Henry R. Hyatt (USA)

A sufficient statistic approach to disability insurance with application to the United States Social Security Disability Insurance program

Abstract

The United States Social Security Disability Insurance (SSDI) program's benefit level is periodically modified by policy-makers. However, few economists have compared its benefit level against a welfare criterion. This paper takes a model of optimal disability insurance benefits, presented in Diamond and Sheshinski (1995), and imposes a small number of weak assumptions that allow a "sufficient statistic" approach to assess the optimal SSDI benefit level. Taking empirical results from studies on the incentive effects of social insurance and the consequences of disability, calibration implies that it is difficult to conclude that the existing replacement rate for SSDI participants is inconsistent with the optimum indicated by the Diamond-Sheshinski model, given the large range of estimates for the optimality condition's key parameters: risk aversion, SSDI participation responsiveness to the benefit level, and the employment effects of payroll taxation.

Keywords: disability, taxation, benefits, social security, disability insurance, social insurance.

Introduction

In order to insure workers against any long-term employment-limiting disability occurs prior to retirement eligibility, the United States government mandates that all employees participate in Social Security Disability Insurance (SSDI) program. This program administers roughly $80 billion dollars in benefits annually to nearly 10 million beneficiaries. Empirical studies of SSDI enrollment, such as Bound (1989) and Kreider (1999), indicate that program administration involves a common form of moral hazard: higher benefit levels induce greater benefit utilization. While a large number of studies have considered the problem of the optimal social insurance in the presence of moral hazard, most studies with straightforward policy conclusions have focused on Unemployment Insurance (UI).

Relatively little work has addressed the optimal SSDI benefit level. In this study, I propose and implement a method for applying the well-known optimality condition proposed by Baily (1978) to SSDI. Starting with the model of optimal SSDI developed by Diamond and Sheshinski (1995 – herein abbreviated DS), I derive a formula for the optimal disability benefit that is a function of a relatively small set of estimable parameters. The formula is then applied to assess whether the SSDI benefit is optimal or not. The benefit rate is the only aspect of the SSDI program under consideration in this paper. I do not consider other very important policy questions, such the optimal screening rule or the waiting period for SSDI, despite the importance of these questions. I also ignore the method of establishing an earnings history for benefit calculation, and adjustments for dependents. The equally important question of the optimal degree of progressivity in SSDI taxation and benefit distribution is also beyond the scope of this analysis, as is the question of the optimal assessment of SSDI payroll taxes between firms and employees.

I demonstrate that the first order conditions of the DS model imply a relationship between the optimal difference in marginal utility between workers and program participants, and the moral hazard induced by raising revenue and providing benefits. This optimality condition can be calibrated after making two restrictions that do not appear in the DS model: that the utility of consumption is constant between workers and benefit claimants, and that the higher-order terms of the utility function are small. I then present what the optimality condition implies, given the existing empirical estimates on (1) the effect of payroll taxes on labor supply, (2) the effect of the benefit level on SSDI participation, and (3) individual risk aversion.

Calibration of the optimality criterion permits inference on whether the drop in consumption that occurs when someone participates in SSDI is optimal, given a small set of parameters. However, a review of the literature yields a wide range of estimates for each of the three key parameters listed above. We can nevertheless draw conclusions about the sets of parameter values that imply that benefits are at their optimal level: if individual risk aversion is low (coefficient of relative risk aversion around 1-2) and SSDI participation is not very responsive to the benefit level (a participation elasticity of 0.5 or lower), the drop is roughly optimal. However, if rates of risk aversion are higher (around 4-5), then the drop in consumption is only optimal when the SSDI participation elasticity is higher, around 1. Despite its difficulty in drawing an exact conclusion about whether SSDI benefits are at their optimum, this study should serve as a useful reference point for empirical research, because it very clearly specifies what empirical estimates are most necessary for welfare calculations of the SSDI benefit level. This paper is similar in principle to the "sufficient statistic" literature catalogued by Chetty (2009), but one important methodological difference places it outside of the framework of these papers. The papers he catalogues propose a setting in which a social planner is considering the level of one distinct policy instrument, and solving involves implementation of the envelope condition for agent maximization. In this paper, I consider the DS model in which the social planner has two policy instruments, namely, the level of benefits for SSDI participants and the level of benefits for those who neither work nor participate in SSDI. This means that I construct a formula that includes elasticities constructed from partial derivatives. The paper proceeds as follows. I first discuss the SSDI program and review the economic literature associated. I then present the DS model, derive an implicit optimality condition, and discuss the simplifying assumptions necessary to calculate the optimal benefit. I then discuss the parameters utilized by the model and provide an assessment of the conditions under which the current benefit regime is an optimal policy. I then discuss the implications of this calibration exercise and attempt to provide some direction for future empirical research.

