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Disability Insurance Incentives and the Retirement Decision
Evidence from the United States

Courtney Coile

1.1 Introduction

The rolls of the US Disability Insurance (DI) program have risen dramatically since the program's inception in 1956. Over the past two decades, the share of the population age twenty-five to sixty-four receiving DI benefits more than doubled, from 2.3 percent in 1989 to 5.1 percent in 2012 (Figure 1.1). The growth of the program is likely to continue, stabilizing at 7 percent of the nonelderly population, according to one projection (Autor and Duggan 2006a). The rising number of DI beneficiaries has jeopardized the program's ability to pay benefits, with annual benefit expenditures reaching $140 billion in 2012 and the DI trust fund projected to be depleted by 2016. As the trustees of the program recently warned, "lawmakers need to act soon to avoid reduced payments to DI beneficiaries three years from now" (OASDI Trustees 2013).

Concerns about the DI program have been amplified by the observation that the program's growth does not appear to be driven by worsening population health. Over the period that DI participation doubled, the fraction of people reporting themselves to be in poor health or suffering from a work-limiting health problem was unchanged, if not declining (Milligan 2012; Duggan and Imberman 2008). These trends have led to renewed interest

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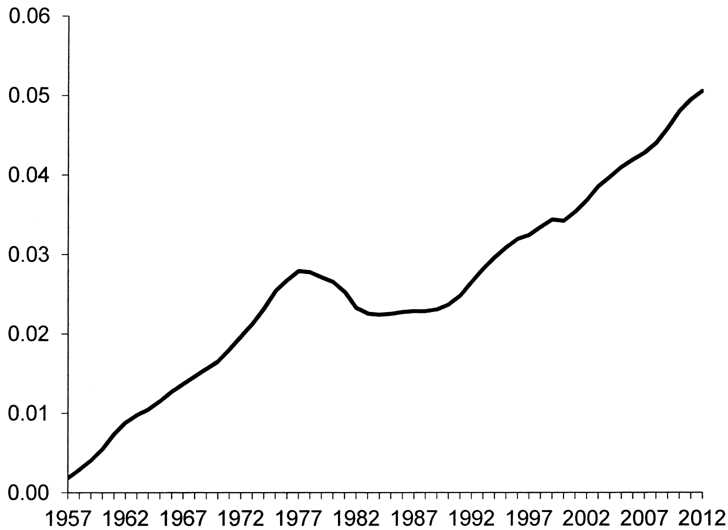

Fig. 1.1 DI beneficiaries as a share of population, age twenty-five to sixty-four (1957–2012)
Source: Authors' calculations based on table 5.D3 from the Social Security Annual Statistical Supplement and population data from the US Census Bureau (www.census.gov).

in understanding the causes of the rise in the DI rolls, as well as its consequences. The effect of DI on labor supply has been a subject of interest since Bound (1989, 1991) and Parsons (1991) reached different conclusions from comparisons of the earnings of accepted and rejected DI applicants. More recent work by Maestas, Mullen, and Strand (2013), French and Song (2012), and Chen and van der Klaauw (2008) has made use of plausibly exogenous variation in DI receipt coming from random assignment of DI applicants to medical examiners or similar sources.

This study takes a different approach to exploring the effect of the DI program on labor supply, specifically labor force withdrawal or retirement. The methodology employed here builds on Coile and Gruber (2004, 2007), who construct several measures of the financial incentives for additional work arising from the structure of the Social Security (SS) program. One measure is the "option value" (OV), which captures the *gain* in utility resulting from retiring at the optimal future date, over and above the utility available by retiring today. Those studies find that having a larger financial incentive for continued work is associated with a reduced probability of retirement. However, these studies ignore the DI program, treating Social Security (and private pensions) as the only possible pathway to retirement.

In the current study, I construct an "inclusive" option value measure that incorporates the financial incentives arising from both SS and DI, and estimate models that relate this new measure to the retirement transitions of workers age fifty to sixty-nine, using data from the Health and Retirement Study (HRS). To explore the effect of incentives on retirement conditional on health, I control for health using an index developed in Poterba, Venti, and Wise (2013). I explore whether the effect of incentives on retirement varies by health and education, both of which are strongly related to the probability of DI receipt. Finally, to put the magnitude of the findings into context and gauge the relevance of DI to retirement decisions, I use the regression estimates to simulate the effect of reducing access to DI.

I have several key findings. First, the probability of DI receipt is strongly linked to education, even conditional on health. Second, the inclusive OV measure has a negative and significant effect on the probability of retirement; the effect is robust to choice of specification and varies by education and health. Finally, the simulations suggest that reducing access to DI would have large effects on the labor force participation of DI applicants.

The remainder of the chapter is structured as follows. In the next section, I provide background on the US DI program and the past literature on DI and labor supply. Next, I describe the empirical strategy, notably how the inclusive OV measure is constructed, as well as the data used. I present descriptive statistics on the probability of DI receipt, and then present the main regression results. I conclude with a simulation of the effect of reducing access to DI and a discussion of the implications of the findings.

1.2 Background

1.2.1 Institutional Features of Social Security and Disability Insurance

Disability insurance in the United States is part of the Social Security program. Eligibility for DI and the calculation of DI benefits is similar to that for SS, with a few key differences.

Workers become eligible for Social Security retired worker benefits after ten years (forty quarters) of covered employment, which now encompasses most sectors of the economy. Benefits are determined by first calculating the Average Indexed Monthly Earnings (AIME), an average of the individual's highest thirty-five years of earnings, indexed by a national wage index. Next, a progressive linear formula is applied to the AIME to get the primary insurance amount (PIA), where ninety cents of the first dollar of earnings is converted to benefits but only fifteen cents of the last dollar. Finally, the PIA is multiplied by an adjustment factor for claiming before or after the normal retirement age ([NRA]; currently sixty-six, but rising slowly to sixty-seven for those born in 1960 or later) to obtain the monthly benefit amount. Benefits are first available at age sixty-two but may be claimed as late as age seventy, and the adjustment factor for early or delayed claiming is considered to be roughly actuarially fair.[1] Before the NRA, workers face an earnings test if their earnings exceed a threshold amount, $15,480, in 2014. Benefits are available for spouses and survivors of retired workers, though a spouse who is also qualified for retired worker benefits receives only the larger of the benefits to which she (or he) is entitled. For the median earner, the Social Security replacement rate is 47 percent of average lifetime earnings (Biggs and Springstead 2008).

While receipt of retired worker benefits upon claiming is automatic for an insured worker, the DI application process is more complex. First, in order to be disability insured, a worker must meet both "recent work" and "duration of work" tests, working in at least five of the last ten quarters (less if disabled by age thirty) and for up to forty quarters over the worker's lifetime (depending on age at disability). An insured worker applying for DI must be determined to have a disability, defined as the "inability to engage in substantial gainful activity (SGA) by reason of any medically determinable physical or mental impairment(s) which can be expected to result in death or which has lasted or can be expected to last for a continuous period of not less than twelve months."[2] The review of a DI application can be a lengthy, multistep process—the initial decision is made by an examiner at a state disability determination (DDS) office, but denied applicants have up to four levels of appeal available to them. One recent study found that although only one-third of applicants were allowed in the initial determination, nearly two-thirds were ultimately awarded benefits (Maestas, Mullen, and Strand 2013). Successful DI applicants begin receiving benefits five months after disability onset, and are eligible for Medicare after two years. Beneficiaries who earn more than the SGA threshold, $1,070 per month in 2014, lose DI eligibility.

The disability screening process has been subject to changes over time. In the late 1970s, DDS offices tightened medical eligibility criteria in response to growing DI enrollments, resulting in a sharp increase in initial denial rates (Gruber and Kubik 1997). A 1980 law increased the number of "continuing disability reviews" (CDRs), leading to the termination of benefits for 380,000 individuals over the next three years (Rupp and Scott 1998). These actions generated a public backlash that led Congress to enact new legislation in 1984. While the new law did not change the statutory definition of disability, it shifted the focus of screening from medical to functional criteria, instructing examiners "to place significant weight on applicants' reported pain and discomfort, to relax its strict screening of mental illness and to consider multiple nonsevere ailments (impairments) as constituting

1. Shoven and Slavov (2013) estimate that returns to delayed claiming have increased over time, particularly since 2000, while Munnell and Sass (2012) argue that the actuarial fairness of the Social Security adjustment factor has changed little over time. Coile et al. (2002) show there is a financial and utility gain from claiming delay for many individuals.

2. Social Security Act, Title II, Section 216 (http://www.ssa.gov/OP_Home/ssact/title02/0216.htm#act-216-i), accessed May 11, 2015.

a disability during the initial determination decision, even if none of these impairments was by itself disabling" (Autor and Duggan 2006b, 8). The 1984 law also put more weight on medical evidence provided by applicants' own health care provider and less on that from the Social Security Administration's medical examination.

Several differences between SS retired workers and DI benefits are relevant for the discussion of financial incentives below. First and foremost, DI benefits are available (to a successful applicant) from the age of disability onset, while retired worker benefits are available only starting at age sixty-two. Second, DI benefits are not subject to reduction for early claiming; thus, a worker claiming retired worker benefits at age sixty-two would receive 75 percent of their PIA (based on current rules), while a worker who was awarded DI benefits at age sixty-two (or any other age) would receive 100 percent of their PIA.[3] Finally, there are some small technical differences in the calculation of the two benefits, such as a lower number of years of earnings and different indexing year (both due to the shorter career) used in the calculation of the AIME and PIA for DI benefits.

