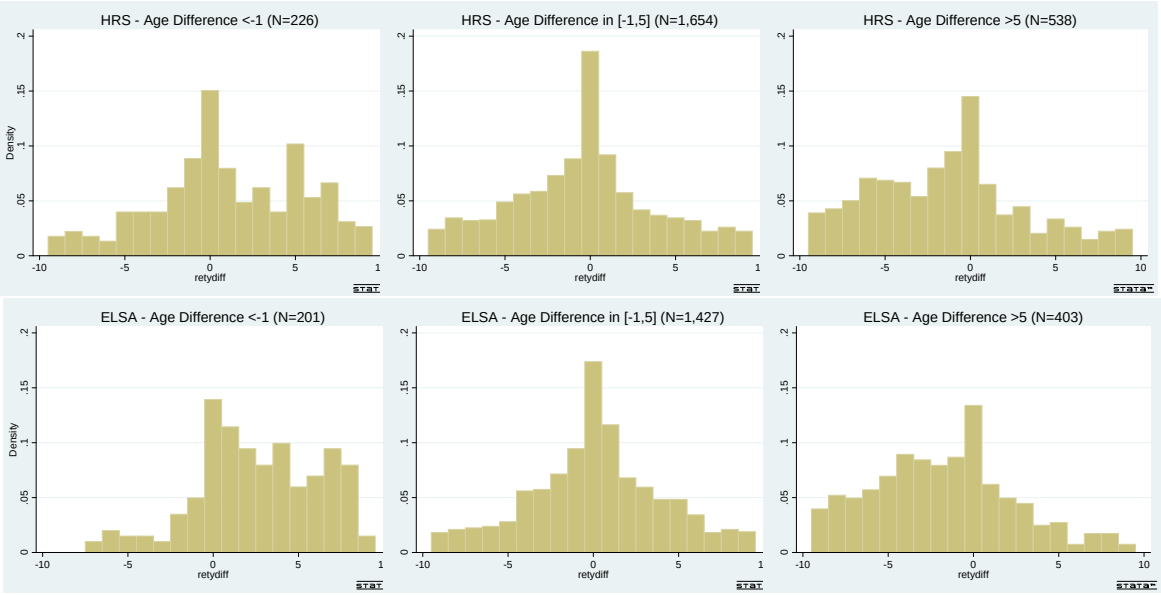
In this section, we consider retirement from a family perspective, focusing on couples and joint retirement. In most developed economies, the typical couple approaching retirement is one where both husband and wife are employed. Increasingly, retirement is a family labor supply decision. As we will argue, ignoring the role of family decisions in modeling retirement can distort the picture of retirement and bias the analysis of retirement policies.

Individuals in couples may retire from the labor market because they face an increased financial incentive to leave the labor market, or because of a layoff from work, or because their health has deteriorated making work less attractive. These motives are much as in the single individual decision-making model of Section 2.5. But for a couple, there are additional considerations. Retirement by individuals in couples might also occur because of interactions between the financial incentives of each spouse, or because one partner has left the labor market and needs to be cared for, or simply because they now wish to spend more time together. Here we review the evidence and consider different motives for retirement in couples, focusing on attempts to separate preferences from financial incentives.

2.6.1 Evidence on Retirement in Couples

Empirical evidence, especially that from the US and the UK, suggests that a significant proportion of husbands and wives retire together. Figure 2.21 presents the distribution of differences in retirement dates across spouses in England and the US – defined as the husband's retirement year minus that of the wife. Each column in the figure corresponds to a different subsample defined according to the age difference between spouses, and each row to a different country – the US on the top and England on the bottom. Consider the middle column, which corresponds to the subsample of couples where the husband is between one year younger and five years older than the wife. This corresponds to approximately 70% of couples in both countries. The median age difference between spouses in this subsample is two years in both the US and England. The modal retirement age difference is zero in both countries. This implies that spouses most frequently retire together. The proportion of joint retirements – i.e. those taking place in

Figure 2.21: Distribution of retirement date differences across spouses



Source: Banks et al. (2015)'s calculations using HRS and ELSA data for the years 2002, 2004 and 2006. The retirement wave is the first one in which an individual makes a transition out of the labor force (i.e. she was active in wave $t+1$ and is inactive in wave t). The difference in retirement waves is defined as the retirement wave of the husband minus that of the wife. The age difference between spouses is defined as husband's minus wife's age.

the same calendar year – is 18% in the US and 17% in England. The proportion of spouses retiring within one calendar year of each other in the US is 37% while in the UK it is 38%.

The prevalence of joint retirement is not confined to couples where the spouses have similar ages. As Figure 2.21 shows, Banks et al. (2015) find that the modal retirement age difference is zero in both the US and the UK even for a subsample of couples where the husband is at least two years younger than the wife. This evidence underscores the prevalence of joint retirements in the US and the UK, even for couples where the spouses have divergent incentives because their different ages mean that they will become eligible for public pension benefits in different calendar years. Note, though, that the ages of eligibility for Social-Security-type programs in the US differ from those in England. For the period covered in Figure 2.21 these are the same for men and women in the US but are five years apart in England.