1. Disability insurance

1.1. Program details. SSDI is a federally mandated income support program for individuals whom the government finds unable to engage in substantial gainful activity but are not eligible for retirement benefits because of their age. In order to participate, applicants must earn no more than $860 per month during a period of five months, after which the applicant is screened by a doctor. If the doctor, following a government-mandated set of criteria (which includes education and occupational history), determines that the applicant is incapable of engaging in substantial gainful activity due to illness, he is admitted into the DI program. Roughly fifty percent of applicants are rejected annually, and they must wait one full year before re-applying. Those who are accepted receive a benefit, which is increasing in pre-disability income at a declining rate. As reported in Autor and Duggan (2006), claimants who, before applying to disability, earned income at the 10th percentile of the national wage distribution receive approximately 60% of their pre-program earnings, and those earning income at the 90th percentile receive 25% of their pre-program earnings.

The Social Security Administration administers SSDI and a mandatory retirement program Old Age and Survivors Insurance (OASI), along with other social insurance programs. SSDI and OASI are financed by a payroll tax of 12.6% of the first roughly one hundred thousand dollars of the annual earnings of each employed person, half of which is paid by employers, the other half is paid by employees. Social Security Disability Insurance is itself financed by a payroll tax of 1.8% (OASI is financed with the remaining 10.8%). The SSDI payroll tax is reset infrequently and does not change from year to year based on the program's revenues and expenditures. The two most recent changes in the payroll tax rate, in 1994 and 2000, have coincided with opposite changes in the OASI payroll tax, so that the payroll tax used to finance these two programs has remained at 12.6% of payroll since 1990.

1.2. Previous economic analyses. Several studies of SSDI have demonstrated that program participation is to the benefit level. Some studies, such as Parsons (1980) and Bound (1989), employ cross-sectional estimates, while other studies, such as Halpern and Hausman (1986) and Kreider (1999), identify the effects of the SSDI benefit level using structural models. These papers do not assess the welfare consequences of their participation estimates. Other studies, including Diamond and Sheskinski (1995) and Lozachmeur (2006), specify structural models in order to draw qualitative conclusions about the structure of optimal disability insurance programs. The goal of these studies is to specify the optimal policy of a welfare-maximizing social planner. However, these studies do not formally incorporate estimates of empirical studies into their optimality conditions.

From the SSDI literature, the analysis in Bound et al. (2003) is the closest to this study. The authors tie together empirical analysis of SSDI on participation and the welfare consequences of increasing SSDI benefits by 1%. The authors make a large number of assumptions in order to conduct this welfare calculation, such as assuming that the deadweight burden of the additional payroll taxes necessary to finance this increase in the benefit level is zero, that there is no utility gain from those who re-optimize their labor supply decision after the benefit increase, that there is an elasticity of -1 between the SSDI benefit level and the earnings of SSDI claimants' spouses, and that the representative individual has a utility function that exhibits constant relative risk aversion of a particular form.

The approach I take differs from the analysis done in Bound et al. (2003) in that it focuses on estimating a model using a small set of sufficient statistics, and explores the optimal level of disability insurance rather than a welfare calculation. I also addresses a broader question: whether, given the range of empirical estimates for its key parameters, the null hypothesis that the current benefit level is optimal can be rejected. This analysis greatly simplifies the basic welfare problem and highlights what the key parameters for welfare analysis are.