1.2.2 Relevant Past Literature

This chapter, like nearly any study of the US DI program, is motivated at least in part by the growth over time in DI enrollments, and thus the literature exploring the reasons for this trend is of interest. Changes in the stringency of medical screening are clearly one important factor. As figure 1.1 illustrates, fluctuations in DI enrollment over time match up with the dates of screening changes, with the DI participation rate falling by 20 percent between 1977 and 1984 (from 2.8 percent of the nonelderly population to 2.2 percent) following the initial tightening of eligibility criteria and increase in CDRs and rising again sharply following the 1984 law. The composition of the DI population has also shifted dramatically in the past two decades, with the number of beneficiaries with musculoskeletal and mental disorders growing by over 300 percent while the number with cancer and heart disease grew by only 30 percent; the explosive growth in the former group is consistent with the 1984 law's relaxed screening of mental illness and greater emphasis on pain and workplace function (Autor and Duggan 2006a).

Economic and demographic factors have also been put forward as possible explanations for the time-series trend. Autor and Duggan (2003) point out that the value of DI relative to potential labor market earnings has risen since the late 1970s because of the interaction between the DI benefit formula and rising income inequality, whereby DI benefits become relatively

3. The rise in the NRA makes it more attractive for early retirees to apply for DI when they retire, since the actuarial reduction for claiming retired worker benefits at age sixty-two is rising over time from 20 percent (for those born before 1938) to 30 percent (for those born starting in 1960). Li and Maestas (2008) find that the increase in the NRA has led to an increase in DI applications, particularly among those in poor health.

more generous if an individual's earnings growth lags behind the average growth of earnings in the economy. Over the past two decades the increase in DI enrollment has been largest for those without a high school degree, consistent with their weakening position in the economy (Katz and Autor 1999). Another potential explanation is rising women's labor force participation, which has made more women eligible for DI. As illustrated below, women's DI participation rates rose more rapidly over this period than did men's, lending some credence to this theory; however, Autor and Duggan (2006a) estimate that increased attachment to the labor force explains only one-sixth of the increase in women's DI participation over time, suggesting that other factors may matter more. Finally, as mentioned above, changes in health do not appear to be a major driver of the growth in DI enrollment, since mortality rates have fallen over time while other health measures have generally been either flat or improving.

A second strand of the literature that is highly relevant for the present analysis concerns the effect of the DI program on labor supply. The long-term decline in the labor force participation of older men that began after the end of World War II (before stabilizing and ultimately reversing starting in the early 1990s) coincided with the rapid growth of the DI program in its first two decades of existence, prompting analysts to explore the effect of DI on men's labor force participation as far back as Parsons (1980). Estimating the effect of the DI program on labor supply is difficult because the counterfactual—how much DI recipients would have worked in the absence of the DI program—is unobservable. Comparing the labor force participation of DI recipients with that of the population at large is fraught because DI recipients are in worse health and may differ in other unobservable ways, introducing bias in the estimation.

Bound (1989) offers a novel solution, using the postdecision earnings of rejected DI applicants as an upper bound estimate of the work capacity of successful applicants, the former group presumably being in better health than the latter. Finding that rejected DI applicants had labor force participation rates of less than 50 percent, Bound concludes that the work capacity of successful applicants is low. Subsequent papers (Parsons 1991; Bound 1991) have raised and debated potential problems with this approach. Rejected applicants may need to remain out of the labor force for years to avoid jeopardizing their appeals and may also suffer depreciation of human capital due to the interruption in their work career (which would not occur in the absence of a DI program). Lahiri and Wixon (2008) found that rejected DI applicants also tend to have intermittent work histories, further calling into question their use as a comparison group.

More recent contributions to this literature have surmounted the usual endogeneity problem by identifying plausibly exogenous sources of variation in DI receipt. Maestas, Mullen, and Strand (2013) exploit variation in the allowance rates of DI examiners at the initial stage in the DI determination process. They find that among the roughly one-quarter of applicants on the margin of program entry, employment would have been nearly 30 percentage points higher in the absence of DI benefits. These effects are heterogeneous, ranging from no effect for the most impaired to a 50 percentage point effect for the least impaired. French and Song (2012) employ a similar methodology, using variation that arises from random assignment of DI cases to administrative law judges, a later stage in the DI determination process. Chen and van der Klaauw (2008) employ a regression discontinuity approach based on discrete changes in eligibility standards at various ages (e.g., age fifty-five) that are codified in the Medical-Vocational Guidelines and used for applicants when a disability determination cannot be made on medical grounds alone. The latter two papers obtain estimates roughly similar to those of Maestas, Mullen, and Strand (2013). Gruber (2000) differs slightly from the other papers in this group in that he focuses on the generosity of DI benefits. Making use of a differential increase in benefits in Quebec versus the rest of Canada in the 1980s to estimate a differences-in-differences model, he finds an elasticity of labor force nonparticipation with respect to DI benefits in the range of 0.3.

The approach employed in this chapter takes a different tack, building on the analysis in Coile and Gruber (2001, 2004, 2007). As explained in more detail below, this approach involves calculating the financial incentive to continued work through the SS and DI programs (option value) and estimating its effect on retirement decisions. Rather than comparing labor supply outcomes of DI recipients and nonrecipients, as most of the above-referenced papers do, the approach taken here compares the labor supply outcomes of those with more and less to gain from continued work. As explained at greater length in the Coile and Gruber papers, there is substantial heterogeneity in the option value measure.[4] While some of this heterogeneity arises from differences in characteristics such as age, marital status, and earnings (which may influence retirement decisions but can be included as control variables), much of it also arises from factors such as nonlinearities in the Social Security benefit formula and how they interact with the particulars of an individual's earnings history. As we argue in those earlier papers, this is a fruitful source of variation for estimating the effect of Social Security on retirement. The innovation in this chapter, relative to those earlier studies, is to incorporate DI incentives in to the option value measure through the construction of the "inclusive option value" measure.

4. This is also true of the purely financial-based incentive measures that play a bigger role in these earlier studies, namely the "accrual," or increase in lifetime present discounted value (PDV) of Social Security benefits arising from an additional year of work, and "peak value," or change in PDV associated with working from the present age to the age at which PDV is maximized.

1.3 Empirical Approach

1.3.1 Data

The data for the analysis comes from the Health and Retirement Study (HRS). The HRS began in 1992 as a survey of individuals then age fifty-one to sixty-one (born in 1931–1941) and their spouses, with reinterviews of these individuals every two years. Over time, new cohorts have been added to the survey to maintain a national panel of individuals over age fifty and their spouses.[5] To date, 11 waves of data (1992–2012) have been collected; as the 2012 data has only recently been made available, this chapter uses the 1992–2010 data. The chapter uses the RAND HRS data file, a cleaned data set that links information over time and across family members and defines variables consistently over time.

A key feature of the HRS is that it includes Social Security earnings histories for most respondents.[6] This allows for the calculation of SS and DI benefit entitlements, which depend on the entire history of earnings. The HRS also contains richly detailed health information that is used in constructing the health index, as detailed below.

The size of the HRS—over 30,000 individuals have appeared in one or more survey wave over the years—as well as the fact that it is a panel allows for the construction of a large sample of person-year observations. Specifically, the estimation sample includes observations for all men and women in any year from 1992 to 2009 in which they met three criteria: (a) they were age fifty to sixty-nine during the year; (b) they were in the labor force at the beginning of the year; and (c) they were observed in the subsequent survey wave, in order to be able to determine whether or not they retired that year. Thus an individual who was, for example, age fifty when first observed in the HRS in 1998 and retired in 2008 at age sixty would contribute eleven person-year observations to the sample, so long as he remained in the survey until 2010 (to determine whether he retired in 2008). The final sample includes 70,675 observations from 10,570 individuals.

The labor supply outcome of interest in the chapter is retirement. Retirement is defined based on the labor force status reported at each wave, an individual being classified as retired when he or she has transitioned from working or unemployed at the previous wave to out of the labor force in the current wave, with the year of retirement assigned based on the date the individual reports at the current wave. Retirement is treated as an absorbing

5. The Asset and Health Dynamics among the Oldest Old (AHEAD) cohort (born before 1924) was added to the survey in 1998, when the previously separate AHEAD survey was merged with the HRS. The War Babies (1942–1947) and Children of the Depression (1924–1930) cohorts were also added in 1998. The Early Baby Boomer cohort (1948–1953) joined the survey in 2004 and the Mid-Baby Boomer cohort (1954–1959) in 2010.

6. These data are restricted and available by application only.

state, so that once an individual reports himself as out of the labor force after age fifty, any subsequent employment spells are not used in the analysis.

1.3.2 Pathways to Retirement

While in some other developed countries early retirement or unemployment insurance benefits offer a viable means of income support from the time a worker leaves his or her job until he or she becomes eligible for social security benefits, in the United States there are only two relevant pathways from employment to retirement: the traditional Social Security ([SS]; meaning retired worker) path and the disability insurance (DI) path.[7]

As noted above, SS benefits are available starting at age sixty-two. In the construction of the incentive measures, described in more detail below, SS benefits are treated as being claimed at the later of age sixty-two or when the individual retires. Although claiming is a separate decision from retirement and an individual could theoretically claim benefits either before retirement (once he or she has reached age sixty-two) or after, this assumption seems reasonable given that the SS earnings test, which is still in place for workers until they reach the NRA, depresses preretirement benefit claiming (Gruber and Orszag 2003) and that it is relatively rare for individuals to delay SS benefit receipt after retirement (Coile et al. 2002).