There is a long history of empirical studies that examine interactions between the retirement of husbands and wives. Using the Retirement History Survey, Blau (1998) established a strong association between the labor force transition probabilities of one spouse and the labor force status of the other spouse, even after controlling for unobserved heterogeneity. His work

explicitly acknowledged the dynamic environment in which choices and incentives play out in couples' retirement decision-making. The synchronization of work schedules in couples is also clearly evident in the Hamermesh (2002)'s study of US data for the 1970s and 1990s. He found significant evidence that spouses' work schedules are coordinated. Coile (2004) studied how retirement probabilities are affected by the spouse's retirement incentives from Social Security and private pensions in the US. She found that husbands are responsive to their wives' incentives to retire, while the reverse was not always true.

Gustman and Steinmeier (2000) develop a dynamic choice model to examine the retirement of dual-career couples in the US using the National Longitudinal Survey of Mature Women. They too find a coincidence of spouses retiring together, despite the younger ages of wives, suggesting explicit efforts at coordination. Their results suggest that one reason behind this coincidence is a correlation of tastes for leisure. In particular, each spouse (husbands in particular) values retirement more once their spouse has retired. The authors find that financial incentives account for peaks in the retirement hazards of each spouse individually but not for peaks in the simultaneous retirement of both spouses. In a follow-up study, Gustman and Steinmeier (2004) provide further insight into household retirement decision-making and the reasons for interdependence in the retirement decisions of each spouse. Using improvements in HRS data and matched employer-provided pension histories allows them to achieve more precise identification of some key parameters governing interdependent behavior within the household. Gustman and Steinmeier show that a measure of how much each spouse values being able to spend time in retirement with the other accounts for a good portion of that apparent interdependence. For the wife, the husband's retirement status influences her retirement decision only if she values spending time in retirement with her husband. For husbands, the effect of having the wife already retired on his retirement decision is roughly doubled if he enjoys spending time in retirement with his wife.

In section 2.6.3 we further discuss these and other results from structural dynamic models of joint retirement. Such models allow the separation of preferences from constraints. Before that, we briefly summarize some of the studies that have looked at data from outside the US and the UK.

An et al. (2004) study the joint retirement decisions of Danish married couples using a multivariate mixed proportional hazard model that incorporates both correlated unobserved heterogeneity terms as sources of dependence among durations. They find evidence consistent with complementarities in leisure times and note that when spouses retire early, they frequently do so to spend leisure time together and retirement dates are actively coordinated. If they retire later, spouses' decisions are still found to resemble each other, and more so than can be explained by financial, health, and other observed heterogeneity. But the authors argue that assortative matching matters too and also note that spouses are driven by similar motives and tastes.

More recently, Stancanelli and Van Soest (2012) and Stancanelli (2013) exploit an early retirement age legislation in France to identify the effect of spousal retirement on own retirement patterns and hours of work. Using a regression discontinuity approach on the pooled years of the French labor force surveys, they find that there is considerable heterogeneity in cross-retirement and cross-hours responses of spouses. The retirement of the husband does not appear to increase the couple's joint leisure hours. In contrast, retirement of the wife increases joint leisure. The authors conclude that joint retirement is not as important as anticipated. In particular, the asymmetry found in responses suggests that leisure complementarities may not be the main engine of joint retirement. Selin (2014) exploits quasi-experimental variation in the wife's retirement incentives from a pension reform in Sweden. He finds little evidence of a response from husbands to changes in their wives' incentives.

Goux et al. (2014) also use legislative changes in France to study interdependencies in spousal labor supply by exploiting the design of the French workweek reduction, which introduced exogenous variation in one's spouse's labor supply, at constant earnings. Those directly affected by the legislation work on average two hours less per week. Their husbands respond by reducing their labor supply by about half an hour, consistent, the authors argue, with substantial leisure complementarity. The husbands are found to cut the non-usual component of their workweek, leaving usual hours unchanged. On the other hand, the women's response to a reduction in their husbands' hours is weak and rarely statistically significant.

Honoré and De Paula (2011) study joint retirement of couples in Europe. They document

wives' retirement behavior across a large number of economies. They note that although there are exceptions, a substantial proportion of individuals retire in the same year as their spouse.

Hospido and Zamarro (2014) study the retirement patterns of couples in a multi-country setting using data from the Survey of Health, Ageing and Retirement in Europe. In particular, they test whether women's (men's) transitions out of the labor force are directly related to the actual realization of their husbands' (wives') transitions, using the institutional variation in country-specific early and full statutory retirement ages to instrument the latter. Exploiting the discontinuities in retirement behavior across countries, they document a significant joint retirement effect for women but the estimated effect for men is insignificant.

What are we to make of this evidence on joint retirement? Some of the studies we have discussed take a purely descriptive approach, some are reduced form, exploiting natural experiments, and some use forward-looking choice models. In the next subsection, we argue that to fully distinguish the role of preferences from incentives, a structural dynamic approach is necessary but we can learn most by combining approaches.

