Work incentives in the Social Security Disability benefit formula*

GOPI SHAH GODA AND JOHN B. SHOVEN

Stanford University and NBER, Stanford, California, USA

SITA NATARAJ SLAVOV

George Mason University and NBER, Arlington, Virginia, USA
(*e-mail:* sslavov@gmu.edu)

Abstract

We examine the connection between taxes paid and benefits accrued under the Social Security Disability Insurance (SSDI) program on both the intensive and extensive margins. We perform these calculations for stylized workers given the existing benefit structure and disability hazard rates. On the intensive margin, we examine the effect of an additional dollar of earnings on the marginal payroll taxes contributed and future benefits earned. We find that the present discounted value of disability benefits received from an additional dollar of earnings, net of the SSDI payroll tax, generally declines with age, becoming negative around age 40 and reaching almost zero at age 63. On the extensive margin, we determine the effect of working an additional year on the additional payroll taxes and future benefits as a percentage of income. The return to working an additional year at an income level just large enough to earn Social Security credits for the year is large and positive through age 60. However, the return to working an additional full year is substantially smaller and becomes negative at approximately age 57. Thus, older workers face strong incentives to earn enough to obtain creditable coverage through age 60, but they face disincentives for additional earnings. In addition, workers aged 61 and older face work disincentives at any level of earnings. We repeat this analysis for stylized workers at different levels of earnings and find that, while the program transfers resources from high earners to low earners, the workers experience similar patterns in the returns to working.

JEL CODES: H31, H53, J22, J26

Keywords: Social Security Disability Insurance, tax rates, work incentives, retirement, older workers.

1 Introduction

The Social Security Disability Insurance (SSDI) program received approximately $119 billion in payroll tax contributions and paid approximately $143 billion in benefit payments in 2015 (Social Security Administration Board of Trustees, 2016,

---

Table 4. A2). According to projections, the SSDI trust fund will be depleted in 2023, and the program will no longer be able to pay benefits as scheduled. The economic efficiency of the program depends heavily on several factors, including, for instance, the relationship between economic conditions and benefit applications and awards and the capacity of SSDI recipients to continue working (Autor and Duggan, 2003; Maestas *et al.*, 2013). In this paper, we examine another aspect of the efficiency of the program, namely the retirement incentives for healthy older workers that arise from the tax and benefit structure of the program. This aspect is important given policy makers' interest in extending working lives in order to shore up entitlement programs and improve retirement security. To the extent that contributions toward payroll taxes differ from the present discounted value of expected benefits earned by those contributions, the SSDI portion of payroll taxes (equal to 1.8% of earnings) may create work incentives or disincentives. Work incentives could arise if the additional benefits earned from additional payroll taxes paid are larger than the payroll taxes paid, and disincentives could result from little or no additional benefits earned from additional contributions.[1]

We use stylized earnings histories and population disability hazard rates to illustrate the extensive margin work incentives from participating in the labor force for an additional year as measured by the expected value of additional SSDI benefits from additional earnings. The eligibility requirements to qualify for disability benefits stipulate that an individual must have worked 5 of the most recent 10 years. Thus, for an individual who has worked continuously, extending his or her career by 1 year is equivalent to purchasing a 1-year term disability insurance policy 5 years into the future. The value of this policy depends on the probability of becoming disabled during that year, the annual benefit amount that would be paid, and the length of the benefit period over which the benefit would be paid. While the probability of becoming disabled increases with age, the length of time a person is expected to receive disability benefits declines. Overall, our results show that the expected present value of benefits declines with age for individuals 50 and older, as the increase in expected benefits from the higher probability of being disabled is outweighed by the reduction in expected benefits from the shorter potential benefit horizon.

The size of the extensive margin benefit relative to the SSDI payroll tax depends on the amount of income earned during the additional year of work. On the one hand, if a worker earns the minimum required to extend eligibility under SSDI, the return on working an additional year can be substantial, equal to more than 35% of the additional earnings at age 50. However, the return rapidly declines with age and becomes negative at age 61. On the other hand, an additional full year of earnings provides a much more modest return net of the 1.8% payroll tax, equal to <1.5% of earnings at age 50 and becoming negative by age 57. This difference occurs because the extension of eligibility does not depend on the amount earned during the additional year of work. Thus, earning more than the minimum required to extend eligibility does not provide much additional benefit. This is confirmed by a calculation of the intensive

---

[1] Our estimates of the expected present value of SSDI likely understate the value of the program to risk-averse individuals, who benefit from the insurance aspect of the program.

margin return to work – the net benefit from earning an additional dollar – which is negative for all workers 50 and older.[2]

In either scenario, after one reaches age 62, the value of the 1-year term disability insurance policy 5 years into the future is zero. At this point, eligibility is already guaranteed through normal retirement age, and the 1-year extension of the eligibility window occurs after normal retirement age. Thus, individuals who become disabled during the additional year of eligibility are simply paid the retirement benefit to which they would be entitled anyway. Although earnings at ages 62–65 (if they are large enough) can still boost any disability benefits claimed before normal retirement age, this effect is small, and the 1.8% payroll tax is almost a pure tax on work at these higher ages.

We repeat this analysis for stylized workers at different levels of earnings. We assume that workers with higher levels of earnings have lower probabilities of becoming disabled, using differences in disability hazards by education as a proxy (von Wachter, 2012). We find that the SSDI program provides high-earning individuals with lower returns from working on the intensive and extensive margins; this difference results from the group's lower disability hazards and higher levels of earnings combined with the progressive nature of the benefit formula. However, the patterns of retirement incentives discussed here persist for all earnings groups.

A number of other papers have examined work and retirement incentives at older ages that arise from the Social Security retirement program, focusing on both the intensive (e.g., Feldstein and Samwick 1992; Cushing 2005) and extensive (e.g., Butrica *et al.*, 2006; Goda *et al.*, 2009; Reznik *et al.*, 2009) margins. Other studies have examined work and retirement incentives in employer-sponsored pensions (e.g., Kotlikoff and Wise 1985, 1987; Stock and Wise 1988; Butrica *et al.*, 2006), retiree health insurance (e.g., Gruber and Madrian 1995; Blau and Gilleskie 2001; French and Jones 2011; Kapur and Rogowski 2011; Marton and Woodbury 2012; Nyce *et al.*, 2013), and Medicare (Glied and Stabile, 2001; Goda *et al*., 2007). The main conclusion from this literature is that older workers can face strong work disincentives from the pattern of benefit accrual in the Social Security retirement programs and private pensions, from the availability of group health coverage that is independent of employment (such as retiree health insurance or Medicare), and from the Medicare as secondary payer policy that effectively forces Medicare-eligible individuals who work for an employer that offers health insurance to give up their Medicare coverage. The studies of extensive margin incentives in the Social Security retirement program have shown that the implicit tax from working an additional year generally increases with age because benefit accrual declines after 35 years

---

[2] As a person ages, both retirement age and the end of life get closer. Disability benefits convert to retirement benefits at the normal retirement age. These retirement benefits are higher than the retirement benefits that someone who is ineligible for disability, and who has the same earnings history, could collect at normal retirement age. This is because individuals who are eligible for disability are not penalized for zero (or low) earnings during years of disability. Our calculations take into account this postretirement net increase in benefits because of disability insurance. However, the net benefit from disability insurance is clearly smaller once retirement benefits are available; after this point, SSDI simply boosts retirement benefits that could have been received even without disability insurance. Thus, the stream of income from disability insurance drops at normal retirement age and ends at death.

of work, after which additional years of earnings are unlikely to have a big effect on future retirement benefits.

Our work here is probably most directly related to Cushing (2005), who describes the work incentives on the intensive margin for both disability and retirement benefits. Cushing finds that the disability program creates strong intensive margin work disincentives for older workers because additional earnings have only a small impact on expected future benefits. This occurs because disability benefits are based on workers' average wages until the year of disability (so earnings later in life have a smaller impact on the average), and the fact that older workers who qualify for disability receive benefits for a shorter period. Eligibility is not a factor since the decision to earn an additional dollar does not affect eligibility for workers who are already above the minimum required to earn credits. We extend this work by calculating extensive margin work incentives, which are most relevant to the decision to retire versus continue working. We show that extensive margin work incentives can be quite different from intensive margin ones, and that these incentives result mainly from eligibility rules.

The remainder of this paper proceeds as follows. Section 2 describes the relevant aspects of the SSDI program, including eligibility for benefits and the calculation of benefits. We also describe the data sources that we use to construct stylized earnings profiles, disability, and mortality hazards. Section 3 describes how we calculate the present discounted value of additional benefits earned from an additional year of work. Section 4 presents results for average earners and high and low earners, and Section 5 discusses policies that could change the incentives faced by workers. Section 6 provides our conclusions.