The DI benefits are treated as being claimed at the time of labor force withdrawal, since there is no advantage to (or even mechanism for) delayed claiming.[8] While this may be a reasonable assumption, it is clearly not realistic to assume that everyone can be a successful DI applicant. There is a medical screening process, and though it may be imperfect (as evidenced by the large number of denied applicants who are successful upon appeal, for example), some individuals—those in worse health, also potentially those who are older or in certain occupations due to the use of vocational guidelines in some cases—would be expected to have a higher probability of

7. Unemployment insurance (UI) benefits are typically available for only six months and only to insured workers who are laid off, limiting their value as a source of early retirement income. Coile and Levine (2007) suggests that UI benefits are not empirically important for the retirement decision, finding that workers who reach age sixty-two in a period of high unemployment are more likely to retire, but that the generosity of UI benefits has no effect on retirement transitions. They conclude that SS may be more relevant than UI in protecting older workers from the impact of a late-career employment shock. In addition, in theory, private pensions should be incorporated in the analysis as well, not as a distinct path to retirement but as an income source available to those individuals in the sample who are eligible for defined benefit (DB) pensions, whether they retire along the SS or DI path. Coile and Gruber (2007) calculate incentive measures using SS income only and using both SS and pension income and obtain very similar regression estimates from the two sets of measures, providing some justification for their omission here.

8. Successful applicants are eligible for benefits after a five-month waiting period from the onset of disability, as discussed earlier, but this detail is ignored in the analysis. The DI applicants often spend more than five months waiting for their final disability determination, but benefits are paid retroactively.

a success. A discussion of how the uncertainty in access to DI benefits is incorporated into the empirical analysis is deferred to the following section.

1.3.3 Option Value Calculations

To review, the goal of the analysis is to develop a retirement incentive measure that will reflect the financial incentives for continued work arising from both the SS and DI programs and to estimate its effect on retirement. To explain the chapter's approach, in this section I first describe the standard SS-only option value measure used in prior analyses (Coile and Gruber 2004, 2007). I then explain how this will be expanded to an "inclusive OV" measure that incorporates DI benefits, including how the uncertainty about an individual's ability to access DI is addressed. Finally, I explain other details relevant to the calculation of the inclusive OV measure.

The option value (OV) approach was pioneered by Stock and Wise (1990) in order to model retirement incentives for workers with defined benefit (DB) pensions. Because DB pensions can have nonmonotonic accrual patterns, for example, very large returns to work in the year that pension vesting occurs or that the individual reaches the pension plan's normal retirement age, the one-year change in the present discounted value (PDV) of pension wealth resulting from an additional year of work (the "accrual") fails to capture the fact that by working this year, the employee is effectively purchasing an option to work in a future year with a larger accrual. Although nonmonotonicities in the accrual of SS benefits do not tend to be as large or frequent as those found for DB pensions, Coile and Gruber (2001) nonetheless show that they exist for SS as well.

Option value is a forward-looking measure of the utility *gain* arising from working to the optimal future retirement date, in excess of the utility available by retiring today. Traditionally, OV has included only SS (and sometimes pension) benefits, but since the present analysis analyzes DI incentives as well, I use the notation OVSS to indicate the traditional measure that only includes SS. The OVSS calculation begins as follows:

$$\mathrm{OVSS}(R)_{ii} = \tag{1}$$
$$\left[\sum_{t=0}^{R}\frac{1}{(1+\delta)^t}\mathrm{probalive}_{it}(\mathrm{wage}_{it})^{\gamma}+\sum_{t=R}^{T}\frac{1}{(1+\delta)^t}\mathrm{probalive}_{it}(k*\mathrm{SSben}(R)_i)^{\gamma}\right]$$
$$-\,\mathrm{OVSS}(R_0),$$

where R refers to a future retirement date, R_0 refers to today, and T is the final period in which the individual could be alive. Also, OVSS(R) is essentially the sum of earnings until time R and of SS benefits (which are a function of R) from time R to time T, discounted for time preference and survival probability, where δ reflects the discount rate, γ reflects the curvature of the utility function, and k reflects the greater utility individuals receive from retirement income due to the utility of leisure. Unlike Stock and Wise (1990), who obtain values for the utility parameters by a structural estimation of their model, we assume that these three parameters take on the values of 0.03, 0.75, and 1.5, respectively.[9]

Equation (1) reflects the utility gain associated with retiring at some future date R, so the individual must repeat this calculation for all possible values of R and estimate:

$$\text{(2)} \qquad \text{OVSS}_i = \max_R \{\text{OVSS}(R_1)_i, \text{OVSS}(R_2)_i, \ldots, \text{OVSS}(R_{\max})_i\},$$

where OVSS is the gain in utility arising from delaying retirement and receipt of SS benefits from the present time until the optimal date, the date at which utility is maximized. In our analysis, age sixty-nine is treated as the last possible retirement age considered by the worker.

Having made this calculation for OVSS, it is straightforward to calculate OVDI in the same manner, temporarily ignoring the possibility that the DI path may be difficult to access for many individuals. In essence the OVDI calculation tells us, if one is going to retire via the DI program, what the optimal date (age) at which to do so is and how large the utility gain is from waiting until that optimal date.

Having calculated OVSS and OVDI brings us to two related questions. First, how can we construct a single incentive measure that incorporates both?[10] Second, what is the appropriate way to account for the fact that not everyone who might want to will be able to choose to retire down the DI path? It turns out that both questions have the same answer, which is to construct an inclusive OV measure that is a weighted average of the two individual measures, as follows:

$$\text{(3)} \qquad \begin{aligned} \text{OVInclusive}_i = {} & (\text{DIprobability}_i * \text{OVDI}_i) \\ & + ((1 - \text{DIprobability}_i) * \text{OVSS}_i), \end{aligned}$$

where OVInclusive is the key regressor in our retirement regressions. The obvious question that arises in its calculation is what value to use for DIprobability. In theory, this measure should reflect the probability that the DI path is a realistic option for a given individual. Our approach is to calculate the probability that people age fifty-five to sixty-four are receiving DI by year, sex, and education cell, and use these cell probabilities. This approach has the practical advantage that it requires relatively little data, making it feasible to apply in contexts where rich data such as the HRS is

9. An informal grid search over a range of possible values for the three parameters suggests that the likelihood function is relatively flat with respect to parameter choice.

10. One very relevant reason for preferring a single measure in the current context is that the results presented here will be combined with those from the other countries participating in the NBER International Social Security project, and the number of pathways may differ across countries. One of the important benefits of having analysts in a large number of countries undertake the same analysis (as nearly as possible) is the insights that can be derived when results are combined.

not available. While it would be possible, using the HRS, to go beyond this approach to estimate a predicted probability that any given individual would go on DI, incorporating health information that is surely relevant to DI application and receipt, an advantage of using cell averages is that it avoids the use of these potentially endogenous covariates. Additionally, since some regression specifications interact our incentive measure with health, it is awkward to also have health embedded in the construction of the incentive measure. In essence, one can think of this as similar to an instrumental variables approach, where we limit ourselves to the variation that is more plausibly exogenous to retirement to obtain a cleaner, if less precise, estimate of DIprobability. The actual values used for DIprobability are reported below.

Finally, I briefly discuss a few salient technical details relevant to the calculation of OVInclusive; more information about these calculations can be found in the appendix to Coile and Gruber (2001). The worker's potential future earnings must be projected to age sixty-nine in order to calculate OVSS and OVDI, as earnings enter directly in the OV measures. Following Coile and Gruber (2004), I grow real earnings by 1 percent per year from the last observed value. I estimate PIAs for all possible future retirement dates using a program that incorporates the Social Security benefits rules and has been cross-checked against the Social Security Administration's ANYPIA model. The appropriate actuarial adjustment factor is applied in the calculation of SSBen(R). For married workers, OVSS and OVDI incorporate dependent spouse and survivor benefits, allowing for the probability that at any given age, either or both spouses may be surviving. The inclusion of spousal benefits is complicated by the fact that a spouse who is qualified for retired worker benefits is entitled to the greater of this or her dependent benefit, which will depend on her retirement date. A full modeling of joint retirement decisions is beyond the scope of this chapter, so I assume that any working wives (or husbands) retire at age sixty-two for the purpose of incorporating dependent benefits on the spouse's record, a seemingly reasonable assumption, given that the median retirement age is sixty-two for married women who were working at age fifty.

1.3.4 Health Quintiles

An important goal of the larger project of which this chapter forms a part is to ask: Given health status, to what extent are differences in labor force participation within and across countries determined by the provisions of DI programs? To be able to answer this, it is necessary to control for health in the analysis, preferably in a way that incorporates as much information as possible and can be replicated across countries.

The approach adopted here, which builds on Poterba, Venti, and Wise (2013) and is described at length elsewhere in this volume, is to construct a health index based on twenty-seven questions, including self-reported health diagnoses, functional limitations, medical care usage, and other health indicators. To do so, one first obtains the first principal component of these indicators, which is the "weighted average of indicators where weights are chosen to maximize the proportion of the variance of the individual health indicators that can be explained by this weighted average." The estimated coefficients from the analysis are then used to predict a percentile score for each respondent, referred to as the health index. An individual's health index value typically will vary by HRS survey wave, as updated health information points are incorporated. As Poterba, Venti, and Wise (2013) demonstrate, the health index is strongly related to mortality and to future health events such as stroke and diabetes onset, though not to new cancer diagnosis. In the analysis below, respondents are divided into health quintiles based on their health index scores.

1.4 Results

1.4.1 Descriptive Analysis: DI Participation Rates

Before turning to the regression results, I present some figures on DI participation. Figures 1.2A and 1.2B show participation rates for men and women ages fifty to sixty-four since 1982, using data on DI beneficiaries from the Social Security Administration and population data from the US Census Bureau. Trends over time for older workers mirror those seen in figure 1.1 for the population at large. By 2012, one in seven men ages sixty to sixty-four (14.2 percent) is on DI, as is one in ten men at ages fifty-five to fifty-nine (10.6 percent), and one in fourteen at ages fifty to fifty-four (7.1 percent). The DI participation rates for older women have risen even more dramatically than for older men in the last three decades, doubling for the age sixty to sixty-four group, from 5.6 percent in 1982 to 11.4 percent in 2012, and tripling for women age fifty to fifty-four, from 2.0 percent in 1982 to 6.4 percent in 2012.