2.6.2 Modeling Retirement Decisions in Couples

Whether or not we observe individuals in couples retiring together or apart, how should we interpret such behavior? What are the implications for models that focus on individual retirement even where the individual is part of a couple?

The answer is not clear-cut since, even if preferences for leisure are strongly complementary, an unexpected decline in labor market opportunities for one partner in a couple may induce the other to stay in the labor market longer simply to maintain family income, even though they have a strong preference to spend their leisure time together. To understand these different forces working within a family, we need to identify the mechanisms through which policies, or other changes in the economic and family environment, affect retirement behavior. This requires a systematic framework for retirement decisions in couples.

Structural models provide a comprehensive approach to the study of decision-making and have the additional advantage of allowing counterfactual policy simulations. But structural models require saying something about how individuals in couples make decisions. Do indi-

viduals in couples act as a single unified agent? Is their behavior non-cooperative, or do they act as separate but cooperative individuals? Spouses in couples may be individually rational but appear time-inconsistent when aggregated as a single unitary agent.

Allowing different preferences and allocations within a couple is an important idea that has stimulated much empirical research following the insights on the collective model Chiappori (1988). Fortin and Lacroix (1997), Donni (2003), Blundell et al. (2007), Van der Klaauw and Wolpin (2008), and Cherchye et al. (2009) are among the key examples we discuss further below.

Different approaches will identify different aspects of couples' retirement behavior and empirical analyses that adopt different approaches will, in general, generate different empirical results. Before exploring the evidence in more detail, we consider alternative structural frameworks for studying retirement decisions in couples.

The canonical model for studying the joint labor supply decisions of a married couple views the couple as a 'unitary' decision-making unit that is assumed to maximize a single (household) utility function whose arguments are male and female labor supply and consumption. Although simple, this framework allows us to derive the implications for behavior of changes in each of their wages, unearned income, and financial incentives more generally. As will be clear from our discussion of collective family labor supply models below, this simple extension of the standard individual choice model is controversial. However, the unitary model is an attractive place to begin our discussion as it extends naturally to cover multi-period labor supply and retirement decisions. It can also be used to incorporate non-linear budget constraints, fixed costs, and participation decisions introduced into a family labor supply setting.

In the unitary framework, choices are made over work hours and the labor force participation decisions using an extension of the forward-looking model developed in Section 2.5. The couple is assumed to supply hours of work for each spouse and save in the face of several forms of uncertainty: survival uncertainty, health uncertainty, and wage uncertainty. This is a standard life-cycle choice problem with the complication that there may be corner solutions in hours of work and wages, being individual specific, which are not observed when the individual is not working.

In the simplest formulation of the unitary model, the couple's maximization problem is given by

$$\max \mathbb{E}_t \sum_{s=0}^{L-t} u_{t+s}\left(C_{t+s}, H_{1,t+s}, H_{2,t+s}; \mathbf{z}_{t+s}\right) \tag{17}$$

subject to a standard intertemporal budget constraint and the inequality constraint on hours in each period $t+s$ of their remaining life cycle, $L-t$. The age subscript on the utility function $u_{t+s}(.)$ captures intertemporal discounting. The primary arguments of the utility function are household consumption, C_t, and the hours chosen by the two earners, H_t and $H_{2,t}$. The utility function also includes characteristics specific to the household ($\mathbf{z}_t$), which may include other dependants and measures of health among other observable characteristics.

The utility function above can be written as a concave function of two individual utilities in each period. But without individual control of resources in the budget constraint, it remains a unitary choice problem. As in Section 2.5.2, this model can be refined with the addition of fixed costs of work, health costs, survival probabilities, and bequests; see Blundell and MaCurdy (1999) for further discussion.

Although abstracting from pension saving and differential mortality, this simple unitary model provides a useful starting place for understanding the interactions between the joint labor supply decisions of spouses. Within-period preferences, $u_{t+s}\left(C_{t+s}, H_{1,t+s}, H_{2,t+s}; \mathbf{z}_{t+s}\right)$, determine whether hours of earner j and consumption are (Frisch) complements or substitutes. The response of one spouse's labor supply to a change in the other's labor supply behavior depends on whether the change is expected or unexpected. An expected change clearly does not entail any unexpected change in the couple's resources; it simply changes the time allocation between work and leisure. Consequently, it will reflect the preference tradeoff at each point in the life cycle, $u_{t+s}\left(C_{t+s}, H_{1,t+s}, H_{2,t+s}; \mathbf{z}_{t+s}\right)$. In comparison, an unexpected change in labor supply by one individual in a couple will not only change the time allocation but also be accompanied by income and wealth effects. For example, suppose one spouse unexpectedly has to retire or has to move from full-time to part-time work. This will certainly increase the time that individual has to spend in non-work activities but it also results in an unexpected reduction in family resources.