2 Background and data

2.1 SSDI financing and benefit calculations

The SSDI program is financed by a payroll tax levied on employees and employers equal to 0.90% of earnings each, for a total of 1.8% of earnings. Economists generally believe that the incidence of both the employee and the employer portions of the payroll tax falls on workers; that is, after-tax earnings would be 1.8% higher without the SSDI program. All earnings below a taxable maximum, which is $118,500 in 2015 and 2016, and increases each year with the average wage index (AWI), are subject to the SSDI tax. Earnings above the taxable maximum are not subject to Social Security taxes and do not contribute to calculated benefits.

Disability benefits are paid by Social Security to people who 'cannot work because they have a medical condition that is expected to last at least 1 year or result in death' (Social Security Administration, 2015). The application process is lengthy and involves several steps to classify individuals as disabled and unable to work. In this paper, we do not focus on the criteria for determining disability, but rather on how earnings before disability onset affect eligibility for SSDI and the benefits received under the program.[3]

---

[3] Applicants are reviewed based on their capacity to work and the severity and type of their medical condition. This process generally takes 3–5 months. Readers interested in the application procedures and criteria for disability are referred to Social Security Administration (2014).

Qualifying for disability benefits requires individuals to meet an insured-status requirement that ensures they have worked long enough and recently enough. An individual receives a Social Security credit for one-quarter of work by earning a minimum amount of income. The minimum amount of income was $1,220 in 2015 (the year in which our stylized workers are assumed to enter the labor force) and increases each year with average wages. Up to four credits can be earned each year. Insured status is met by passing a 'recent work' test and a 'duration of work' test. The requirements for passing the recent work test and the duration of work test depend on the age at which a person becomes disabled and are summarized in Tables 1 and 2. While the qualification rules for eligibility before age 31 are somewhat different, an individual who becomes disabled at age 31 or older must have worked during 5 of the previous 10 years in order to pass the recent work test. This rule essentially implies that someone who has worked for several years before exiting the labor market will continue to have eligibility for another 5 years. This requirement is the main driver of work incentives on the extensive margin, as each additional year worked extends eligibility by 1 year.

Work incentives are also affected by how benefits are calculated if one is deemed to be disabled. The computation of disability benefits is somewhat similar to the computation of retirement benefits under Social Security, but differs in some important ways. SSDI benefits are calculated based on the worker's average indexed monthly earnings (AIME). The AIME is calculated in a series of steps. First, annual covered earnings are indexed either to the second calendar year before the year of disability or to the year in which the individual turns age 60, whichever is earlier. The indexing is performed using the AWI, which reflects economy-wide average wage growth and is updated each year by the Social Security Administration (SSA). Our simulations assume that the AWI increases by 3.83% per year, in line with the intermediate assumption of the *2014 Social Security Trustees Report* (SSA Board of Trustees 2014) regarding the long-run growth rate of covered wages. Earnings in years after the indexing year are counted at their nominal value. Second, the number of computation years is determined. The number of years of earnings used to calculate the AIME is the number of full calendar years elapsed between age 21 and the year of disability, less the number of dropout years. One dropout year is allowed for every 5 years elapsed, up to a maximum of 5 dropout years.[4] The number of computation years must be at least 2 and at most 35. Finally, the highest years' indexed earnings are summed and divided by the number of months in the computation period. For example, consider someone who began working upon turning age 18 and became disabled upon turning age 39. The number of full calendar years between ages 21 and 39 is 17.[5] One dropout year is allowed for each of the three full 5-year periods in 17 years. Therefore, the person's 14 highest indexed years of earnings would be averaged to calculate the AIME.

---

[4] The number of dropout years may be increased based on years spent on child care. However, because we focus on stylized workers, we ignore this provision.

[5] These are the 17 calendar years in which the individual turned ages 22 through 38. The years in which the individual turned 21 and 39 are partial calendar years.

Table 1. *Recent work test*

If you become disabled …	Then you generally need …
… in or before the quarter you turn age 24.	… 1.5 years of work during the 3-year period ending with the quarter your disability began.
… in the quarter after you turn age 24 but before the quarter you turn age 31.	… to work during half the time for the period beginning with the quarter after you turned age 21 and ending with the quarter you became disabled.
… in the quarter you turn age 31 or later.	… to work during 5 years out of the 10-year period ending with the quarter your disability began.

Source: Social Security Administration, Disability Benefits (Washington, DC: Social Security Administration, 2015), http://www.ssa.gov/pubs/EN-05-10029.pdf.

Table 2. *Duration of work test*

Age of disability	Number of years of work needed
Before 28	1.5
30	2
34	3
38	4
42	5
44	5.5
46	6
48	6.5
50	7
52	7.5
54	8
56	8.5
58	9
60	9.5

Source: Social Security Administration, Disability Benefits (Washington, DC: Social Security Administration, 2015), http://www.ssa.gov/pubs/EN-05-10029.pdf.
Note: The table does not cover all situations.

The AIME is then translated to a monthly benefit amount, known as the primary insurance amount (PIA). This translation occurs through a non-linear formula that provides a proportionally higher PIA for individuals with lower AIMEs. For workers who become disabled in 2015 (the year in which our stylized workers start their careers), the PIA equals the sum of 90% of the first $826 of AIME, 32% of the next $4,154 of AIME, and 15% of AIME over $4,980. These dollar thresholds – or 'bend points' – used to calculate PIA change each year with the AWI. The PIA calculation uses the bend points that are in place during the year of disability or the year in which the individual turns 62, whichever is sooner. Cost of living adjustments (COLAs) are applied to the PIA each year after it is calculated. Our simulations

assume that future COLAs are 2.7% per year, in line with the long-run inflation assumption made in the intermediate scenario of the 2014 Trustees report (SSA Board of Trustees 2014).

Disabled beneficiaries are paid the PIA initially in the sixth month after disability occurs and until either recovery or attainment of normal retirement age, whichever comes first.[6] Once a beneficiary attains normal retirement age, disability benefits are converted to retired worker benefits. However, the period of disability affects the calculation of retired worker benefits as years of disability are disregarded in the retirement PIA calculation. Thus, the level of benefits does not change at normal retirement age, and the presence of SSDI boosts retirement benefits relative to what could have been received by a worker with an identical earnings history who is ineligible for disability.

2.2 *Stylized earnings*

We perform our analysis on stylized earnings histories to plainly illustrate the effect of program rules on work incentives. Our stylized-earnings histories are based on a methodology developed by the SSA Office of the Chief Actuary, which produces hypothetical earnings histories to illustrate a variety of different features of the Social Security program, including benefit levels, replacement rates, money's worth measures, and internal rates of return (Clingman and Burkhalter, 2014). Please note that, while stylized earnings isolate the effect of program rules, they do not reflect years spent out of the labor force or fluctuations in earnings levels over one's career.

The Office of the Chief Actuary develops a set of *scaled factors*, on which their stylized earnings histories are based, through a series of steps. Using earnings from the Continuous Work History Sample, *raw scaled factors* are calculated by taking the ratio of average earnings at each age relative to the economy-wide AWI in each particular year. This type of calculation is superior to one that assumes workers earn a constant percentage of the AWI each year throughout their careers, as that method tends to ignore the life-cycle patterns of earnings that are typically low for younger and older ages and higher during prime working ages. An adjustment is applied to the raw factors for ages 62 and older to account for the fact that workers who tend to work beyond age 62 in the data may be selected from a non-representative sample. The factors are also multiplied by the percentage of individuals at each age who are working to make them representative of all individuals, working or non-working.

We generate stylized earnings histories by starting with these scaled factors and modifying them as follows. First, we adjust the factors to be representative of someone who works in each year of life and therefore divide by the percentage of individuals with earnings at each age. Second, we are interested in simulating earnings for a wider set of ages (18–66) than is provided by the SSA (21–64), so we make

---

[6] Auxiliary disability benefits may also be payable to children and spouses of disabled workers, who are not taken into account in this analysis because of the focus on stylized earners. This omission would lead us to underestimate the returns to working for individuals with dependents, particularly those with young children who could receive auxiliary benefits for several years.

some assumptions to extend the series. In particular, we assume that workers earn the same percentage of the AWI at ages 18–20 as they earn at age 21 and that the same fraction of individuals work at ages 18–20 as at age 21. We assume that 65- and 66-year-olds earn the same nominal earnings as someone age 61 (an assumption similar to what SSA uses for earnings after age 61). We also assume that the same percentage of individuals works at ages 65 and 66 as at age 64. While these assumptions are not completely plausible, our results are insensitive to reasonable changes in the stylized earnings levels for these years. Finally, we convert the earnings histories to the 1997 cohort (which turns 18 in 2015) using a projected AWI increase of 3.83% per year.