Figures 1.3A through 1.3D show rates of DI receipt by education and health for men and women ages fifty-five to sixty-four. These and subsequent figures use data from the HRS;[11] representative years from 1992 through 2008 are shown on the graph, though calculations are made for all years. The first thing to note is that the values shown on figures 1.3A and 1.3B are the DIprobability values used in the construction of OVInclusive, as they are year-sex-education cell average participation rates.

Figure 1.3A shows a substantial DI participation gradient by education, with the lowest education group, high school dropouts, being five to six times more likely to be on DI than the highest education group, college

11. The data in these figures reflect all HRS respondents in the relevant age group, and are not limited to workers.

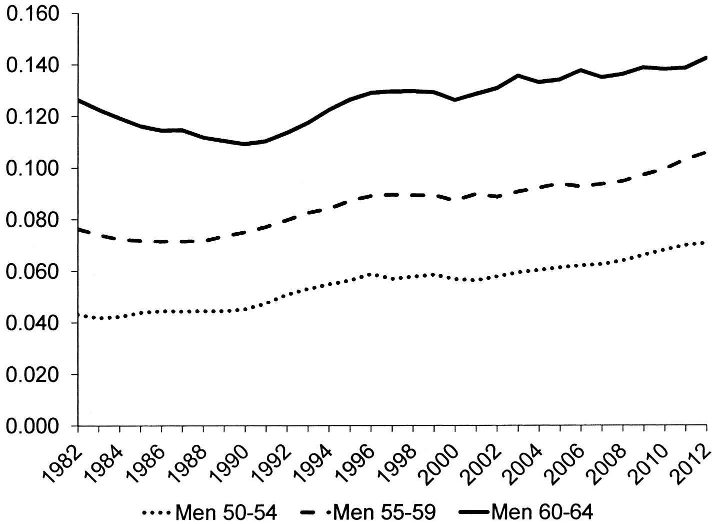

Fig. 1.2A DI participation rates for men age fifty to sixty-four, 1982–2012
Source: Authors' calculations based on table 5.D3 from the Social Security Annual Statistical Supplement and population data from the US Census Bureau (www.census.gov).

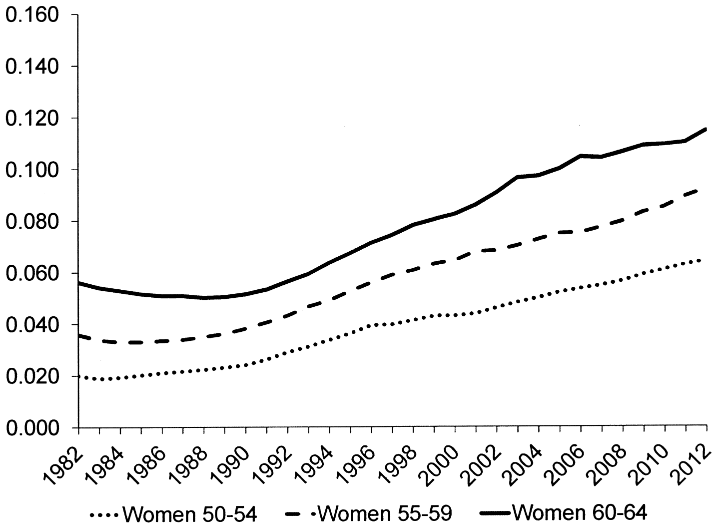

Fig. 1.2B DI participation rates for women age fifty to sixty-four, 1982–2012
Source: Authors' calculations based on table 5.D3 from the Social Security Annual Statistical Supplement and population data from the US Census Bureau (www.census.gov).

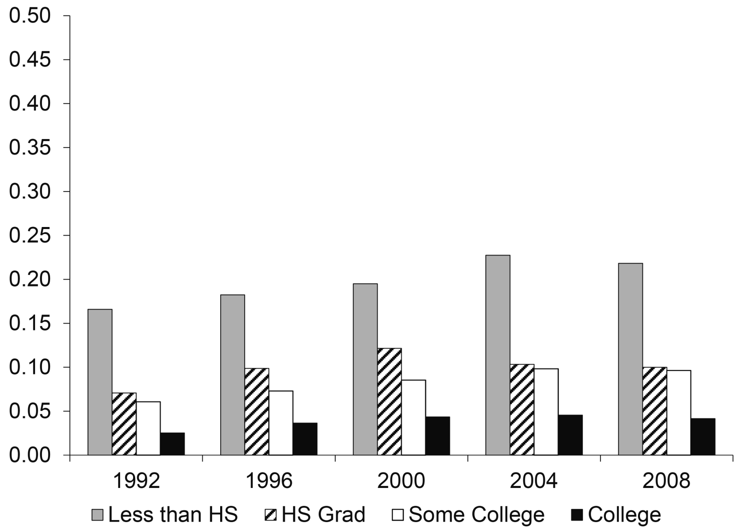

Fig. 1.3A Probability men age fifty-five to sixty-four in HRS have received DI, by education and year

Source: Authors' calculations from the HRS.

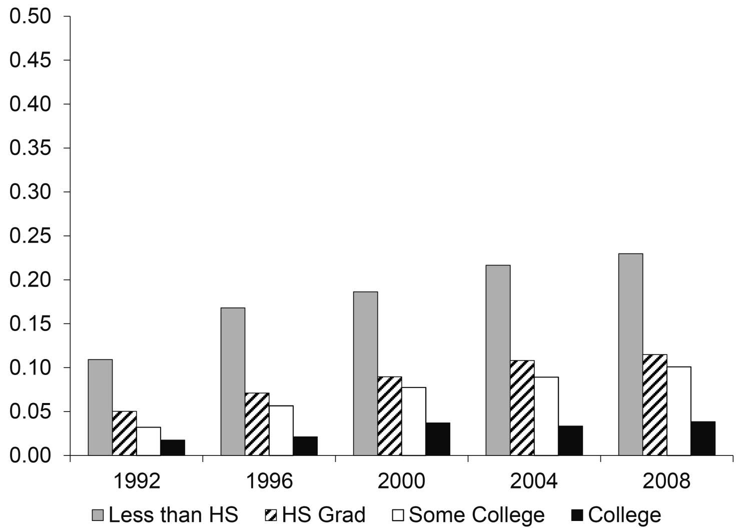

Fig. 1.3B Probability women age fifty-five to sixty-four in HRS have received DI, by education and year

Source: Authors' calculation from the HRS.

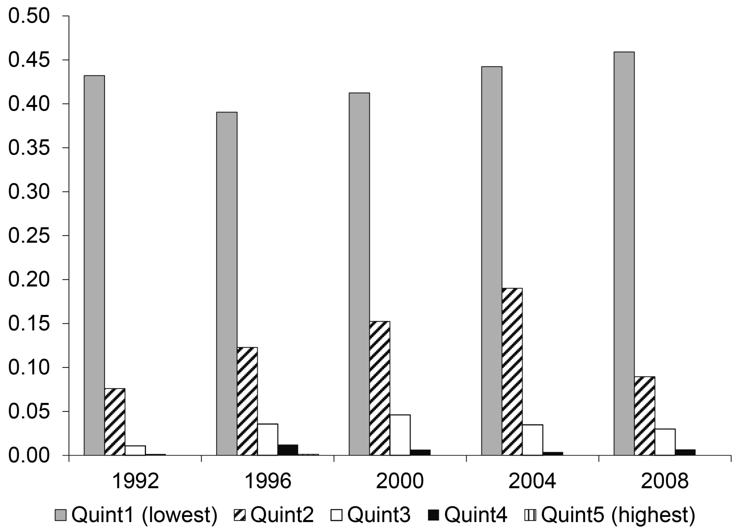

Fig. 1.3C Probability men age fifty-five to sixty-four in HRS have received DI, by health quintile and year

Source: Authors' calculation from the HRS.

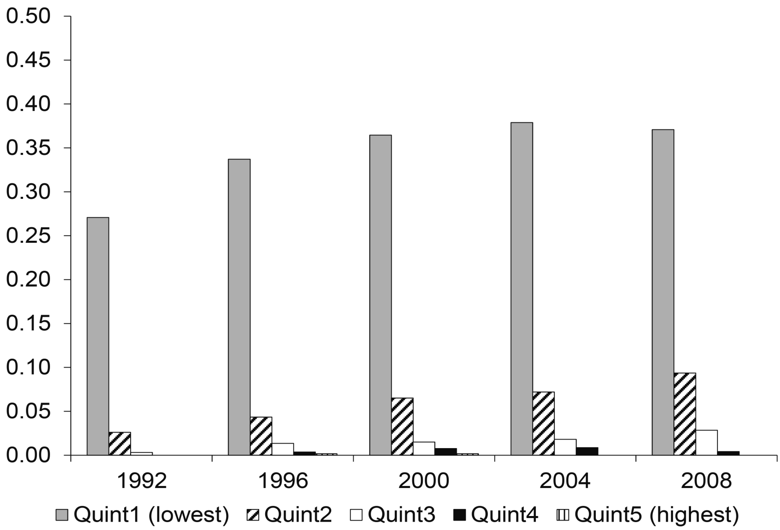

Fig. 1.3D Probability women age fifty-five to sixty-four in HRS have received DI, by health quintile and year

Source: Authors' calculation from the HRS.

graduates; in 2008, the rates were 22 percent for the former group and 4 percent for the latter. The rise in DI rates over time that was evident in earlier figures is present here as well for all education groups; the DI participation rate for high school graduates, for example, rises by 41 percent from 1992 to 2008, from 7.1 percent to 10.0 percent. Figure 1.3B shows that the DI participation gradient by education is, if anything, steeper for women; the rise in DI over time is also more pronounced, consistent with earlier figures.