2. The model

This section presents the DS model and derives a testable optimality condition. This model considers an economy in which the population is divided between those who work, those who do not work and receive SSDI, and those who do not work and receive another benefit, which can be thought of as a welfare benefit. The government's problem is to set the SSDI benefit and welfare benefit levels. This model differs from UI models that explore simpler optimality conditions. Baily (1978) and Chetty (2006a) consider models where agents can be in one of two states: either employed or participating in UI: the authors do not consider unemployment apart from participation in a single program. Kroft (2008) models benefit take-up in a framework in which agents either work, participate in UI, or are unemployed without program participation. Those who are unemployed without participating in UI receive no benefits. In all of these models, the government only has one policy mechanism, the UI benefit level.

2.1. Basic form. Following DS, consider an economy in which agents produce one unit of a single consumption good when working and nothing otherwise. These agents vary in disutility of working θ, which is distributed according to $F(\theta)$. The government has an imperfect screening mechanism that it uses to separate individuals with a high disutility of working from those with a low value. Specifically, each individual has a probability $p(\theta) \in [0,1]$ of being admitted into a disability compensation program, where p is a continuous function and weakly increasing in θ. The government sets the consumption of individuals who work c_a, those who are screened as having a high disutility of work c_d, and those who do not work but do not signal a high disutility of work c_b. Each individual receives consumption utility $u(.)$ and $v(.)$, while working and not working, respectively, both of which are increasing in consumption. Then there are unique values of θ_d and θ_b defined by $u(c_a) - \theta_d = v(c_d)$ and $u(c_a) - \theta_b = v(c_b)$, where an individual is indifferent between not working and either participating in the disability program or not working at all without disability compensation respectively. Then all individuals with a value of θ less than θ_d will always work and all individuals with a θ greater than θ_b will never work, regardless of whether the individual is on disability. Assume in the following that there is an interior solution to the optimal benefit problem, i.e. that $\theta_d < \theta_b$. In this paper, I define the goverment's optimization problem as how to set consumption levels c_a, c_b and c_d[1].

Before beginning the formal mathematical treatment, it is helpful to consider, broadly, what happens when the government adjusts the level of consumption for a group. Consider, for example, the effect of an increase in the disability benefit, c_d. This change is shown in Figure 1.

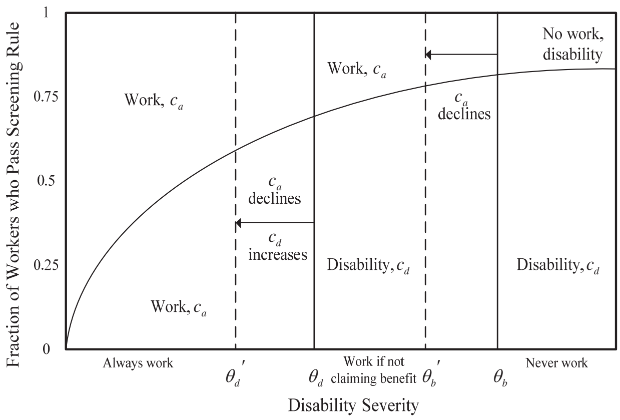

Fig. 1. An increase in the benefit level in the Diamond-Sheshinski model

The disutility value at which the utility of employment is equal to the utility of disabled consumption is $\theta_d = u(c_a) - v(c_d)$. In order to finance this increase in benefits c_a decreases and, consequently, $u(c_a)$ decreases. Likewise the increase in benefits causes the $v(c_d)$ increase of. These two effects cause θ_d to decrease to θ_d': in other words, when disability benefits are higher, less disabled individuals will choose to participate in the program. The difference between the consumption value of employment, $u(c_a)$, and the outside option $v(c_b)$ grows as well, lowering the disutility threshold at which agents choose to never work regardless of participation in the program $\theta_b = u(c_a) - v(c_b)$ from θ_b to θ_b'. In summary, an increase in benefits will raise the number of individuals on disability, raise the number who pursue no gainful activity but are not on Disability Insurance, and lower the number who work.