2.3 Disability and mortality hazards

We use disability incidence rates and mortality hazards to determine the expected present value of changes in SSDI resulting from additional earnings or career length. Disability incidence rates are drawn from Table 4 of Zayatz (2011), which reports awards per thousand by age, year of award, and gender for years between 1986 and 2009. We use the incidence rates for 2009 in our simulations. These incidence rates are reported in 5-year age intervals, from ages 15–19 through ages 60–64. There is also an incidence rate reported for age 65+. The 5-year age buckets create artificial discontinuities from one interval to the next. Therefore, we smooth the incidence rates by assuming the values shown apply to the midpoint of each 5-year interval (e.g., the incidence rate for the age 20–24 age bucket applies to age 22) and by linearly interpolating from one point to the next. The incidence rate for age 65+ is assumed to apply at age 67, the last year in our model. This allows us to interpolate between age 62 (based on the 60–64 incidence rate) and age 67. The resulting incidence rates for 2009, which we use in our simulations, are shown in Figure 1. Disability incidence rates increase with age until age 62 but then decline. The decline after age 62 likely reflects the fact that many disabled individuals simply stop working and claim retirement benefits.

Mortality hazards for disabled individuals differ by age and by the length of time one is disabled. Zayatz (2011), in Tables 8A–8C, reports survival tables for male and female disabled workers based on data during 2001–2005. These appear to be based on period, rather than cohort, mortality, but to our knowledge, this is the best available data on mortality for disabled individuals. We use these survival probabilities to discount any income received during years of disability to the year in which the individual became disabled. Survival probabilities for non-disabled individuals are based on 1997 birth cohort mortality tables from the intermediate scenario of the *2013 Social Security Trustees Report* (SSA Board of Trustees 2013). We combine the disabled and non-disabled survival probabilities to discount the expected value of any potential future disability awards. For example, consider the risk that a 50-year-old faces of becoming disabled at age 55. In calculating the expected present value of the disability award that would be received in this scenario, the disabled survivor probabilities are used to discount income received after age 55 to the year in which the individual is age 55. The non-disabled survivor probabilities are used to further
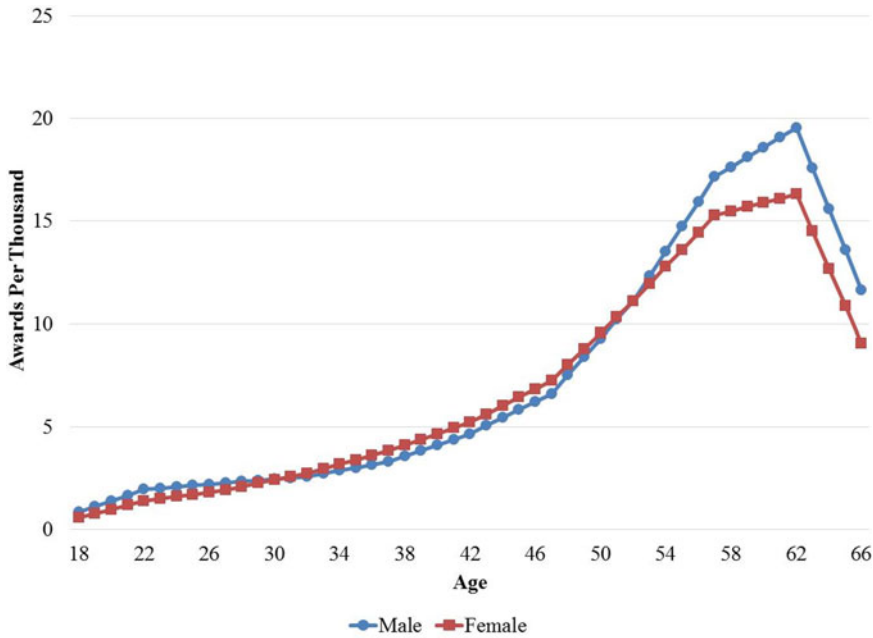
Figure 1. (Colour online) Disability incidence rates, 2009.
Source: Zayatz (2011), Table 4.
Note: Rates are linearly interpolated within 5-year age intervals.

discount this amount to the year in which the individual is age 50. The disabled survival probabilities vary greatly from the non-disabled survival probabilities. For example, the Zayetz table indicates that of 96,912 men who become disabled at age 33,79,551 survive to age 43, a survival rate of 82.1%. In contrast, the SSA cohort mortality table suggests that 98.5% of 33-year-old men survive to age 43.

2.4 Differences by earnings

We are interested in examining how work incentives vary for workers with different levels of earnings, which are also likely to be associated with different levels of disability incidence rates.

The Office of the Chief Actuary reports scaled factors that represent workers with career-average earnings levels equal to 25%, 45%, 100%, and 160% of the AWI. These factors simply shift the age-earnings profile up or down by a proportionate amount at each age. We refer to workers with career earnings equal to the AWI as 'average' workers. Workers with career earnings equal to 25%, 45%, and 160% of the AWI are referred to as 'very low', 'low', and 'high' earners, respectively. The stylized earnings profiles for each of the four earner types are shown in Figure 2.[7]

---

[7] We adjust earnings levels slightly for the low-income earner so that a full year of work is enough to gain four Social Security credits.
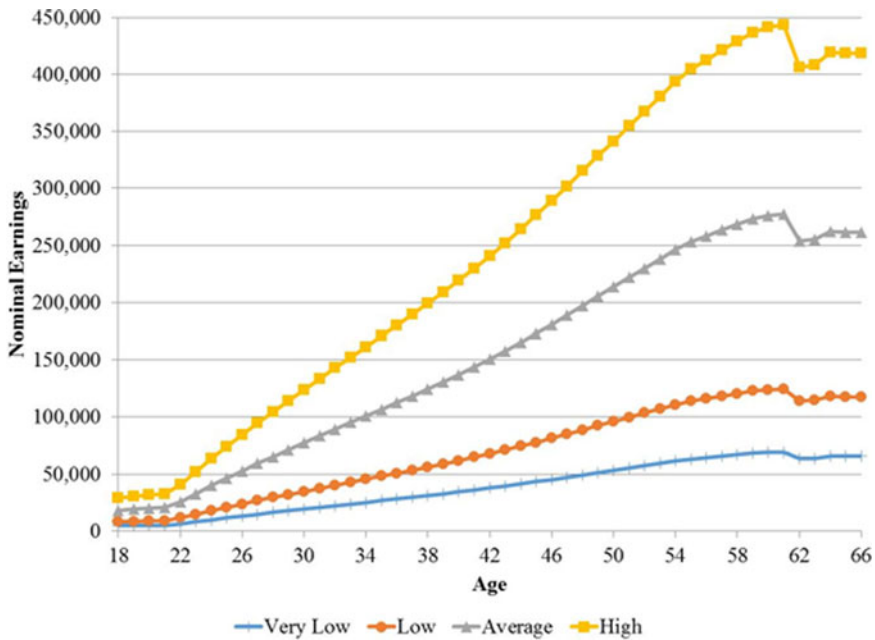
Figure 2. (Colour online) Stylized earnings profiles.
Source: Authors' calculations based on Clingman and Burkhalter (2014), for cohort born in 1997. See text for details.

We combine these earnings profiles with information from von Wachter (2012) about disability incidence by education, reproduced in Table 3. Von Wachter uses Current Population Survey data to report how incidence rates differ by education. We assume that the differences in incidence rates by education roughly correspond to differences in incidence rates by earnings levels as follows: the worker with career earnings equal to 25% of the AWI has disability incidence rates similar to those among individuals with less than a high school education, the worker with career earnings equal to 45% of the AWI has disability incidence rates similar to those among individuals with a high school education, the worker with career earnings equal to the AWI has disability incidence rates similar to those among individuals who have completed some college, and the worker with career earnings equal to 160% of the AWI has incidence rates similar to those among individuals with a college education or more. We use ratios from Table 3 to generate incidence rates by earnings that imply the same proportional differences in incidence by education that are reported by von Wachter (2012), assuming that individuals with some college reflect the incidence rates for average earners.[8] For instance, to generate incidence rates for very low earners, whom we assume to have disability hazards similar to

---

[8] The table presents three alternative sets of incidence rates based on different measures of SSDI receipt. We use the first measure reported, believed to be the most accurate. This measure counts individuals as receiving SSDI if they are receiving Social Security benefits for the reason of disability and are age 64 or younger.

Table 3. *Disability incidence rates by educational attainment*

Education category	SSDI incidence, %
Less than high school	0.79
Equal high school	0.57
Some college	0.37
College or beyond	0.17

Source: Reproduced from von Wachter (2012), using first definition of SSDI receipt, which counts a person as receiving SSDI if the reason for receiving Social Security benefits is disability and the person is under age 64.

those with less than a high school education, we multiply the incidence rates in Figure 1 by (0.79/0.37).