The response of earner j to such a long-term adverse shock in the earnings of the part-

ner is (typically) negative, i.e. earner j increases his or her labor supply when earner i is hit by a permanent negative shock. As Blundell et al. (2016c) point out in their study of family labor supply and consumption, this effect can be negative even where preferences $u_{t+s}\left(C_{t+s}, H_{1,t+s}, H_{2,t+s}; \mathbf{z}_{t+s}\right)$ suggest their labor supplies are (Frisch) complements. That is, even where, other things equal, the couple would prefer to spend time together, the wealth effect may overturn the value of time together. The upshot of this is that evidence of whether or not couples retire together, although useful, cannot provide a definitive view of complementarity in preferences unless we know the nature and durability of the incentives and shocks that the couple face.

We might also allow permanent (and transitory) shocks to be contemporaneously correlated across spouses. This correlation is theoretically ambiguous. If spouses were to adopt sophisticated risk-sharing mechanisms, they would select jobs where shocks are negatively correlated. Alternatively, assortative mating or other forms of sorting imply that spouses work in similar jobs, similar industries, and sometimes in the same firm – hence their shocks may be potentially highly positively correlated.

A structural dynamic approach to couples' retirement has the potential to untangle these different mechanisms. But, as we noted above, structural models of family decisions require saying something about how individuals in couples make decisions. The unitary model is restrictive. It assumes, for example, that all resources are pooled. The household behaves as a single decision-maker, irrespective of the number of individuals in the household. The 'ownership' of resources has no impact on outcomes. There are also the non-participation or 'corner solution' conditions, which state that if one individual is at a corner solution (not working), it is the reservation wage of that individual rather than the market wage that affects the labor supply decision of the partner. As in the case of the income pooling assumption, this is far from innocuous, implying as it does that the 'outside option' value of paid work for a non-participant does not influence the allocation of consumption and leisure within the household.

There is much empirical evidence that does not fit the unitary model. The Slutsky symmetry and negativity restrictions are usually rejected when confronted with consumption or labor

supply data (see Fortin and Lacroix (1997), Browning and Chiappori (1998), Vermeulen et al. (2006), Blundell et al. (2007), Cherchye and Vermeulen (2008), and Cherchye et al. (2009) for some recent examples). Indeed, these studies suggest that intra-household bargaining aspects within multi-person households cannot be ignored in general. Consequently, a growing literature in microeconomics has focused on intra-household decision-making models.

An attractive alternative to the unitary model is the collective family labor supply model (Chiappori, 1988), which starts from the basic assumption that a multi-person household is formed by individuals with their own rational preferences, while these individuals are engaged in a bargaining process that results in Pareto-efficient intra-household allocations. This effectively relaxes the income allocation rule among individuals so that allocations may depend on relative wages and other variables in a way that reflects the bargaining position of individuals within the family, rather than reflecting the marginal conditions underlying the joint optimizing framework of the traditional unitary approach. Even when individuals within the family are altruistic and allocations are Pareto efficient, the allocation rule can deviate from that in the traditional unitary model. Compelling evidence for the collective model is provided in the careful empirical work of Fortin and Lacroix (1997) and Donni (2003). As Michaud and Vermeulen (2011) note in their insightful review, the collective model entails theoretical implications that appear more in accord with the evidence when tested on multi-person household data.

In the standard collective model, the 'utility' of each family is assumed to be either 'egoistic', $u_j(C_j, H_j, \mathbf{z})$, or 'caring', $F_j(u_1(C_1, H_1, \mathbf{z}), u_2(C_2, H_2, \mathbf{z}))$. The contribution of individual decisions in any period is then written as a weighted sum of individual utilities, where the utility weight for each partner is given by some non-negative function of wages and other distribution factors. This is equivalent to a sharing rule, or decentralized solution, in which each individual receives a share of household utility and then makes his or her labor supply and consumption choices.

Given Pareto efficiency and the standard neoclassical assumptions on individual utilities, the conditions identifying preferences and the sharing rule (up to a linear translation) typically require one observable and assignable private good – here assumed to be the individual's leisure. Chiappori (1988) showed that if preferences are egoistic or of the Beckerian caring

type, then a so-called sharing rule (which summarizes how household means are allocated to the household members) can be identified up to a constant, whereas individual preferences can be identified up to a translation, by means of a couple's observed labor supply.

The intuition behind identification is simple: under the exclusive good assumption, the spouse's wage can only have an effect through the sharing rule. Variation of income and the wage then permit consistent estimation of the marginal rate of substitution in the sharing rule. A researcher can do this for both spouses and, since the sharing rule must sum to 1, recover the partial derivatives of the sharing rule. Although the standard symmetry, income pooling, and participation conditions are not implications of this model, one can derive alternative testable restrictions. Blundell et al. (2007) present identification and estimation results for the collective model of labor supply in which there are discrete choices, censoring of hours, and non-participation in employment. They show why potential wages may affect individuals' bargaining positions and derive the collective restrictions on labor supply functions, contrasting them with restrictions implied by the usual 'unitary' framework. Using the large changes in the wage structure between men and women in the UK, their estimates of the sharing rule show that male wages and employment have a strong influence on bargaining power within couples.