Figures 1.3C and 1.3D repeat the exercise, stratifying by health quintile (as defined above) rather than by education group. The DI participation gradient with respect to health is much steeper than that for education. This is not terribly surprising, in that there is a medical screening process for DI, so those in worse health (measured using data from the current survey wave) should be more likely to be on DI. Among men ages fifty-five to sixty-four in 2008, 46 percent of those in the lowest health quintile were on DI versus 9 percent for the second quintile, 3 percent for the third, and essentially no one in the top two quintiles. The strong relationship between DI receipt and the health index would seem to provide some reassurance that both the health index we construct is a useful summary statistic for health status and that the DI medical screening process is at least somewhat successful in identifying the least healthy. The graph for women is very similar, though the probability of being on DI for those in the lowest health quintile is somewhat lower, only 37 percent in 2008.

One question raised by these figures is whether the correlation between education and DI receipt seen in figures 1.3A and 1.3B primarily reflects the effect of health, since low socioeconomic status is known to be correlated with poor health (Smith 1999), or whether there is a relationship between education and DI receipt even conditional on health. This question is answered in figures 1.3E and 1.3F, which show the probability of DI receipt by education and health, averaged across all years. The education gradient is substantially smaller, but remains nontrivial, with male high school dropouts in the lowest health quintile being 46 percent more likely to be on DI than college graduates in the same health quintile (50 percent vs. 34 percent), while female high school dropouts are 66 percent more likely to be on DI (38 percent vs. 23 percent). The education gradient is equally strong, if not stronger, in higher health quintiles, though the absolute rates of DI participation are quite small in the top two quintiles. Thus, we can conclude that education has a robust relationship with DI receipt. This is consistent with rising income inequality being one of the explanations for the rise in the DI rolls, as mentioned above. It is also consistent with finding that DI applications and awards tend to rise with the unemployment rate (Autor and Duggan 2003), since less educated workers experience higher rates of unemployment.

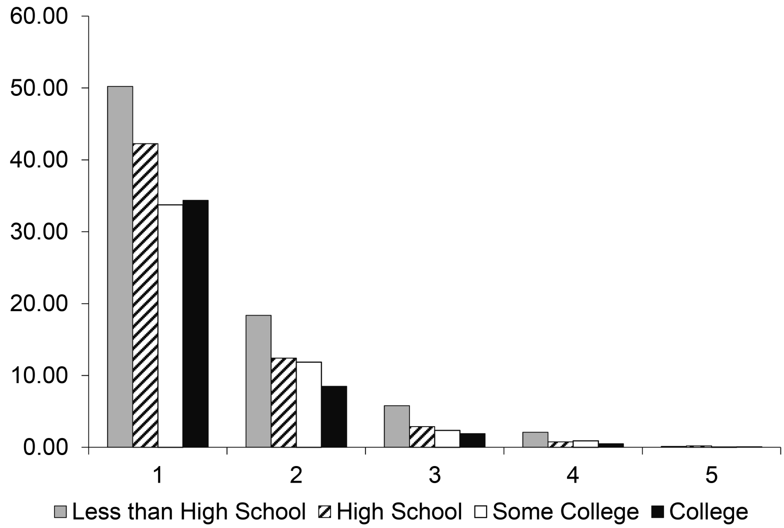

Fig. 1.3E DI participation by health quintile and education, men fifty-five to sixty-four, 1992–2009

Source: Authors' calculations from the HRS.

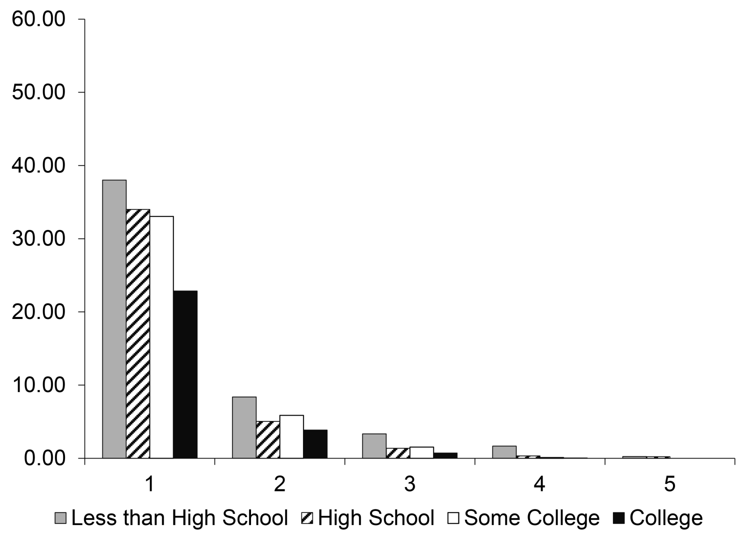

Fig. 1.3F DI participation by health quintile and education, women fifty-five to sixty-four, 1992–2009

Source: Authors' calculations from the HRS.

1.4.2 Descriptive Analysis: Incentive Measures

Before examining the regression results, it is useful to take a closer look at the incentive measures that are the key regressors in those models. Figures 1.4A and 1.4B show the mean values of the OV measures by age for men and women. These figures are constructed by taking a sample of workers at age fifty and computing their incentive measures at all future ages through age sixty-nine; there is no concern of sample selection (e.g., higher income workers being less likely to retire) as the sample ages, as mean OV is calculated using data for all workers, regardless of their ultimate retirement decision.

Starting with figure 1.4A, the first thing to note is that the mean for all of the OV measures (OVSS, OVDI, and OVInclusive) is positive, indicating that on average there is some utility gain associated with remaining in the labor force until the optimal future retirement date, whether the individual is contemplating retirement along the SS or DI path. For all measures, the mean value is declining with age, reflecting the fact that the closer one gets to the optimal retirement date, the smaller the utility gain associated with waiting until that date to retire.[12] As far as the magnitudes, the OV measures are in utility units rather than in currency units, so the values do not have an easy interpretation, though higher values reflect a larger gain from retirement delay. The values of OVDI are lower than those for OVSS, for reasons I explain below, but have the same pattern of declining with age. The values for OVInclusive are much closer to those of OVSS than OVDI; this is expected, given that OVInclusive is a weighted average of the two and the average DIprobability in the sample is approximately 10 percent, putting more emphasis on OVSS in the calculation. The values for women, shown in figure 1.4D, are lower than for men, as women's lower average earnings mean that they have less to gain from retirement delays (recall that the OV measures incorporate the value of earnings through retirement as well as the value of SS or DI benefits after retirement). However, the decline with age and relative magnitudes of the different measures display the same patterns observed for men.

Some additional insight into these measures, and particularly into the relationship between OVSS and OVDI, can be gleaned from figures 1.4C and 1.4D. These report a simpler measure, the PDV of lifetime SS or DI benefits associated with each possible retirement date. The PDV measures reflect the financial (not utility) gain from additional work if one retires along either the SS or DI path, and include only changes in the value of benefits and not the additional wages that may result from additional work.

As figure 1.4C indicates, PDVSS rises moderately with additional work through age sixty-two, the age of SS eligibility, as additional years of earn-

12. By construction, OV cannot be negative, but it will be zero once the individual has passed his or her optimal retirement date.

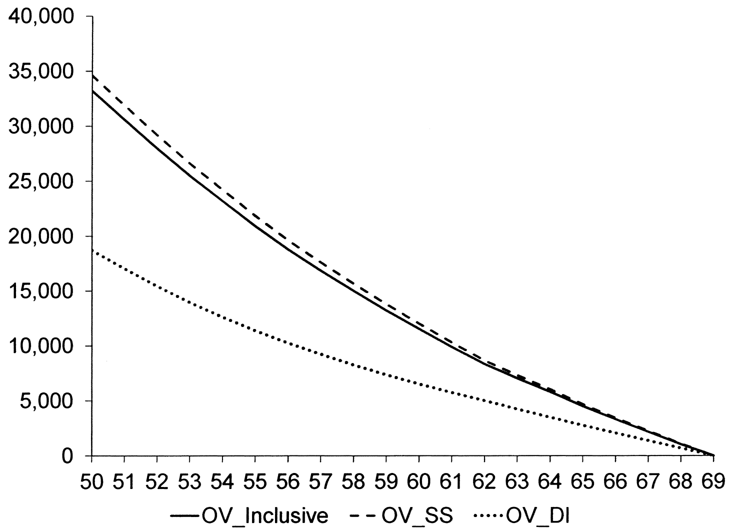

Fig. 1.4A Mean OV by age for men

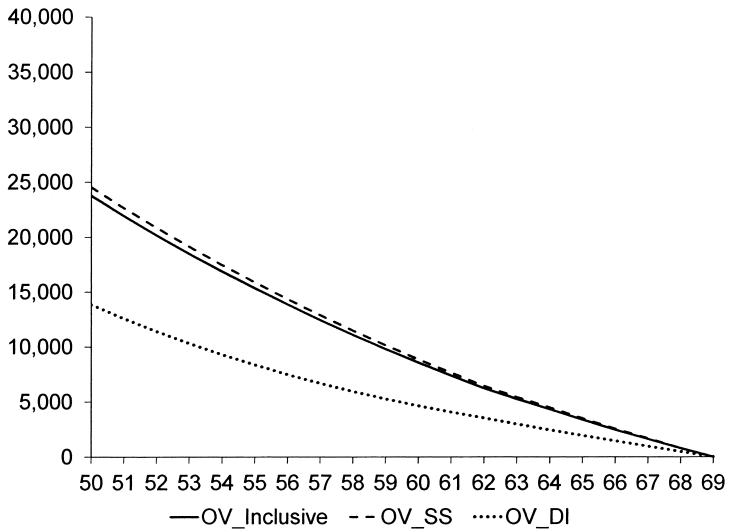

Fig. 1.4B Mean OV by age for women

ings may replace zeroes or low-earnings years in the SS benefit calculation. After age sixty-two, the PDVSS grows more slowly, as an additional year of work is accompanied by a delay in the SS benefit claim that results in the loss of one year of SS benefits (lowering the PDV) but also in a higher actuarial adjustment and permanently higher SS benefits once receipt commences