3 Methodology

3.1 Calculating the expected value of SSDI

We assume that each stylized earner was born on January 2, 1997,[9] that decisions about labor force participation and earnings for each year are made at the beginning of the year, and that disability may occur on any subsequent birthday. Individuals in the 1997 birth cohort turn 18 in 2015 and have a normal retirement age of 67. We assume that work begins at age 18 and ends upon either disability or reaching age 67, whichever is sooner. We also assume that, once disabled, an individual remains disabled for the remainder of life; that is, we ignore the possibility of recovery.[10] We focus on work incentives at ages 50 and older, as the extensive margin work decision we consider – extending work by an additional year versus retiring now – is not likely to be relevant for younger workers.

Mathematically, the expected present value of SSDI benefits in the event of disability starting at age a, and discounted to the year in which the individual turns a, is given by the following:

$$B_a(E_{a-1}) = \sum_{t=a}^{T} \frac{s_t^{d,a} b_t(E_{a-1})}{[(1+r)(1+\pi)]^{t-a}} - \sum_{t=\max(62,a)}^{T} \frac{s_t^{d,a} b_t^R(E_{a-1})}{[(1+r)(1+\pi)]^{t-a}}. \tag{1}$$

Here $E_{a-1} = (e_{18}, e_{19}, \ldots, e_{a-1})$ is the vector of earnings from age 18 through age $a-1$; $s_t^{d,a}$ is the probability of a disabled person surviving to age t conditional on having

---

[9] Our calculations are simplified if calendar years coincide with ages. Under Social Security rules, individuals born on the first of a month are treated as though they were born in the previous month. Thus, January 2 effectively corresponds to the start of the calendar year. See Social Security Administration (2008) for details.

[10] Allowing for the possibility of recovery significantly increases the dimensionality of the problem. Assuming that disability is permanent overstates the present discounted value of SSDI. In practice, the probability of recovery is <1% each year (Autor 2011). But if the probability of recovery varies with age, it may also bias our estimates of the pattern of work incentives over the life cycle. However, we note that our estimates of intensive margin work incentives are similar to those of Cushing (2005), who allows for the possibility of recovery, suggesting that any bias is small.

survived to age a (so, in the first term, $s_a^{d,a} = 1$); r is the real interest rate; π is the inflation rate; and t is the maximum possible lifespan (assumed to be 110 years). In the first term, b_t is the SSDI or converted retirement benefit received at age t; the SSDI benefit received in the first year is assumed to begin in June because of the 5-month waiting period, and COLAs are applied to benefits in subsequent years. Note that the first term includes payments made at or after normal retirement age, which are technically classified as retirement benefits. While these benefits are generally higher than the retirement benefits that would be available to someone who is not eligible for disability, the value of maintaining eligibility for disability insurance is only the net gain in benefits relative to what would already be available through the retirement program. The second term accounts for this. In this term, b_t^R denotes the retirement benefit that could be received at age t by an ineligible individual with the same earnings history (i.e., with an earnings history in which work stops at the age of disability). The retirement benefit is assumed to be claimed at either age 62 or the age at which earnings stop, whichever is later.[11,12] The appropriate actuarial reduction is applied for claims made before normal retirement age, and COLAs are applied to retirement benefits paid after age 62. In this formula, the real interest rate is set to 2.9%, in line with the long-run intermediate assumption made in the 2014 Trustees report (SSA Board of Trustees, 2014). The inflation rate is set to 2.7%, the same value used for the COLAs.

Now consider an individual currently age i who faces a risk of disability onset at any future age $a = i + 1$, $i + 2$, …, 66. The expected present discounted value of disability coverage for this individual is

$$EV_i(E) = \sum_{a=i+1}^{66} \frac{I_a p_a s_a^{n,i} B_a(E_{a-1})}{[(1 + r)(1 + \pi)]^{a-i}}. \tag{2}$$

Here, $E = (e_{18}, e_{19}, \ldots, e_{66})$ is the full earnings history from age 18 to age 66 assuming that no disability occurs, I_a is an indicator equal to 1 if the individual is eligible for SSDI at age a and 0 otherwise, $s_a^{n,i}$ is the probability that a non-disabled person survives to age a conditional on survival to age i, and p_a is the probability of becoming disabled at age a. In other words, the overall expected value of SSDI is the discounted sum of the expected value of SSDI across all possible future ages of disability onset.

For example, consider a male average earner (i.e., someone with career-average earnings equal to the AWI) who begins work at age 18. Suppose this individual becomes disabled at age 64 (in January 2061). Earnings are indexed to their 2057 level (the year of turning 60). AIME is $23,834.78 and PIA is $10,131.01.[13] This PIA calculation assumes that the 2015 bend points of $826 and $4,980 are increased

---

[11] In general, individuals have to be age 62 throughout the entire first month in which they begin an early benefit. For most people, this means that benefits can begin only the month after they turn 62. However, individuals who were born on the second day of the month, like our stylized workers, are treated as though they turned age 62 on the first day of the month and can thus receive benefits during the month in which they turn 62. See Olson (1999) for details.

[12] Note that we are implicitly assuming that, should disability occur, an individual is forced to stop working regardless of eligibility for disability insurance. In other words, an ineligible person's only choice upon becoming disabled is to stop working and wait to claim retirement benefits.

[13] For simplicity, we ignore the SSA's practice of rounding PIAs down to the nearest 10 cents.

by 3.83% per year, reflecting growth in the AWI. The individual receives his or her PIA during each of the last 7 months of 2061 (reflecting the 5-month delay period). In subsequent years, the individual receives the PIA each month, with the addition of a 2.7% COLA for each year after 2061. If the worker was not eligible for disability, he could claim a retirement benefit of $8,548.38 per month starting immediately, with COLAs added in subsequent years.[14] SSDI provides income only to the extent that it boosts that amount.[15] Discounting the stream of income from SSDI, net of what would be available anyway from the retirement program, produces a sum of $168,194.95. The large difference is because an individual who claims disability at age 64 does not face an actuarial reduction in benefits for claiming 3 years before full retirement age, while the person who claims retirement benefits at age 64 does.[16] This value is $B_{64}(E_{63})$ from Equation (1), the expected present value of SSDI if disability occurs at age 63. A similar calculation can be performed for every potential age of disability onset from 50 through 66. From the perspective of any age i, taking the expectation of $B_a(E_{a-1})$ across all future ages $(a > i)$ produces $EV_i(E)$ from Equation (2).

To calculate the extensive margin work incentive at each age i, we assume that individuals have worked until age $i - 1$ and received earnings according to the profiles in Figure 2. Then, we examine the effect of working for an additional year compared with stopping work forever. That is, we calculate

$$Extensive\ margin_i = \frac{EV_i(e_{18}, \ldots, e_i, 0, \ldots, 0) - EV_i(e_{18}, \ldots, e_{i-1}, 0, \ldots, 0)}{e_i}. \quad (3)$$

We consider two alternative assumptions about e_i, the earnings in the additional year of work. First, we assume that the individual earns the minimum amount required to earn four-quarters worth of Social Security credits for the year. This minimum amount is $4,880 (i.e., $1,220 × 4) in 2015, and we assume it increases by 3.83% per year, in line with expected increases in the AWI, in each subsequent year.[17] In other words, the individual earns just enough to extend eligibility under the recent work test. This calculation captures the effect of working at the minimum income versus not working, and we refer to it as the *minimum earnings extensive margin*. Second, we assume the individual earns the amount specified in the stylized earnings profile. This calculation captures the effect of working a full year versus not working, and we refer to it as the *full earnings extensive margin*.[18]

An additional year of work can have two effects on expected disability benefits: it can extend eligibility, and it can raise benefits received during years of existing

---

[14] The AIME and PIA are the same as for the disability calculation. However, an individual who claims Social Security 3 years before normal retirement age receives 80% of the PIA, plus 2 years' worth of cost-of-living adjustments for ages 63 and 64.

[15] Because there is no waiting period for retirement benefits, SSDI lowers income during the first year of disability if disability occurs at age 62 or later, but it raises income in all subsequent years.

[16] This amount is also large because it is expressed in 2061 (the year the individual turns 64) dollars. Therefore, it includes nominal wage growth over the individual's career (pre-2057 wages are indexed to 2057 wages, and subsequent wages count at their nominal value). It also includes 2 years of COLAs (for ages 62–64).

[17] We ignore the provision that minimum earnings amounts are rounded to the nearest $10.