Although convenient, the widely used assumption of egoistic or caring preferences is rather restrictive. Both types of preferences imply that an individual's marginal rate of substitution between own leisure and consumption remains unaffected by his or her spouse's labor supply. As soon as other preference structures are considered, alternative (but related) assumptions must be introduced to obtain identification. For example, Chiappori and Ekeland (2009) demonstrate that if all commodities are publicly consumed, then it generally suffices to have one exclusive commodity per household member for identification. Blundell et al. (2005) extend the collective model of household behavior to allow for the existence of public consumption. They show how this model allows the analysis of welfare consequences of policies aimed at changing the distribution of power within the household. The setting provides a conceptual framework for addressing issues linked to the 'targeting' of specific benefits or taxes. They are able to show that the observation of the labor supplies and the household demand for the public good allows one to identify individual welfare and the decision process. Michaud and Vermeulen (2011) de-

velop a collective labor supply model with complementarities in leisure and where a Hicksian consumption good is publicly consumed.

As Chiappori and Mazzocco (2014) note in their comprehensive survey, the choice of the outside options in intertemporal extensions of these models is crucial. They point to two possible choices: the value of being divorced for at least one period and the value of non-cooperation while married. The standard assumption is that members of the couple agree to sacrifice potential personal gains in order to maximize the joint outcome, and they are fully able to commit to maintaining that joint outcome. An alternative scenario is where these assumptions no longer hold, and in which members of the couple may deviate unilaterally from the optimal joint outcome. This is similar to a married individual's optimization problem in an economy with divorce as an outside option. Chiappori and Mazzocco conclude that a unitary model should be avoided when the question asked requires a good understanding of the changes in intra-household decision power. If that is not the case, the unitary model is still a good choice since it is less complicated than a collective model.

2.6.3 Separating Preferences and Financial Incentives for Joint Retirement

We have argued that to distinguish the role of preferences from the role of incentives, a structural model of couples' retirement is required. The development of structural models of family labor supply behavior, in general, and of couples' retirement, in particular, remains an important ongoing area of research. Improvements in the collection of longitudinal data on labor supply and consumption choices of older couples continue to stimulate new research. However, even with advances in theory and data, no model can include every aspect of behavior. This is particularly the case when examining interactions between agents. Understanding the sensitivity of key findings to alternative modeling assumptions is an important prerequisite to drawing conclusions.

The Blau (1998), Gustman and Steinmeier (2000), and Gustman and Steinmeier (2004) papers are the leading early studies that considered labor force dynamics of older married couples within a structural framework that aimed to distinguish financial incentives for retirement

within couples from preferences. As mentioned above, Gustman and Steinmeier (2000) found that each spouse, and perhaps husbands in particular, values retirement more once their spouse has retired. Gustman and Steinmeier (2004) finds that a measure of how much each spouse values being able to spend time in retirement with the other accounts for a good portion of that apparent interdependence. For the wife, the husband's retirement status influences her retirement decision only if she values spending time in retirement with her husband. For husbands, the effect of having the wife already retired on his retirement decision is roughly doubled if he enjoys spending time in retirement with his wife, but there is some effect even if he does not. This is consistent, the authors argue, with their earlier findings that the husband is more influenced by having a retired spouse than the wife is.

Gustman and Steinmeier (2004) also use the model to investigate the labor supply effects of alternative Social Security policies, examining the effect of dividing credit for earnings evenly between spouses or of basing Social Security benefits on the amounts accumulated in private accounts. Both policies change the relative importance of spouse and survivor Social Security benefits within the household and both raise the relative reward to work later in the life cycle. The incentives created are modest, and retirement responds accordingly. Nevertheless, at some ages, such as 65, the authors find that there may be as much as a 6% increase in the old-age work force under private accounts.

Van der Klaauw and Wolpin (2008) develop and estimate a model of retirement and savings incorporating limited borrowing, stochastic wage offers, health status and survival, Social Security benefits, Medicare and employer-provided health insurance coverage, and intentional bequests. Their model is estimated on a sample of relatively poor households from the first three waves of the HRS, for whom we would expect Social Security income to be of particular importance. The estimated model is used to simulate the responses to changes in Social Security rules, including changes in benefit levels, in the payroll tax, in the Social Security earnings tax, and in early and normal retirement ages.

Banks et al. (2015) draw on the evidence in Figure 2.21 to show that the rules used to compute an individual's Social-Security-type retirement benefit have an indirect effect on the spouse's labor supply. Specifically, there is a drop in married men's participation at their wives'

age of eligibility for a public pension. The authors then show that the decline in men's participation arises as a response to their spouses' retirement transitions. The husbands' labor supply response does not appear to be driven by correlated shocks or unobserved preferences, and its sign is incompatible with an income effect. Instead, Banks et al. argue, there is evidence of leisure complementarity between the spouses, which results in a greater tendency to retire together.