Following DS, the planner problem is:

$$\max_{c_a, c_d} \int_0^{\theta_d} \left[u(c_a) - \theta \right] dF + \int_{\theta_d}^{\theta_b} \left[p(\theta) v(c_d) + (1 - p(\theta)) \left[u(c_a) - \theta \right] \right] dF + \int_{\theta_b}^{\infty} \left[p(\theta) v(c_d) + (1 - p(\theta)) v(c_b) \right] dF \tag{1}$$

subject to the budget constraint

$$\int_0^{\theta_d} (c_a - 1) dF + \int_{\theta_d}^{\theta_b} \left[p(\theta) c_d + (1 - p(\theta))(c_a - 1) \right] dF + \int_{\theta_b}^{\infty} \left[p(\theta) c_d + (1 - p(\theta)) c_b \right] dF = 0. \tag{2}$$

[1] Note that this paper only considers the benefit level as specified by the DS model. DS considered the case in which the government tightens or relaxes the screening rule. Adding a severity optimization problem would change the optimal benefit levels through changing the elasticity parameters and population fractions at an optimal screening rule.

The first order conditions with respect to c_a, c_d and c_b are, respectively,

$$\left[u'(c_a)-\lambda\right]\int_0^{\theta_d} dF+\left[u'(c_a)-\lambda\right]\int_{\theta_d}^{\theta_b}(1-p(\theta))dF=\lambda\left[(c_a-1-c_d)p(\theta_d)f(\theta_d)+(c_a-1-c_b)(1-p(\theta_b))f(\theta_b)\right]u'(c_a), \quad (3)$$

$$\left[v'(c_d)-\lambda\right]\int_{\theta_d}^{\infty}(p(\theta))dF=-\lambda(c_a-1-c_d)p(\theta_d)f(\theta_d)v'(c_d) \quad (4)$$

and $\left[v'(c_b)-\lambda\right]\int_{\theta_b}^{\infty}(1-p(\theta))dF=-\lambda(c_a-1-c_b)1-(p(\theta_b))f(\theta_b)v'(c_b).$ (5)

These first order conditions appeared in the original paper by Diamond and Sheshinski (1995). It is possible to go further and write down an exact formula for the optimal benefit level as follows. For convenience, let the fraction of individuals who work be called $P_1=\int_0^{\theta_d} dF+\int_{\theta_d}^{\theta_b}(1-p(\theta))dF$ and the fraction of individuals who participate in the disability compensation program $P_2=\int_{\theta_d}^{\infty}(p(\theta))dF$, and the fraction of individuals who neither participate in the SSDI program nor work $P_3=\int_{\theta_b}^{\infty}(1-p(\theta))dF$. Let $\varepsilon_{P_1,1-c_a}$ be the elasticity of the fraction of the labor force that works with respect to the payroll tax rate $1-c_a$, ε_{P_1,c_a} the elasticity of the fraction of the labor force that works with respect to its own consumption, ε_{p_2,c_d} be the elasticity of the fraction of the labor force on SSDI with respect to the benefit rate, and ε_{p_3,c_b} be the elasticity of the fraction of the population receiving the second benefit with respect to the level of that benefit. Note that these elasticities are expressed in terms of the partial derivative of the fraction of the population either working or on disability with respect to the benefit level or payroll tax rate, respectively, holding the other differentiator constant. For example, $\varepsilon_{P_1,1-c_a}$ is the elasticity of labor force participation with respect to the payroll tax rate, holding the two benefit levels constant.

2.2. Derivation of an optimality condition. I now derive an implicit optimality condition. Rearrange these first order conditions and divide them to get:

$$\frac{v'(c_d)}{u'(c_a)}=-\frac{P_1}{P_2}\frac{(c_a-1-c_d)p(\theta_d)f(\theta_d)v'(c_d)-P_2}{P_1\varepsilon_{P_1,1-c_a}-c_d p(\theta_d)f(\theta_d)u'(c_a)-c_b(1-p(\theta_b))f(\theta_b)u'(c_a)+P_1}. \quad (6)$$