[18] The stylized earnings profiles are actually based on average earnings for all workers, including those who work part time. In the extensive margin calculations, we refer to these earnings as 'full earnings' for convenience in distinguishing them from the minimum earnings required to extend SSDI eligibility.

eligibility. For example, consider a male average earner who has just turned 55 in January 2052 and has worked since age 18. This individual clearly meets the duration of work test shown in Table 2. Under the recent work test shown in Table 1, if this individual stops work now, eligibility for SSDI would continue for another 5 years, to age 60. On the other hand, if the individual continues working for an additional year and earns at least the minimum income required to earn credits, eligibility is extended for an additional year, to age 61. If the individual earns the minimum needed to continue eligibility, then the disability benefit that could be received at ages 56 through 60 remains the same as the additional year of earnings is small and therefore gets dropped from AIME calculation. But if the additional year of work represents a full year of earnings – that is, at the earnings specified in the earnings profile from Figure 2 – then the additional year of work also boosts SSDI benefits conditional on disability at ages 56 through 60 as well. Both of these effects are included in our calculations of the extensive margin.

For illustration, we also calculate the intensive margin work incentive for our stylized workers under the assumption that they work a full career, with the earnings profiles given in Figure 2. We examine the effect of increasing earnings by $1 at each age on the expected present value of SSDI benefits at that age. That is, for each age i, we calculate

$$
\begin{aligned}
Intensive\ margin_i = {} & EV_i(e_{18}, \ldots e_{i-1},\ e_i + 1,\ e_{i+1}, \ldots, e_{66}) \\
& - EV_i(e_{18}, \ldots e_{i-1},\ e_i,\ e_{i+1}, \ldots, e_{66}).
\end{aligned}
\tag{4}
$$

We calculate intensive margin incentives for workers at all ages since the choice to earn an additional dollar is also applicable to younger people.

For example, consider a male average earner (with career-average earnings equal to the AWI) who began work at 18, has just turned 24, and is considering earning an extra dollar during the coming year. This additional dollar changes the present value of SSDI benefits in subsequent years. For example, the value of future SSDI benefits conditional on disability onset at age 25 goes up by $2.17; this is the increase in $B_{25}(E_{24})$ from Equation (1). In fact, the expected value of SSDI – $B_a(E_{a-1})$ from Equation (1) – increases at all ages of disability onset until age 37. For disability onset at age 37 or later, earnings at age 24 get dropped and no longer increase SSDI payments – the first term in Equation (1). However, age 24 earnings do increase the retirement benefits that would be available anyway – the second term in Equation (1) – until age 59, as retirement benefits for non-disabled individuals are calculated based on the highest 35 years of earnings. Thus, an additional dollar of earnings reduces the net value of SSDI for onset between 37 and 59 and has no effect on the net value of SSDI for onset after age 59. Discounting and summing these changes in $B_a(E_{a-1})$ over all future possible dates of disability onset produces an increase of 1.97 cents (1.97% of the additional dollar earned) in the overall present discounted value of SSDI benefits. To examine the intensive margin work effort, we compare this value with the 1.8% SSDI payroll tax that would be paid on the extra dollar earned.
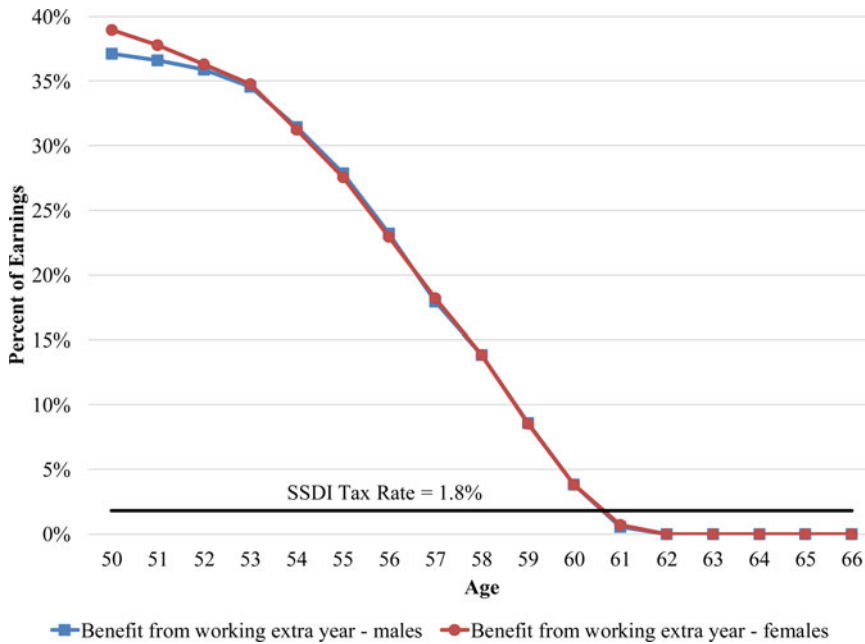
Figure 3. (Colour online) Minimum earnings extensive margin work incentives by gender (average earners).
Source: Authors' calculations based on Equation (3). Workers are assumed to earn the minimum amount required to earn Social Security credits during the additional year of work. See text for more details.

4 Results

4.1 Extensive margin work incentives

Figures 4 and 5 show the minimum earnings and full earnings extensive margin effects, respectively, for men and women by comparing the increase in the expected value of SSDI from working an additional year with the 1.8% SSDI payroll tax rate. For both extensive margins, each additional year of work extends eligibility by exactly 1 year (through age 62, at which point eligibility is guaranteed until retirement). The value of that additional year of eligibility varies as a result of two factors. First, the hazard of disability generally increases with age (at least until the early 60s), a factor that tends to increase the value of the additional year of eligibility. Second, the benefits awarded later in life are paid over a shorter period, a factor that tends to reduce the value of any benefits commenced during the extra year of eligibility. From age 50 onwards, the latter factor is larger, resulting in a declining benefit from an additional year of work.[19]

---

[19] The benefit from working an additional year increase until age 50. Results are not presented because a decision to stop work permanently is less likely to be relevant at these ages. However, they are available upon request.
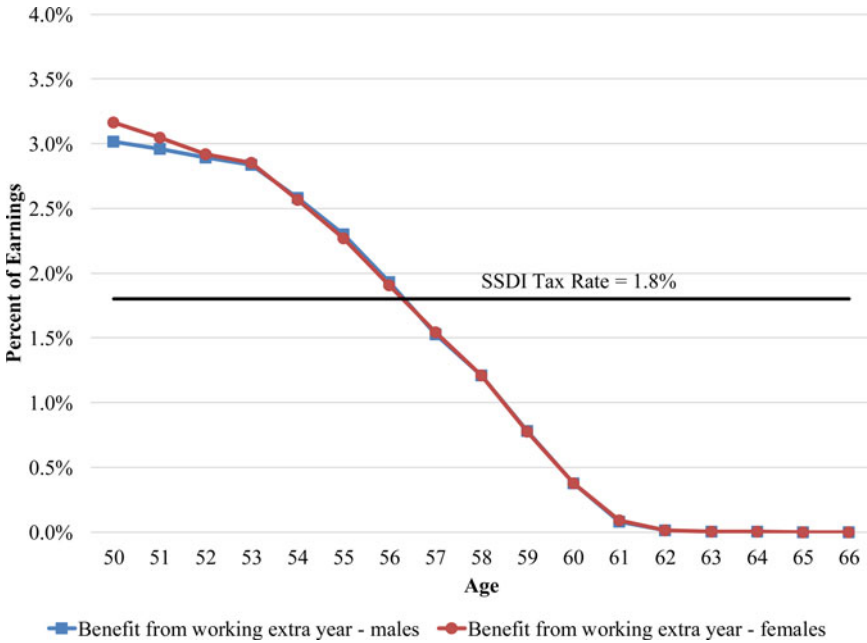
Figure 4. (Colour online) Full earnings extensive margin work incentives by gender (average earners).
Source: Authors' calculations based on Equation (3). Workers are assumed to earn the amount shown in the average earnings profile in Figure 2 during the additional year of work. See text for more details.
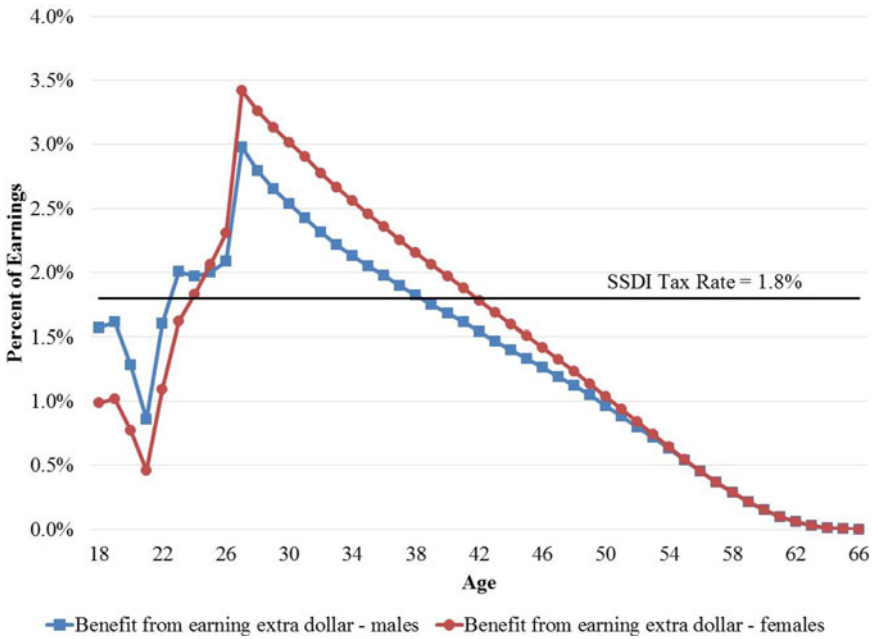

Figure 5. (Colour online) Intensive margin work incentives by gender (average earners).
Source: Authors' calculations based on Equation (4). See text for more details.