In her comprehensive study of retirement in couples, Casanova (2009) takes the structural dynamic approach further by estimating the effect of leisure complementarities on spouses' retirement timing within a rich dynamic model of participation and saving decisions that carefully accounts for the main financial incentives and sources of uncertainty facing older couples. The model includes a detailed specification of the Social Security rules, allows for limited borrowing, and accounts for uncertainty in future wage income, out-of-pocket medical expenditures, and survival. Each spouse's preferences are represented by his or her own utility function, and the substitutability between consumption and leisure is not constrained to being the same for husband and wife. Individuals within and across couples are heterogeneous in the persistent component of their wage offers, which is estimated from the data. In order to capture leisure complementarities, each spouse's utility is allowed to depend on the partner's participation status.

The Casanova (2009) study uses a subsample of older individuals from the HRS for the US. Her estimation results show that leisure complementarities are positive and significant, and account for up to 8% of observed joint retirements. The Social Security spousal benefit is found to account for an additional 13% of them. These results imply that incentives for joint retirement play a crucial role in determining individual choices. Since these incentives cannot be captured in a model that takes one spouse's behavior as exogenous, this suggests that individual models of retirement are no longer an appropriate approximation of the average household's behavior, given the increasing number of working couples approaching retirement age. Knapp (2014) and Jorgensen (2015) present similar models that allow for complementarities in retirement.

Michaud and Vermeulen (2011) present a collective labor supply model with complementarities in leisure and in which there is a Hicksian consumption good is publicly consumed.

Their identification strategy is built upon the assumption that an individual's preferences can only change in a particular manner after the dissolution of the couple. The change in preferences comes from changes in observable variables that can be controlled for and from the loss of the possibility to jointly enjoy leisure after the couple's dissolution. Preference parameters capturing the individual tradeoff between consumption and leisure are identified by means of singles' observed labor supply choices, while the change in preferences due to marriage, along with parameters capturing the intra-household bargaining process, is identified through observed labor supply choices of individuals in couples. Intuitively, Michaud and Vermeulen's collective labor supply model can be identified due to them also making use of singles' labor supply responses. Since there is, by definition, only one decision-maker in such households, the unitary model can be directly applied to singles and it is completely identified if its restrictions are satisfied.

Michaud and Vermeulen (2011) find that the marginal effect of the spouse's leisure is significantly positive for both the husband's and the wife's preferences. This leads them to conclude that complementarities in leisure are indeed important and cannot be ignored without cost. Health effects are also found to be important and the authors argue that different measures of health all have their place in a realistic labor supply model. They find that the Pareto weights in the intra-household allocation process significantly depend on the spouses' relative earning capacities, implying a strong rejection of the standard unitary model.

Honoré and De Paula (2011) and Honoré and De Paula (2014) develop a model for simultaneous durations. Whereas conventionally used duration models cannot account for joint retirement, their model admits joint retirement with positive probability, accounting for simultaneity and nesting the traditional proportional hazards model. Honoré and De Paula (2011) run simulations using the HRS in the US to gauge the magnitude of the 'effects' and contrast, for example, outcomes when all men are ascribed to a defined contribution plan and when they all have a defined benefit plan. Comparing the difference in the median retirement ages in these two scenarios, they find the (indirect) effect on the median retirement age of women is around 3.3% of the change in median retirement age of men. Comparing 25th percentiles, they find that the indirect effect on women (25th percentile) is 15.4% of the direct effect on men (again,

25th percentile). Honoré and De Paula (2014) focus on Europe using data from SHARE and ELSA. Examining the reform to the state pension age for women in the UK, they look at the simultaneous duration model and allow for a direct effect of the reform on men's retirement age. They find a small and statistically insignificant coefficient for this direct effect. Nevertheless, when they estimate not using the simultaneous model, the coefficient for the effect on men's retirement is statistically significant. They view this as a sign that the effect is mostly felt indirectly by the men.

To build in divorce, Voena (2015) develops a dynamic model of household decision-making that captures the key aspects of changes in divorce laws. The model indicates that the impact of divorce laws crucially depends on how spouses allocate resources (consumption, leisure, assets) while married. A spouse with a sufficiently low share of marital resources benefits from an equal division of property upon divorce, especially if he or she can obtain divorce without the consent of the other party. Voena exploits the variation in US divorce laws over time and across states using data from the Panel Study of Income Dynamics and from the National Longitudinal Survey of Youth to examine the behavior of the couples who married before these reforms and experienced the new regimes while already married. She finds that when unilateral divorce is introduced in states where property is divided equally, the women who are already married become less likely to work, while no significant change is observed in states that do not impose an equal division of property.

Turner and Gallipoli (2013) study the retirement incentives induced by the US Social Security system in a framework that allows for different degrees of cooperation and strategic interaction between spouses. They develop a model in which spouses maximize joint household utility, subject to the additional constraint that neither partner finds it optimal to deviate from the best constrained household allocation. They argue that accounting for 'non-cooperative' behavior through this additional constraint can rationalize various choices of older couples observed in the 1932–42 cohort of the HRS. In particular, non-cooperative behavior helps with two recurring puzzles in the retirement literature: (i) the clustering of benefit claiming at the early retirement age of 62 despite significant gains associated with delayed claiming by husbands; and (ii) the joint benefit claiming of couples. Turner and Gallipoli contrast their findings

to those from a standard unitary model of the household, extended to include a process for declining health, and show that the latter can rationalize neither early nor joint claiming behavior if individuals can independently make benefit and labor force participation decisions.