It is useful to note the following partial derivatives of the population shares with respect to the consumption parameters c_a and c_d:

$$p(\theta_d)f(\theta_d)v'(c_d)=\frac{\partial}{\partial c_d}\int_{\theta_d}^{\infty}(p(\theta))dF=\frac{\partial P_2}{\partial c_d}, \quad (7)$$

$$p(\theta_d)f(\theta_d)u'(c_a)=\frac{\partial}{\partial c_a}\int_{\theta_d}^{\infty}(p(\theta))dF=\frac{\partial P_2}{\partial c_a}, \quad (8)$$

$$(1-p(\theta_b))f(\theta_b)u'(c_b)=\frac{\partial}{\partial c_a}\int_{\theta_b}^{\infty}(1-p(\theta))dF=\frac{\partial P_3}{\partial c_a} \quad (9)$$

and

$$f(\theta_b)u'(c_a)+p(\theta_d)f(\theta_d)u'(c_a)-p(\theta_b)f(\theta_b)u'(c_a)=$$
$$=\frac{\partial}{\partial c_a}\left[\int_0^{\theta_d}dF-\int_{\theta_d}^{\theta_b}p(\theta)dF\right]=\frac{\partial P_1}{\partial c_a}. \quad (10)$$

Now, we can rearrange terms to show:

$$\left[P_1\varepsilon_{P_1,1-c_a}-c_d\frac{\partial P_2}{\partial c_a}-c_b\frac{\partial P_3}{\partial c_a}+P_1\right]\frac{v'(c_d)}{u'(c_a)}= \quad (11)$$
$$=-(c_a-1-c_d)\frac{P_1}{P_2}p(\theta_d)f(\theta_d)v'(c_d)+P_1.$$

The government's balanced budget constraint implies that

$$c_a-1=-\frac{P_2c_d+P_3c_b}{P_1}, \quad (12)$$

Combining the rearranged first-order conditions with the balanced budget constraint and rearranging terms, the proportionate difference between marginal utilities between consumption while working c_a and consumption while receiving a disability benefit c_d can be written as follows:

$$\frac{v'(c_d)-u'(c_a)}{u'(c_a)}=\frac{\left(\frac{P_1+P_2+P_3k}{P_1}\right)\varepsilon_{p_2,c_d}}{\left[\varepsilon_{P_1,1-c_a}-\frac{c_d}{P_1}\frac{\partial P_2}{\partial c_a}-\frac{c_b}{P_1}\frac{\partial P_3}{\partial c_a}+1\right]}-\frac{\varepsilon_{P_1,1-c_a}-\frac{c_d}{P_1}\frac{\partial P_2}{\partial c_a}-\frac{c_b}{P_1}\frac{\partial P_3}{\partial c_a}}{\left[\varepsilon_{P_1,1-c_a}-\frac{c_d}{P_1}\frac{\partial P_2}{\partial c_a}-\frac{c_b}{P_1}\frac{\partial P_3}{\partial c_a}+1\right]}, \quad (13)$$

where k is the ratio of the SSDI consumption c_d to the alternate benefit consumption c_b.

Thus, the model allows the proportionate difference in marginal utilities to be expressed as a function of a few parameters: the fraction of the population that is employed, the fraction participating in the disability program, the fraction of the population that neither participates in SSDI nor works, the elasticity of SSDI participation with respect to the benefit level, and the elasticity of labor force participation with respect to the tax rate.

This optimality condition has a number of intuitive properties. The proportionate difference in marginal utility at the social optimum is decreasing in the degree of participation moral hazard, and is increasing in the extent to which payroll taxes discourage work, so long as the fraction of the population that works is sufficiently large. This is because a higher elasticity makes the second benefit less able to be used to increase welfare, thereby being a second source of increasing the optimal consumption of those who decide to work. In other words, when the alternative benefit is more costly to provide, the payroll tax is lower.