On the minimum earnings extensive margin (Figure 3), the benefit from an additional year of work is substantial for both men and women. At age 50, the return from working an additional year, net of the 1.8% payroll tax, is more than 35%. The value of an additional year of work drops below the 1.8% SSDI tax rate at age 61 for both men and women. It becomes zero at age 62 and later as the additional year of work at such a low level of income neither extends eligibility nor increases benefits in the event of disability. On the full earnings extensive margin (Figure 4), the benefit from an additional year of work is much more modest, starting at <1.5% of earnings (net of the 1.8% payroll tax) at age 50. The value of an additional year of work drops below 1.8% at age 57. It reaches close to (but not exactly) zero at age 62, as additional years of work at full earnings do not extend eligibility but do modestly increase benefits in the event of disability.

These results suggest that there is a strong incentive to work enough to maintain eligibility for SSDI through age 62; however, there is not much incentive to earn additional income beyond that threshold. This disincentive to earn additional income is a reflection of the intensive margin, which we also calculate for illustration. Figure 5 shows the increase in the value of SSDI benefits from earning an additional dollar for men and women with average earnings. Comparing these increases with the 1.8% SSDI tax rate (the solid horizontal line) reveals the intensive margin work incentive. For both men and women, the benefit from earning an extra dollar is relatively low early in life. This level is low because these low-earning years stop affecting SSDI benefits once they are replaced by higher earning years in the AIME calculation. Indexed earnings are lowest at age 21; therefore, this year of earnings is the first to be dropped, resulting in a very small increase in SSDI benefits. The benefit from earning an extra dollar peaks at age 27, after which it declines gradually, reaching (almost) zero at age 63. This pattern arises because (a) the increase in SSDI benefits applies to disability that occurs in any future year before normal retirement age and (b) SSDI benefits after the normal retirement age are limited. As normal retirement age approaches, there are fewer future years in which disability could occur. In addition, benefits received at younger ages are paid over a longer period. Starting at age 66, there are no future years in which disability could occur, and therefore the benefit from earning an additional dollar at this age is exactly zero.

The increase in the value of SSDI from earning an additional dollar exceeds the 1.8% tax paid until age 38 for men and age 41 for women. At this point, the return from earning an additional dollar relative to the tax paid becomes negative. Once workers reach their early 60s, they face a net tax rate that is very close to the full 1.8% payroll tax rate. While the patterns for men and women are similar, there are some gender differences that arise from differences in disability incidence and mortality. In particular, as shown in Figure 1, disability incidence rates tend to be similar for men and women until the mid-50s, at which point the incidence rate rises for men relative to women. Both healthy and disabled women also tend to have lower mortality.

These results are similar to the intensive margin calculations that Cushing (2005) reports. Cushing's results suggest that workers initially receive a positive net return on their SSDI taxes. However, this return declines steadily, becoming negative around age 35. Workers in their early 60s face net tax rates that are close to the full 1.8%.

Overall, extensive margin work incentives remain positive late in life despite negative intensive margin work incentives. However, in the early 60s, both intensive and extensive margin work incentives are negative, and workers face close to the full 1.8% SSDI tax. The extensive margin benefit is close to zero starting at age 62, as additional years of work do not extend eligibility at all. All 62-year-olds who have worked for the past 5 years have already met the recent work test through age 67, at which point they receive only retirement benefits that would have been available anyway. If earnings are high enough, additional years of work at age 62 or later can boost AIME, and therefore, the benefit that would be paid upon disability. However, this effect is very small. Thus, the structure of SSDI provides a strong incentive for older workers to continue working part time at least through age 60, but a disincentive to earn a full level of earnings beyond age 55 or to earn additional income after around age 40. There is also a disincentive to both participate in the labor force and earn additional income beyond age 60.

We note that our analysis abstracts from several important features of SSDI. First, individuals who qualify for SSDI become eligible for Medicare after receiving SSDI for 2 years. Second, individuals who do not qualify for SSDI (or who qualify for a very low SSDI benefit) may qualify for Supplemental Security Income (SSI) as well as Medicaid. Finally, SSDI provides insurance and liquidity value to risk-averse and credit-constrained individuals that goes beyond an expected present value calculation. However, we argue that considering these features would not change our qualitative results. On the extensive margin, Medicare eligibility substantially increases the expected lifetime benefit from SSDI and therefore the payoff from extending SSDI eligibility by a year by working longer. The insurance value of SSDI has the same effect. The possibility of receiving SSI and Medicaid in the absence of SSDI eligibility reduces the net expected lifetime benefit from SSDI and therefore lowers the payoff from extending eligibility. However, the general pattern – that the value of extending SSDI eligibility by an additional year declines as individuals age (because they collect disability payments over a shorter time horizon), and becomes zero at age 62 (because individuals no longer gain from extending eligibility) – does not change. On the intensive margin, Medicare eligibility does not change the work incentives. Earning an additional dollar increases the cash disability payment an individual receives but not the value of Medicare. SSI and the associated Medicaid eligibility may affect the intensive margin for individuals earning low levels of income as earning additional income may not increase the total payment they receive in the event of disability. But higher income individuals who are not close to qualifying for SSI can still increase the value of their disability benefit by working additional hours. The insurance value of SSDI increases the payoff from earning an additional dollar but is unlikely to change the age profile of this payoff.

4.2 Differences by earnings

Figures 6–8 show the minimum earnings extensive margin, full earnings extensive margin, and intensive margin effects, respectively, for male workers with different levels of earnings. While the pattern of work incentives over the life cycle is similar, Figures 7 and 8 show that SSDI clearly transfers income from high to low earners. This transfer results from the progressivity of the benefit formula and from the fact that the risk of
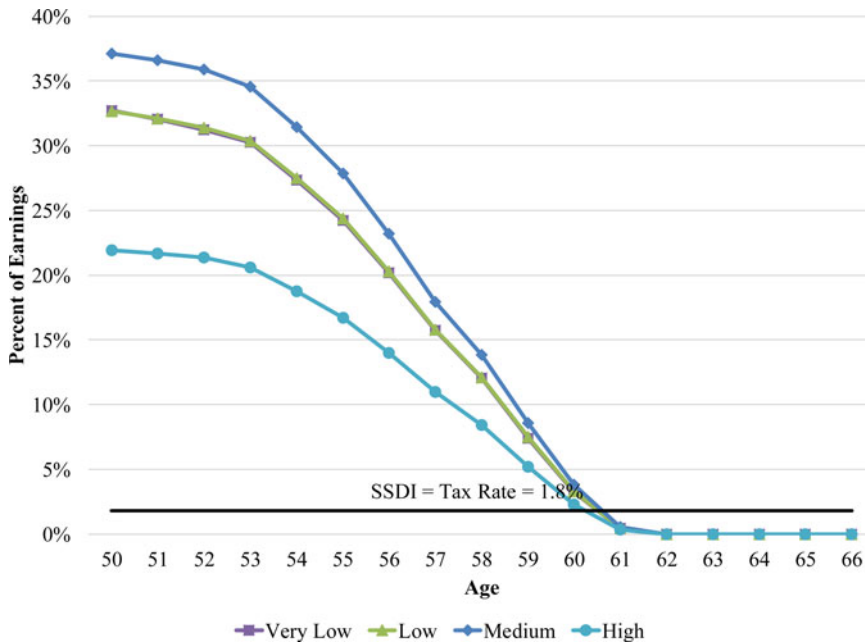
Figure 6. (Colour online) Minimum earnings extensive margin work incentives by earnings (males).
Source: Authors' calculations are based on Equation (3), stylized earnings histories reported in Figure 2, and variation in disability incidence rates reported in Table 3. Workers are assumed to earn the minimum amount required to earn Social Security credits during the additional year of work. See text for more details.

disability is assumed to decline with earnings. High earners face work disincentives (i. e., benefit accrual rates that are <1.8%) on both the intensive and full earnings extensive margins throughout their careers. Workers with very low earnings face positive work incentives on the intensive margin until age 50 and on the full earnings extensive margin until age 59. Figure 6 shows that workers at all levels of earnings face positive work incentives on the minimum earnings extensive margin throughout most of their careers. Thus, older workers at any earnings level face positive incentives to earn a minimum level of earnings through age 61, but they often face disincentives for earning additional income, particularly at higher earnings levels. The pattern of redistribution is less obvious from Figure 6 as the additional year of work for all levels of earnings is assumed to produce the same (minimum) level of earnings. The absolute level of benefits is greater for individuals with higher earnings but their probability of disability is lower, so there is no clear pattern in the increase in the expected value of SSDI relative to the additional income earned.