Gustman and Steinmeier (2014) develop a dynamic model using the HRS panel in which a spouse's utility depends on his or her partner's labor supply choice. Their model includes saving, health status, borrowing constraints on future income and Social Security, and a detailed modeling of DB pensions. One interesting aspect of their work is the focus on partial retirement and part-time work. They argue that the increasing labor supply of women in older ages can help explain the falling labor market participation of older men. This is despite spouses having a preference for time together, highlighting the value that modeling joint decisions in an intertemporal framework can have in resolving some puzzling features of labor market behavior when viewed from a static individual decision-making perspective. They also use the model to address some key policy questions relating to an increase in the early retirement age and an increase in partial retirement opportunities, pointing out that the latter policy has offsetting effects when viewed through the lens of a joint decision-making framework.

Finally, Michaud et al. (2014) adopt a novel stated preference approach to estimate a structural collective choice model of joint labor supply and retirement with interdependent preferences. Identification of the preferences and the intra-household bargaining process relies on stated preferences data from the HRS. Respondents were asked to choose between several hypothetical retirement trajectories, describing the retirement age and replacement rates of both spouses from different perspectives: considering their own preferences only, the preferences of their spouse only, or the most likely decision for the household. Michaud et al.'s results reject the unitary model in favor of the collective model. Simulations based upon their estimates suggest that unobserved heterogeneity plays the most important role in determining joint retirement. It accounts for almost 30%, while observed heterogeneity and complementarities in leisure account for around 5% and 13% respectively.

2.6.4 What Have We Learned about Joint Retirement?

There are three main channels that link spouses' retirement decisions. The first one operates through the household budget constraint. Under certain conditions, the fact of sharing resources can increase the probability of joint retirement. For example, a spouse allowance in Social Security has been pointed out to be a candidate to explain coordination in retirement dates from the incentive side. The second channel originates from preferences. It is highly plausible that spouses prefer to spend time together (complementarities in leisure). A third channel operates through correlation in spouses' unobserved taste for leisure and correlation in shocks to their earnings.

Recent empirical applications, which we have reviewed here, have attempted to separate these channels and apportion importance to each in observed retirement. The results point to clear evidence of complementarity of preferences but also note the importance of correlated shocks to resources and the key distinction between wealth and substitution effects.

Ignoring the family context can clearly distort our understanding of retirement behavior and the impact of retirement policies. We have seen that the impact of a financial incentive for one spouse may be attenuated if the partner has an incentive to remain in work but accentuated if the partner has chosen to leave work. Benefits, such as Social Security, depend on the partner's labor supply. The model with just the husband as a decision-maker, for example, will miss the changes in the budget constraint in the year when the wife retires. However, if the partner has left work due to a layoff, the adverse wealth effect may override any immediate incentive effect to retire. The partner may provide insurance. For example, in the US, if they were both aiming to retire at 62 but one became disabled at 55, the other may choose to work more hours or retire later to compensate for the lost income. A model that missed this would overstate the risk facing the household and likely the consumption drop at retirement. On the other hand, if the shocks to health, income, etc. are correlated, the bias could go the other way. The consumption drop would then be on average larger than predicted by a model that only considers a single worker.

We have also seen that one spouse's labor supply is likely a function of the other's. This could be the case in a unitary model if there are complementarities in preferences. Or it could

just be a result of the bargaining process. For example, in a simple setting, suppose the husband's labor supply depends on his accrued Social Security and the wife's labor supply. The wife's labor supply, in turn, is likely to depend on the husband's Social Security too, leading to omitted variable bias. The direction of bias would depend, among other things, on whether there are complementarities in leisure (this is important even in the bargaining context, as it would give an incentive to husbands to transfer resources to wives to convince them to retire with them). In any case, getting the effect of Social Security and other financial/health incentives wrong would be problematic for policy prescriptions.

Without distinguishing between these different mechanisms, which is the aim of the structural models we have discussed, it is hard to draw conclusions for pension policy design or for the likely impact of retirement policy reform.

2.7 Conclusions and Challenges

The period since the Lumsdaine and Mitchell (1999) survey has seen enormous progress in the study of the retirement decision. Our aim has been to bring together these developments in a coherent framework. We identify three related areas that contributed to this advance.

First, there are now better data than existed twenty years ago. These data advances in turn have come from two dimensions: high-quality longitudinal surveys, such as the US Health and Retirement Study (HRS), the English Longitudinal Survey of Ageing (ELSA), and the related longitudinal surveys around the world.[10] These surveys collect detailed information on pension plans, savings and assets, consumption, and housing. Moreover, many are linked to large administrative data. For example, the HRS is now linked to employer-provided pension information, Social Security earnings histories, Medicare data, mortality data, and genetic information. Furthermore, many countries have made available to researchers population-level administrative data, which have large sample size and relatively little measurement error.