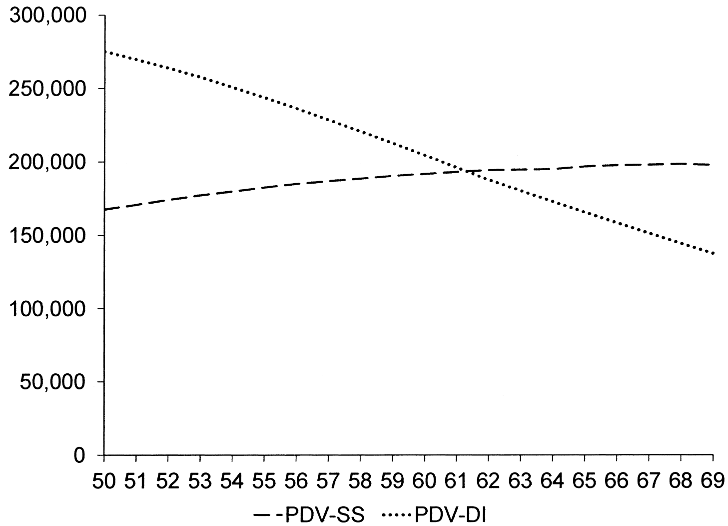

Fig. 1.4C Mean PDV-SS and PDV-DI by age, men (2011 euros)

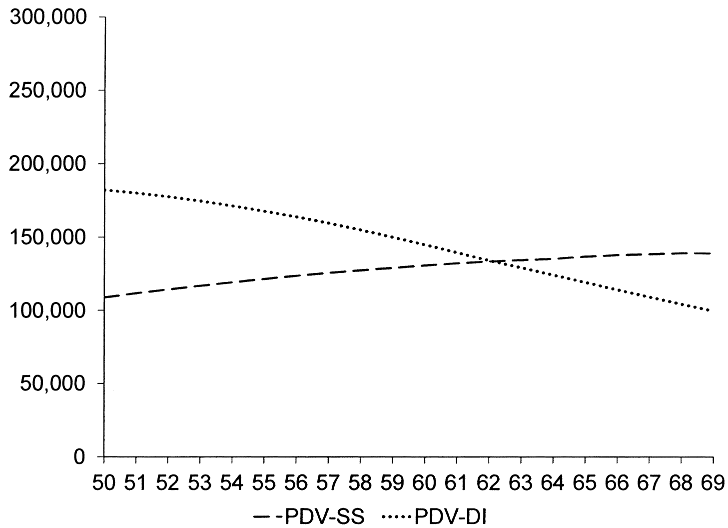

Fig. 1.4D Mean PDV-SS and PDV-DI by age, women (2011 euros)

(raising the PDV); at the mean, the net of these two effects is positive, but modestly so.[13] With a 3 percent discount rate, the series essentially peaks at or

13. These results will be sensitive to the choice of the discount rate, since the cost of remaining in the labor force for an additional year is borne now and the benefit is received in the future.

near the NRA. Here, the values (reported in 2011 euros, for consistency with other studies in this volume) do have a concrete meaning—working from age fifty to sixty-two raises the PDV of SS benefits by about 27,000 euros.

The evolution of PDVDI with the age of retirement is much different—PDVDI starts at a much higher value than PDVSS, but declines much more sharply with age thereafter. The reasons for this relate to the differences between SS and DI benefits highlighted above. While additional years in the workforce can raise DI benefits by replacing a zero or low-earnings year with a higher-earnings year, as for SS, this effect is relatively less important for DI because DI uses a shorter averaging period.[14] More importantly, DI benefits are available immediately upon DI award (after a five-month waiting period) and are not subject to actuarial adjustment. Therefore delaying onset of DI benefit receipt means a loss of benefits today, with no compensating increase in future benefits. For men, mean PDVDI falls from 270,000 euros if retirement occurs at age fifty to 151,000 euros if it occurs at age sixty-six. As expected, PDVSS and PDVDI for women have lower values but display the same patterns as for men.

Returning to figures 1.4A and 1.4B, OVDI can be positive (and declining with age) even when PDVDI peaks at a retirement age of fifty because the OV measures include earnings as well as SS or DI benefits. The replacement rates from SS and DI are fairly low, both in absolute terms and by international standards, and so even though the OV calculation puts a greater value on a dollar of retirement income than a dollar of earnings because of the utility of leisure, it may still be optimal to delay retirement along the DI path even if DI benefits are immediately available in order to accumulate additional years of earnings. Nonetheless, the key point is that the sharply different profiles of PDVSS and PDVDI explain the much lower values of OVDI relative to OVSS in figures 1.4A and 1.4B—there is simply much less to be gained by remaining in the labor force for those retiring along the DI path, relative to the gains available from delaying retirement for those retiring along the SS path.

1.4.3 Regression Results

Finally, we turn our attention to the regression models and results. These models generally take the form:

$$R_{it} = \beta_0 + \beta_1 \mathrm{OV}_{it} + \beta_2 \mathrm{AGE}_{it} + \beta_3 \mathrm{Health}_{it} + \beta_4 X_{it} + \varepsilon_{it}, \quad (4)$$

where retirement (R_{it}) is a dummy variable equal to 1 if the individual retires during the year (reports being out of the labor force at the following survey

14. To elaborate on this, a fifty-year-old considering retiring now through the SS path would likely have zeroes in the calculation of his PIA for SS benefits, as he is unlikely to have thirty-five years of covered earnings by this point. By contrast, for a fifty-year-old considering retiring now through the DI path, the PIA would be calculated based on only the highest twenty-three years of earnings, so it is less likely that this calculation would include zeroes.

year and specifies this year as the year of retirement); OV_{it} is the inclusive option value described above. We also use a "percent change" version of this variable by dividing the option value by the level of utility available by retiring today. The variable AGE represents either a set of age dummies or a linear variable for the individual's age. The variable Health represents either a set of quintile dummies or the continuous health index. Finally, we include as a set of other controls (X_{it}) the individual's marital status, citizenship status, education, occupation, industry, and the spouse's employment status.

The main regression results are presented in table 1.1A. The first key finding is that OVInclusive has a negative and statistically significant effect on earnings. An increase of 10,000 units (which is somewhat smaller than the mean value of OV, which is 14,526) would reduce the probability of retirement by 3.3 percentage points, or about 40 percent relative to the baseline retirement rate of 7.9 percent. The estimates also suggest that a one standard deviation change in the OV (a 14,770-unit change) would lower the probability by 5.6 percentage points. This result is quite consistent across specifications—using age dummies versus linear age or health quintiles versus the continuous health index has little effect on the results.

The other coefficients on table 1.1A are much as expected. Health is an important determinant of retirement. In the models using health quintiles, relative to the poorest health group (omitted), those in higher health quintiles are 2.8 to 3.9 percentage points less likely to retire in any given year. The pattern of the four health quintile dummies suggests that the healthiest group has the lowest probability of retirement, though the difference between the lowest quintile and all others is more important than the differences between any of the other quintiles. The linear health index similarly suggests that better health (which is indicated with a larger index value) makes one less likely to retire, though the implied retirement gradient with respect to health is flatter using this continuous measure than that found using the quintiles. The probability of retirement rises with age, and the age dummies (not shown) exhibit the expected spikes at ages sixty-two and sixty-five.

In table 1.1B, the standard OVInclusive measure is replaced with the percent change version of this measure. The results suggest that a 100 percent increase in OVInclusive would reduce the probability of retirement by 5.9 percentage points. A 100 percent increase in OVInclusive, evaluated at the mean, would represent something like a 14,000-unit increase. Thus, it seems about right that this effect (5.9 percentage points) is roughly similar to the one standard deviation change effect (5.6 percentage points), since that simulates a similar change in OVInclusive.