5 Policy implications

The patterns in the extensive and intensive margin work incentives from the SSDI program mainly stem from two features of the program. First, to be eligible to receive
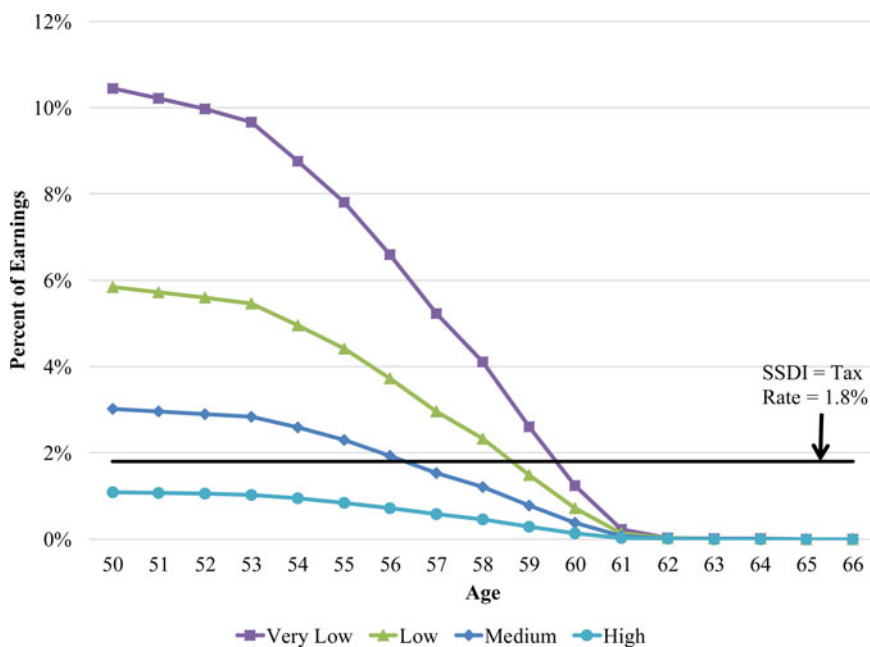
Figure 7. (Colour online) Full earnings extensive margin work incentives by earnings (males).
Source: Authors' calculations are based on Equation (3), stylized earnings histories reported in Figure 2, and variation in disability incidence rates reported in Table 3. Workers are assumed to earn the amount shown in corresponding earnings profile in Figure 2 during the additional year of work. See text for more details.

benefits, individuals must pass a recent work test, implying that exiting the labor force affects benefit eligibility at some point in the future. Second, disability benefits are converted to retirement benefits at the normal retirement age and terminated at death, leading to a declining period over which benefits are paid as workers advance in age. The combination of these two features leads to almost no increase in the present value of SSDI benefits as a result of working beyond age 61. Once an individual has worked to age 61, eligibility for SSDI is already guaranteed through age 66. At this point, extending eligibility has no value, as the additional years of eligibility occur after normal retirement age. Moreover, any substantial increase in benefits as a result of the extra work is paid over an extremely short period. This result is true regardless of the level of earnings assumed or gender, and it suggests that the 1.8% SSDI payroll tax is almost a pure tax on earnings, which could discourage work at older ages.

We are not aware of any empirical evidence on the effect of these incentives on labor supply. The disability benefit formula is complicated, and it is possible that individuals do not calculate or understand the labor supply incentives it creates. However, other studies have examined the perceived labor supply incentives (Liebman and Luttmer, 2014) and effect on labor supply (Liebman *et al.*, 2009) of the Social Security retirement program, which has similarly complex rules. Liebman and Luttmer (2014) find that people are generally aware of the link between Social
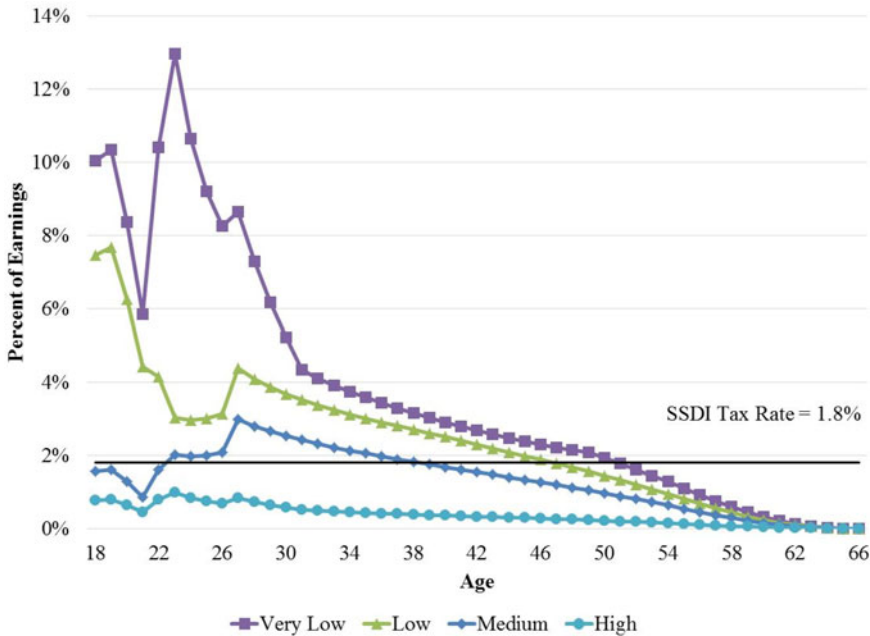
Figure 8. (Colour online) Intensive margin work incentives by earnings (males).
Source: Authors' calculations are based on Equation (4), stylized-earnings histories reported in Figure 2, and variation in disability incidence rates reported in Table 3. See text for more details.

Security benefits and earnings, although they are less familiar with the rules governing the earnings test, the spousal benefit, and the number of years that enter into the benefit calculation. Liebman *et al.* (2009) find that, on the extensive margin, a 10% increase in the net-of-tax share (which is defined as 1 minus the effective tax rate and represents the fraction of income that is retained by the worker) reduces the probability that a worker will retire in the next 2 years by around 14%. On the intensive margin, they find that hours worked, but not earnings, respond to changes in benefit accrual. Whether the incentives in the SSDI program are perceived similarly or have a similar effect on behavior remain questions for further research.

To provide a starting point for thinking about the incentive effect of modifications to the benefit formula, we discuss one policy that might reduce work disincentives for older workers: exempt earnings from the SSDI payroll tax beyond age 60. Under this policy, workers would remain eligible for SSDI benefits if they were eligible at age 60, and any earnings beyond this age would not affect their benefit calculation. The payroll tax at younger ages could be increased slightly to keep the system revenue-neutral in the aggregate. Depending on the incidence of the payroll tax, this policy could affect either labor supply among older workers by increasing the take-home pay of those affected or labor demand by encouraging more firms to hire older workers. While the SSDI payroll tax is small relative to that dedicated to retirement benefits or Medicare, it is imposed on top of other payroll taxes, and older workers have

relatively high labor supply elasticities (French, 2005). Thus, exempting workers age 61 and older from SSDI payroll taxes could have an important effect.

Our results also show stark differences in the value of extending eligibility for SSDI benefits versus the value of marginal increases in these benefits from additional earnings. Generally speaking, the main benefit from the SSDI program of continued work is to insure against the risk of becoming disabled in the future rather than to transfer resources from working years into retirement (as the Social Security retirement program does). Because the hazard of becoming disabled increases with age, the benefit of continuing in the labor force increases until age 50.[20] After this point, the shrinking period over which benefits are paid reduces the return from the SSDI program of participating in the labor force. The program could be made more age neutral by adjusting the minimum required earnings amount by age. However, it is not clear from our results that the existing pattern creates distortions that concentrate earnings at ages at which the work incentives from the minimum earnings extensive margin are high.