Second, the literature now has many more policy reforms to evaluate. As we documented in Section 2.4, many countries, especially in Europe, have made reforms to encourage later retirement. These reforms, in combination with better data, have allowed us to more credibly

[10]The HRS 'sister surveys' are documented at http://hrsonline.isr.umich.edu/index.php?p=sisters.

assess the responsiveness of employment to various policies.

Third, better computing power has allowed for estimation and evaluation of more sophisticated retirement models. These models can now include, amongst other things, savings, participation in different social insurance programs (such as disability), risks from uncertain wages, job offers, medical spending, and longevity. These models can also accommodate realistic modeling of budget sets, including the non-convexities that often arise in the budget sets of retirement systems.

Together these advances have allowed us to move beyond knowing whether the provisions of pension programs impact retirement decisions: they do. The difficult task ahead is in measuring the size of these effects and understanding why they occur in the first place. This next step will prove demanding, for a number of reasons. We have shown how pension policies interact in important ways and one has to be particularly careful to disentangle the different mechanisms.

For example, a dramatic finding for many countries is that when they increase the earliest age that individuals can draw benefits, people delay retirement, to an often dramatically large degree. There are many reasons this may be the case. First, pension schemes are often not actuarially fair towards delayed retirement. Second, it may be that changing benefits changes lifetime wealth, providing incentives to work to make up for lost wealth. Third, people may be borrowing constrained and may be unable to finance retirement until the earliest age of pension receipt. Fourth, it could be that state pension ages provide a focal point. Disentangling these motivations is of more than just academic interest. If the effects are large because of borrowing constraints, then delaying the first age of benefit receipt may have negative welfare consequences, since it means taking benefits away at an age when people need them. If, on the other hand, the effects are large because of focal points, then it likely means that the welfare consequences of delayed benefit receipt are more benign.

We have also found compelling arguments to analyze joint retirement in the context of collective models of intra-household decision-making. We have seen that these models have the potential to provide deeper and broader insights into family labor supply decisions and retirement. They provide a role for internal allocations and outside options. A major challenge

with these models is the identification and estimation of general versions of them given the typical data we have available. In an intertemporal setting, in which retirement choices are being made, assumptions on commitment and appropriate outside options are required. There has yet to emerge a uniformly accepted approach, but new theoretical results and new data are having an important impact on the application of bargaining approaches to retirement choices in couples.

Understanding the use of time and the nature of consumption in retirement is another factor that can further help in understanding retirement behavior. Better measurement of disaggregated consumer expenditures, such as in the CAMS module in the HRS, can be expected to provide a solid empirical base for future analysis. Research on the interaction between consumption and retirement, and on the difference between measured spending and actual consumption, has already produced many key insights. As noted in Banks et al. (1998), non-separabilities between consumption and labor supply can help explain the fall in spending at retirement. The analysis of detailed consumption data, as in Aguiar and Hurst (2005), can be used to uncover the nature of home production and enrich our understanding of labor supply incentives at retirement.

A pressing challenge for future research will be to better understand the causes of the relatively recent rise in the age at which people retire. This, as we have documented, has occurred across a large number of countries. Do these changes largely reflect changes in incentives to retire later? As we have seen in this chapter, the incentives for retirement have indeed reduced in many countries. This has caused at least part of the rise in employment at older ages in these countries. However, the Schirle (2008), Blau and Goodstein (2010), and Hurd and Rohwedder (2011) attempts to decompose the relative magnitudes of different factors find the magnitudes to be very much in doubt. Furthermore, what is remarkable is that despite the fact that many pension schemes are now actuarially fair towards delayed retirement, people still retire much earlier than they did 60 years ago. It seems unlikely that wealth effects can explain this. Moreover, there is strong evidence that we are likely healthier than the population of 60 years ago. There may well be a role for cognition and the paper by Keane and Thorp in this volume notes the importance of cognitive capacity in making choices for older individuals.

An important and related aim for future research will be to understand the extent to which individual preferences for retirement are affected by the retirement of others. We have already seen that interactions in the family are important in understanding individual decisions. Interactions in the workplace may also be important but have been little explored. Retirement patterns may also take time to adjust within firms, and within society more generally.

The discussion we have conducted here is aimed at understanding longer-run secular trends in behavior brought about by changes in the Social Security and pension rules, in the wage structure, in health status, and in family structure. Short-run fluctuations and adjustments due to labor market frictions are important for policies aimed at labor market stabilization and for the timing of policy interventions, but possibly less important for understanding the overall structure of behavior and of long-run policy reform. Nevertheless, assessing the importance of restrictions on hours, the organization of shift work, the value of new computer skills, the incentives to become self-employed, the minimum wage, and the design of alternative labor market contracts will be important in further refining the analysis we have presented.

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