The next set of tables explore whether the effects seen in tables 1.1A and 1.1B vary by health. In theory, it is not clear whether the impact of a given change in OVInclusive should have a bigger or smaller effect for someone in poor health. On the one hand, poor health may make individuals less likely

Table 1.1A **Effect of inclusive OV on retirement**

	Specification							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
OV_inclusive	–0.0333	–0.0325	–0.0338	–0.0331	–0.0332	–0.0325	–0.0338	–0.0331
	(.0011)	(.0011)	(.0011)	(.0011)	(.0011)	(.0011)	(.0011)	(.0011)
	[–0.056]	[–0.055]	[–0.057]	[–0.056]	[–0.056]	[–0.055]	[–0.057]	[–0.056]
Health quint 2	–0.0282	–0.0281	–0.0260	–0.0259				
(second lowest)	(.0022)	(.0021)	(.0022)	(.0021)				
Health quint 3	–0.0302	–0.0302	–0.0283	–0.0283				
	(0.0022)	(0.0022)	(0.0022)	(0.0022)				
Health quint 4	–0.0353	–0.0349	–0.0326	–0.0323				
	(.0022)	(.0021)	(.0022)	(.0022)				
Health quint 5	–0.0388	–0.0385	–0.0362	–0.0360				
(highest)	(.0022)	(.0021)	(.0022)	(.0022)				
Health index					–0.0007	–0.0007	–0.0006	–0.0006
					(.00004)	(.00004)	(.00004)	(.00004)
Age	0.0017		0.0019		0.0015		0.0016	
	(.0002)		(.0002)		(.0002)		(.0002)	
Age dummies		Included		Included		Included		Included
Female			–0.0031	–0.0031			–0.0037	–0.0037
			(.0022)	(.0022)			(.0022)	(.0022)

Married			0.0044	0.0040			0.0040	0.0037
			(.0025)	(.0025)			(.0025)	(.0025)
Spouse works			–0.0151	–0.0146			–0.0149	–0.0144
			(.0022)	(.0021)			(.0022)	(.0021)
Total assets			0.0002	0.0000			0.0002	0.0000
(in millions of euros)			(.0013)	(.0013)			(.0013)	(.0013)
Occup. dummies			Included	Included			Included	Included
Educ.: <High school			0.0170	0.0157			0.0170	0.0159
			(.0040)	(.0039)			(.0040)	(.0039)
Educ.: High school			0.0100	0.0091			0.0100	0.0092
			(.0031)	(.0031)			(.0031)	(.0031)
Educ.: Some college			0.0023	0.0016			0.0021	0.0015
			(.0032)	(.0031)			(.0032)	(.0031)
No. of observations	67,228	67,228	67,228	67,228	67,228	67,228	67,228	67,228
Mean ret. rate	0.079	0.079	0.079	0.079	0.079	0.079	0.079	0.079
Mean of OV	14,526	14,526	14,526	14,526	14,526	14,526	14,526	14,526
Std. dev. of OV	14,770	14,770	14,770	14,770	14,770	14,770	14,770	14,770

Notes: Coefficients are marginal effects of a 10,000-unit change in OV from probit models. Standard errors are shown in parentheses. The effect of a one standard deviation change in OV is shown in brackets (this is estimated as the effect of increasing inclusive OV from the current value –0.5 std. dev. to the current value +0.5 std. dev.).

Table 1.1B **Effect of percent gain in inclusive OV on retirement**

	Specification			
	(1)	(2)	(3)	(4)
Percent gain in OV	–0.0578	–0.0555	–0.0615	–0.0593
	(.0118)	(.0114)	(.0129)	(.0124)
Linear age	X		X	
Age dummies		X		X
Health quintiles	X	X	X	X
Other Xs			X	X
No. of observations	63,564	63,564	63,564	63,564
Mean ret. rate	0.079	0.079	0.079	0.079
Mean of % gain in OV	0.687	0.687	0.687	0.687
Std. dev. of % gain in OV	1.135	1.135	1.135	1.135

Note: Models are the same as models 1–4 in table 1.1. Coefficients are marginal effects. Standard errors are shown in parentheses.

to respond to economic incentives, as health becomes the most important factor in the retirement decision. On the other hand, the incentives may be more important for individuals in poorer health because they are more actively considering retirement, while those in good health may just plan to continue working until they reach some critical age, such as sixty-two. The results presented in tables 1.2A, 1.2B, and 1.2C support the second hypothesis, as the responsiveness to the incentives is higher for those in poor health. For example, in table 1.2A (specification [1]), the impact of a 10,000-unit increase in the option value would be to lower retirement probability by 6.2 percentage points for those in the lowest health quintile, but only by 2.0 percentage points for those in the top quintile. This pattern of results is similar across specifications and for both the option value and percentage gain in option value formulations.

In tables 1.3A and 1.3B, the effect of OVInclusive is allowed to vary by education group. Workers with lower education will have lower lifetime earnings, and thus can expect to receive a higher replacement rate (though lower benefits in absolute terms) from DI and SS relative to that experienced by higher-income workers, due to the progressive nature of the benefit calculation. This, along with the increased likelihood that less educated workers are in poor health (which has already been found to increase the responsiveness to incentives) may make less educated workers more responsive to financial incentives.

Tables 1.3A and 1.3B confirm this hypothesis. More highly educated individuals are less responsive than lower-educated individuals to the same incentive. For example, in table 1.3A (specification [1]), the impact of a 10,000-unit increase in the option value would be to lower retirement probability by 6.3 percentage points for high school dropouts, but only by 2.0

Table 1.2A **Effect of inclusive OV on retirement by health quintile**

	No. of obs.	Mean ret. rate	Mean of OV	Std. dev. of OV	Specification (1)	(2)	(3)	(4)
OV: Lowest quintile	13,701	0.132	10,632	11,818	–0.0617	–0.0608	–0.0604	–0.0594
(worst health)					(.0038)	(.0038)	(.0038)	(.0038)
					[–0.076]	[–0.075]	[–0.074]	[–0.073]
OV: 2nd quintile	13,525	0.081	12,702	13,232	–0.0347	–0.0338	–0.0363	–0.0353
					(.0027)	(.0027)	(.0027)	(.0026)
					[–0.050]	[–0.049]	[–0.053]	[–0.052]
OV: 3rd quintile	13,398	0.074	14,205	14,149	–0.0339	–0.0328	–0.0346	–0.0336
					(0.0024)	(0.0023)	(0.0023)	(0.0023)
					[–0.055]	[–0.054]	[–0.057]	[–0.056]
OV: 4th quintile	13,476	0.062	16,103	15,579	–0.0239	–0.0232	–0.0240	–0.0234
					(.0019)	(.0019)	(.0019)	(.0018)
					[–0.043]	[–0.042]	[–0.044]	[–0.044]
OV: Highest quintile	13,128	0.054	17,192	15,847	–0.0197	–0.0192	–0.0202	–0.0197
(best health)					(.0017)	(.0017)	(.0017)	(.0017)
					[–0.036]	[–0.035]	[–0.037]	[–0.037]
Linear age					X		X	
Age dummies						X		X
Other Xs							X	X

Notes: Models are the same as models 1–4 in table 1.1, but are estimated separately by health quintile; each coefficient on the table is from a different regression. Coefficients are marginal effects of a 10,000-unit change in OV from probit models. Standard errors are shown in parentheses. The effect of a one standard deviation change in OV is shown in brackets (this is estimated as the effect of increasing inclusive OV from the current value –0.5 std. dev. to the current value +0.5 std. dev.).

Table 1.2B **Effect of percent gain in inclusive OV on retirement by health quintile**

					Specification			
	No. of obs.	Mean ret. rate	Mean of % OV	Std. dev. of % OV	(1)	(2)	(3)	(4)
OV: Lowest quintile	12,802	0.132	0.561	0.850	–0.0641	–0.0620	–0.0674	–0.0653
(worst health)					(.0319)	(.0308)	(.0345)	(.0334)
OV: 2nd quintile	12,739	0.081	0.607	1.050	–0.0598	–0.0566	–0.0631	–0.0599
					(.0185)	(.0172)	(.0201)	(.0187)
OV: 3rd quintile	12,713	0.074	0.639	0.684	–0.0772	–0.0738	–0.0806	–0.0774
					(0.0060)	(0.0058)	(0.0059)	(0.0057)
OV: 4th quintile	12,829	0.062	0.698	0.773	–0.0531	–0.0510	–0.0564	–0.0544
					(.0052)	(.0051)	(.0050)	(.0049)
OV: Highest quintile	12,481	0.054	0.793	1.866	–0.0390	–0.0374	–0.0407	–0.0393
(best health)					(.0047)	(.0045)	(.0046)	(.0044)
Linear age					X		X	
Age dummies						X		X
Other Xs							X	X

Notes: Models are the same as models 1–4 in table 1.1, but are estimated separately by health quintile; each coefficient on the table is from a different regression. Coefficients are marginal effects. Standard errors are shown in parentheses.

Table 1.2C **Effect of inclusive OV on retirement with health index interaction**

	Specification			
	(1)	(2)	(3)	(4)
OV	–0.0392	–0.0387	–0.0396	–0.0391
	(.0034)	(.0034)	(.0033)	(.0033)
	[–0.065]	[–0.065]	[–0.067]	[–0.066]
OV*health index	0.00009	0.00010	0.00009	0.00009
	(.00005)	(.00005)	(.00005)	(.00005)
Health index	–0.0008	–0.0008	–0.0007	–0.0007
	(.00006)	(.00006)	(.00006)	(.00005)
Linear age	X		X	
Age dummies		X		X
Other Xs			X	X
No. of observations	67,228	67,228	67,228	67,228
Mean ret. rate	0.079	0.079	0.079	0.079
Mean of OV	14,526	14,526	14,526	14,526
Std. dev. of OV	14,770	14,770	14,770	14,770

Notes: Models are the same as models 5–8 in table 1.1, with the addition of an OV*health index interaction. Coefficients are marginal effects of a 10,000-unit change in OV from probit models. Standard errors are shown in parentheses. The effect of a one standard deviation change in OV is shown in brackets (this is estimated as the effect of increasing inclusive OV from the current value –0.5 std. dev. to the current value +0.5 std. dev.).

percentage points for college graduates. The results are generally robust across specifications, though in table 1.3B, where the incentive measure is defined in terms of a percentage change, the coefficients for high school dropouts are small and statistically insignificant.

Overall, our regression results confirm the findings of Coile and Gruber (2004, 2007) that the financial incentives for continued work arising from the structure of the Social Security system—now construed broadly to include both SS retired worker benefits and DI benefits—have a significant effect on retirement decisions. The effect is in the expected direction, in that workers with a larger financial incentive to delay retirement are more likely to do so, and its magnitude suggests that a large change in financial incentives will have a large impact on the probability of retirement. In addition, I find that the impact of financial incentives on retirement is strongest for those in poor health and those with less education, potentially reflecting a greater salience of financial incentives for groups that may tend to begin to consider retirement at relatively younger ages.