6 Conclusions

This paper summarizes the returns to working on the extensive margin from the SSDI program. We use stylized earnings histories, disability incidence, and mortality rates from recent Social Security experience, and details of the eligibility and benefit computation rules to show how the expected increase in disability benefits received from working an additional year varies for older workers. Our results suggest that the returns to extending one's career depend on the level of earnings one is expected to receive. If an individual is considering participating in the labor force just enough to extend his or her eligibility, the return to working is substantial and as high as 35% of earnings at age 50. However, the return to earning amounts above the minimum required for eligibility are much lower. Therefore, an additional full year of earnings provides a much more modest return relative to the disability payroll tax paid. The returns to extending one's career are positive at age 50 but drop below the SSDI payroll tax rate after that. The benefit from working an additional year approaches zero at age 62, implying that the payroll tax is almost a pure tax after this point. These results, which are driven primarily by eligibility rules, are different from prior research on intensive margin work incentives. On the intensive margin, the returns to earning an additional dollar of income at a full level of earnings start above the combined SSDI payroll tax rate of 1.8% of earnings but decline gradually to almost zero as one approaches the normal retirement age.

The implication of these findings is that the returns to participating in the labor force and earning the minimum required to extend eligibility for SSDI benefits, net of the payroll tax, is positive for workers in their 50s. However, the returns become negative after age 60 for average earners and therefore provide a disincentive to remain in the labor force. Earning more than the minimum required provides much

---

[20] Calculations for ages below 50 are not shown because a decision to permanently exit the labor force is not likely to be relevant at these ages. However, they are available upon request.

smaller returns, only affecting disability benefits paid if earnings in the year in question increase the calculated disability benefit. Starting at age 57, workers face disincentives for earning a full year of earnings.

We also explore how work incentives vary by earnings levels and find similar patterns over the life cycle, although at different levels because of redistribution in the SSDI program. In addition to the fact that disability benefits are higher as a percentage of predisability earnings for low earners, we also assume that stylized workers with lower levels of earnings experience higher rates of disability incidence. As a result, the returns to working are much higher for those with lower levels of earnings than for those with higher levels of earnings.

One limitation of our analysis is that it is based on stylized workers and therefore may not represent the different earnings patterns and career interruptions that actual workers experience. Differences in lifetime earnings patterns may affect our conclusions, and examining actual workers' earnings histories remains an important direction for future work.

The SSDI payroll tax rate of 1.8% of earnings is low relative to that dedicated to retirement benefits, and we are not aware of any empirical evidence on how much the work incentives in the benefit formula actually change behavior. However, the SSDI payroll tax is layered on top of payroll taxes levied for the retirement program and income taxes, and other research shows that older workers are particularly responsive to work incentives. One policy option that could reduce work disincentives at older ages is a 'paid up' rule, under which workers over a certain age are exempt from SSDI payroll taxes.

References

Autor, D. H. (2011) *The Unsustainable Rise of the Disability Roles in the United States: Causes, Consequences, and Policy Options*. National Bureau of Economic Research (NBER) Working Paper 17697. Cambridge, MA: NBER.

Autor, D. H. and Duggan, M. G. (2003) The rise in the disability rolls and the decline in unemployment. *Quarterly Journal of Economics*, **118**(1): 157–206.

Blau, D. M. and Gilleskie, D. B. (2001) Retiree health insurance and the labor force behavior of older men in the 1990s. *Review of Economics and Statistics*, **83**(1): 64–80.

Butrica, B. A., Johnson, R. W., Smith, K. E., and Steuerle, E. (2006) The implicit tax on work at older ages. *National Tax Journal*, **59**: 211–234.

Clingman, M., and Burkhalter, K. (2014) *Scaled Factors for Hypothetical Earnings Examples Under the 2014 Trustees Report Assumptions*. Actuarial Note 2014.3. Washington, DC: Social Security Administration.

Cushing, M. J. (2005) Net marginal social security tax rates over the life cycle. *National Tax Journal*, **58**(2): 227–245.

Feldstein, M., and Samwick, A. (1992) Social security rules and marginal tax rates. *National Tax Journal*, **45**(1): 1–22.

French, E. (2005) The effects of health, wealth, and wages on labour supply and retirement behaviour. *Review of Economic Studies*, **72**(2): 395–427.

French, E. and Jones, J. B. (2011) The effects of health insurance and self insurance on retirement behavior. *Econometrica*, **79**(3): 693–732.

Glied, S. and Stabile, M. (2001) Avoiding health insurance crowd-out: evidence from the Medicare as secondary payer legislation. *Journal of Health Economics*, **20**(2): 239–260.

Gruber, J. and Madrian, B. C. (1995) Health insurance availability and the retirement decision. *American Economic Review*, **85**(4): 938–948.

Goda, G. S., Shoven, J., and Slavov, S. N. (2007) *A Tax on Work for the Elderly: Medicare as a Secondary Payer*. National Bureau of Economic Research (NBER) Working Paper 13383. Cambridge, MA: NBER.

Goda, G. S., Shoven, J., and Slavov, S. N. (2009) Removing the disincentives in social security for long careers. In Brown, J., Liebman, J. and Wise, D. (eds), *Social Security Policy in a Changing Environment*. Chicago: University of Chicago Press, pp. 21–23.

Kapur, K. and Rogowski, J. (2011) How does health insurance affect the retirement behavior of women? *Inquiry*, **48**(1): 51–67.

Kotlikoff, L. J. and Wise, D. A. (1985) Labor compensation and the structure of private pension plans: evidence for contractual versus spot labor markets. In Wise, D. (ed.), *Pensions, Labor, and Individual Choice*. Chicago: University of Chicago Press, pp. 55–88.

Kotlikoff, L. J. and Wise, D. A. (1987) The incentive effects of private pension plans. In Bodie, Z., Shoven, J. B. and Wise, D. A. (eds), *Issues in Pension Economics*, Chicago: University of Chicago Press, pp. 283–340.

Liebman, J. B. and Luttmer, E. F. P. (2014) *The Perception of Social Security Incentives for Labor Supply and Retirement: The Median Voter Knows More Than You'd Think*. National Bureau of Economic Research (NBER) Working Paper 20562. Cambridge, MA: NBER.

Liebman, J. B., Luttmer, E. F. P., and Seif, D. G. (2009) Labor supply responses to marginal social security benefits: evidence from discontinuities. *Journal of Public Economics*, **93**(11–12): 1208–1223.

Maestas, N., Mullen, K. J., and Strand, A. (2013) Does disability insurance receipt discourage work? Using examiner assignment to estimate causal effects of SSDI receipt. *American Economic Review*, **103**(5): 1797–1829.

Marton, J. and Woodbury, S. A. (2012) Retiree health benefits as deferred compensation: evidence from the health and retirement study. *Public Finance Review*, **41**(1): 64–91.

Nyce, S., Schieber, S. J., Shoven, J. B., Slavov, S. N., and Wised, D. A. (2013) Does retiree health insurance encourage early retirement? *Journal of Public Economics*, **104**: 40–51.

Olson, J. A. (1999) Who is '62 enough'? Identifying respondents eligible for social security early retirement benefits in the health and retirement study. *Social Security Bulletin*, **62**(3): 51–56.

Reznik, G. L., Weaver, D. A., and Biggs, A. G. (2009) *Social Security and Marginal Returns to Work Near Retirement*. Issue Paper No. 2009-02. Washington, DC: US Social Security Administration, Office of Retirement and Disability Policy.

Social Security Administration (2008) *Social Security Benefits: Benefit Reduction for Early Retirement*. Washington, DC: Social Security Administration. Available online at http://www.ssa.gov/oact/quickcalc/earlyretire.html.

Social Security Administration (2014) *Annual Statistical Report on the Social Security Disability Insurance Program, 2013*. Washington, DC: Social Security Administration. Available online at http://www.ssa.gov/policy/docs/statcomps/di_asr/.

Social Security Administration (2015) *Disability Benefits*. Washington, DC: Social Security Administration. Available online at http://www.ssa.gov/pubs/EN-05-10029.pdf.

Social Security Administration (SSA) Board of Trustees (2013) *Annual Report of the Board of Trustees of the Federal Old-Age and Survivors Insurance and Federal Disability Insurance Trust Funds*. Washington, DC: Social Security Administration.

Social Security Administration (SSA) Board of Trustees (2014) *Annual Report of the Board of Trustees of the Federal Old-Age and Survivors Insurance and Federal Disability Insurance Trust Funds*. Washington, DC: Social Security Administration.

Social Security Administration (SSA) Board of Trustees (2016) *Annual Report of the Board of Trustees of the Federal Old-Age and Survivors Insurance and Federal Disability Insurance Trust Funds*. Washington, DC: Social Security Administration.

Stock, J. H. and Wise, D. A. (1988) *The Pension Inducement to Retire: An Option Value Analysis.* National Bureau of Economic Research (NBER) Working Paper 2660. Cambridge, MA: NBER.

von Wachter, T. (2012) *Assessing Systematic Differences in Industry-Award Rates of Social Security Disability Insurance.* National Bureau of Economic Research (NBER) Retirement Research Center Working Paper NB12-13, Cambridge, MA: NBER.

Zayatz, T. (2011) *Social Security Disability Insurance Program Worker Experience.* Actuarial Study 122. Washington, DC: Social Security Administration.