1.5 Simulations and Discussion

One of the benefits of constructing an inclusive measure that incorporates the financial incentives from both SS and DI is that it can be used to simulate

Table 1.3A **Effect of inclusive OV on retirement by education group**

					Specification			
	No. of obs.	Mean ret. rate	Mean of OV	Std. dev. of OV	(1)	(2)	(3)	(4)
OV: < High school	10,756	0.109	8,697	9,139	–0.0633	–0.0603	–0.0647	–0.0614
					(.0054)	(.0053)	(.0053)	(.0051)
					[–0.062]	[–0.059]	[–0.064]	[–0.061]
OV: High school	24,006	0.086	12,444	12,077	–0.0413	–0.0405	–0.0430	–0.0421
					(.0023)	(.0023)	(.0023)	(.0023)
					[–0.055]	[–0.054]	[–0.058]	[–0.057]
OV: Some college	15,541	0.070	16,033	14,893	–0.0293	–0.0285	–0.0305	–0.0297
					(0.0019)	(0.0019)	(0.0019)	(0.0019)
					[–0.050]	[–0.049]	[–0.053]	[–0.052]
OV: College	16,925	0.060	19,715	18,560	–0.0201	–0.0198	–0.0204	–0.0202
					(.0013)	(.0013)	(.0013)	(.0013)
					[–0.043]	[–0.043]	[–0.044]	[–0.044]
Linear age					X		X	
Age dummies						X		X
Health quintiles					X	X	X	X
Other Xs							X	X

Notes: Models are the same as models 1–4 in table 1.1, but are estimated separately by education group; each coefficient on the table is from a different regression. Coefficients are marginal effects of a 10,000-unit change in OV from probit models. Standard errors are shown in parentheses. The effect of a one standard deviation change in OV is shown in brackets (this is estimated as the effect of increasing inclusive OV from the current value –0.5 std. dev. to the current value +0.5 std. dev.).

Table 1.3B **Effect of percent gain in inclusive OV on retirement by education group**

					Specification			
	No. of obs.	Mean ret. rate	Mean of % OV	Std. dev. of % OV	(1)	(2)	(3)	(4)
OV: < High school	9,864	0.109	0.550	2.171	–0.0229	–0.0213	–0.0242	–0.0224
					(.0165)	(.0154)	(.0174)	(.0162)
OV: High school	22,875	0.086	0.602	0.668	–0.0785	–0.0756	–0.0858	–0.0829
					(.0085)	(.0082)	(.0087)	(.0084)
OV: Some college	14,989	0.070	0.767	0.955	–0.0581	–0.0564	–0.0628	–0.0611
					(0.0046)	(0.0044)	(0.0046)	(0.0044)
OV: College	15,836	0.060	0.819	0.840	–0.0487	–0.0475	–0.0515	–0.0504
					(.0037)	(.0037)	(.0037)	(.0037)
Linear age					X		X	
Age dummies						X		X
Other Xs							X	X

Notes: Models are the same as models 1–4 in table 1.1, but are estimated separately by education group; each coefficient on the table is from a different regression. Coefficients are marginal effects. Standard errors are shown in parentheses.

the effect of changes to the DI program. Such simulations are also another way to gauge whether the magnitude of the estimated effects seems sensible. Note that the simulations discussed below are not intended to reflect likely real-world changes to the DI program, but rather to give some sense of the program's importance for labor supply decisions.

I undertake several simulations, all of which essentially amount to reducing the likelihood that workers are able to access the DI path. The results of the simulations are shown in figures 1.5A and 1.5B. The first set of bars on figure 1.5A show the predicted work life expectancy if individuals may only consider retiring along the SS path versus along the DI path. To elaborate on how this calculation is made, I first use the regression estimates from table 1.1A specification (4), to predict each individual's probability of retirement using OVDI (or equivalently, setting DIprobability to 1 and recomputing OVInclusive) and using OVSS (setting DIprobability to 0). I then sum the predicted probability of retirement by age for the whole sample under each scenario and retain the mean value, using this to generate a survival function and using the survival function to estimate the average expected remaining work life.

This calculation yields the prediction that on average, individuals age fifty would work for an additional 11.9 years if SS were the only pathway to retirement versus 10.2 years if DI were the only path. Relative to the expected work life (after age forty-nine) when DI is the only path, workers work 17.3 percent longer when they must retire through SS—this figure is reported on figure 1.5B.

The second set of bars repeats this calculation using only those individuals who ever apply for DI. In general, they are in worse health, so their projected remaining work life is smaller than that for the full sample, whether contemplating retiring via SS or DI. But the increase in work life when access to the DI path is turned from off to on is fairly similar to that for the whole sample, 15.7 percent. The remaining two calculations are similar but reflect the fact that it is unlikely that the DI program would be eliminated entirely in the real world. Rather, it is more likely that the medical screening might be tightened, as it was in the late 1970s. Thus I estimate the effect if access to DI were lost for two-thirds of DI applicants (third set of columns) or for one-third of DI applicants (last set of columns). Naturally, the projected effects of these program changes are smaller than that of eliminating DI entirely—they are projected to increase the labor supply of the DI applicant pool by 10.1 percent and 5.0 percent, respectively. Since DI applicants make up only a fraction of the total population, the effect on aggregate labor supply (not estimated here) would be smaller.

In conclusion, this study revisits the question of how retirement incentives arising from the structure of Social Security affect retirement decisions, expanding on earlier work that focused on Social Security retired worker

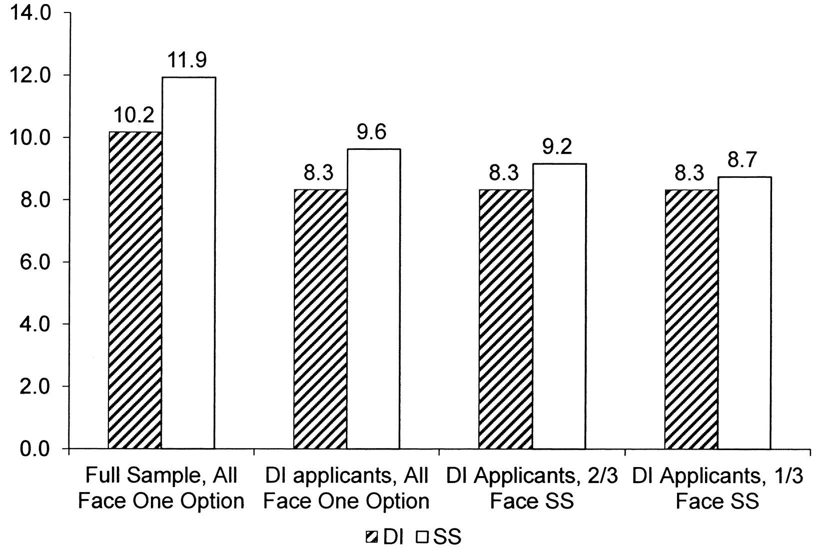

Fig. 1.5A Expected years of work life on SS versus DI path

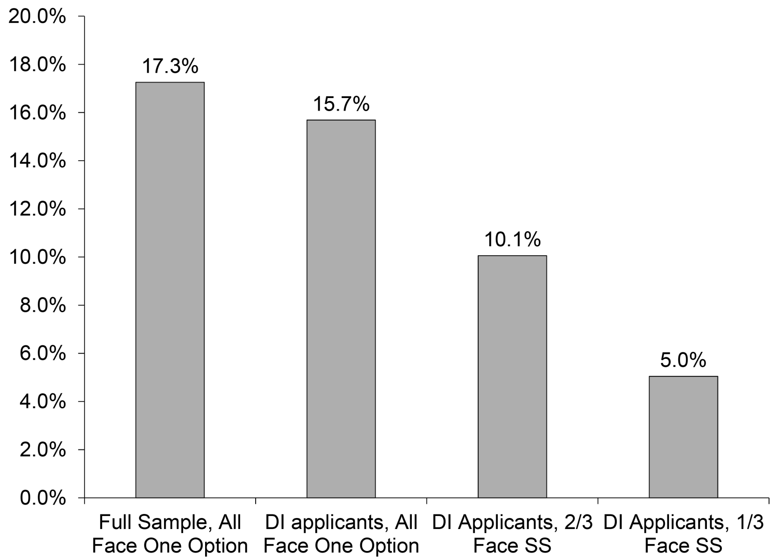

Fig. 1.5B Change in expected work life

benefits to incorporate the incentives from the disability insurance program, which previously had been ignored. The chapter uses a new inclusive option value measure to explore this question, in which the incentives from Social Security (SS) and disability insurance (DI) are combined into a single incentive measure.

The chapter has several key findings. First, descriptive statistics on DI participation reveal that there is a strong link between education and DI take-up, even once one controls for health. This is consistent with past work suggesting that rising income inequality and unemployment influence DI application decisions. Second, the inclusive OV measure has a negative and significant effect on retirement. Effects are robust to specification choice and are stronger for those in poor health or with low education, perhaps reflecting that they are more actively considering retirement. Finally, the simulations suggest that a large change in the probability that the DI path is available would have a sizable effect on the expected work life of the DI applicant pool. An important implication of these findings is that if the United States were to tighten eligibility for DI, as was done in the late 1970s, individuals still in the labor force at age fifty would be expected to respond by working longer, though there would almost certainly be heterogeneity in workers' ability to respond in this way and losses in lifetime income as a result.

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