2.3. Fitting the optimality condition into a sufficient statistic framework. Equation (12) is implied directly by the DS model. However, it is possible to make two further assumptions that permit the calibration of this model. These are the additive separability of consumption and leisure and that the third-order conditions of the utility function are small. An additively separable utility function means that different levels of utility of leisure change the optimal benefit by changing the values of θ where agents are indifferent between work and its alternatives, and so it enters into the above formula through the elasticities of program participation and labor force participation with respect to the level of disability benefits. This is the relationship that has been calibrated by Baily (1978), Gruber (1997), Chetty (2006a) and Kroft (2008) for unemployment insurance. Noting that, when the third-order and higher terms of the utility function are small,

$$u'(c_d) \cong u''(c_a)(c_a - c_d), \tag{14}$$

leads to

$$\gamma \frac{c_a - c_d}{c_a} = \frac{\left(\dfrac{P_1 + P_2 + P_3 k}{P_1}\right)\varepsilon_{p_2, c_d}}{\left[\varepsilon_{P_1, 1-c_a} - \dfrac{c_d}{P_1}\dfrac{\partial P_2}{\partial c_a} - \dfrac{c_b}{P_1}\dfrac{\partial P_3}{\partial c_a} + 1\right]} - \frac{\varepsilon_{P_1, 1-c_a} - \dfrac{c_d}{P_1}\dfrac{\partial P_2}{\partial c_a} - \dfrac{c_b}{P_1}\dfrac{\partial P_3}{\partial c_a}}{\left[\varepsilon_{P_1, 1-c_a} - \dfrac{c_d}{P_1}\dfrac{\partial P_2}{\partial c_a} - \dfrac{c_b}{P_1}\dfrac{\partial P_3}{\partial c_a} + 1\right]}, \tag{15}$$

where γ is the rate of relative risk aversion.

3. Parameterization

In this section, I calibrate equation (15) using parameters found in the broader literature on taxation and social insurance. The values of the parameters selected are shown in Table 1, and their sources are explained in the subsections that follow.

Table 1. Parameter values and sources for Diamond-Sheshinski calibration

Parameter	Symbol	Value	Source
Fraction working	P_1	93%	Estimated from the following sources: US Bureau of Labor Statistics (2012): 121 million people aged 25-64 in the labor force. US Social Security Administration (2006): 8 million SSDI claimants in 2005 US Census Bureau (2012): 1.3 million TANF households in 2005
Fraction receiving disability benefit	P_2	6%	
Fraction receiving welfare benefit	P_3	1%	
Elasticity of SSDI participation to the SSDI benefit rate	ε_{P_2,c_d}	0.2-0.9	Bound and Burkhauser (1999): with respect to application rate: 0.2-1.3 with respect to nonparticipation rate: 0.2-1
Income elasticity of labor force participation	ε_{P_1,c_a}	0-0.2	Gruber and Krueger (1990): Labor force participation elasticity in the range of 0-0.2 Gruber (1997): ~0 Anderson and Meyer (1998): ~ 0
Marginal effect on SSDI participation	$\dfrac{\partial P_2}{\partial c_a}$	0-0.2	Upper bound pinned down by $\varepsilon_{P_1,1-c_a}$, $1-c_a$, P_1
Marginal effect on welfare participation	$\dfrac{\partial P_3}{\partial c_a}$	0-0.2	Upper bound pinned down by $\varepsilon_{P_1,1-c_a}$, $1-c_a$, P_1
Ratio of SSDI benefits to welfare benefits	k	2	Social Security Administration (2006): Monthly DI benefit for 2005 is ~$760 US Census Bureau (2012): In 2005, TANF-participating households received $351/month
Drop in consumption between work and SSDI participation	$\dfrac{c_d - c_a}{c_a}$	20%-60%	Autor and Duggan (2006): Replacement rates are in the range of 25%-60% Meyer and Mok (2007): Food expenditures drop 20%, housing expenditures drop 25%
Risk aversion	γ	1-5	Barsky et al. (1997): ~4 Cohen and Einav (2007): 0.4-50 Chetty (2006b): 1-2

3.1. Population shares. Calibration of the DS model involves settling on levels of the population that are in the different groups under consideration: those who work, those who are on SSDI, and those who receive a welfare benefit. However, it is not obvious how to define the population that receives a welfare benefit. It could be defined to be the group of rejected applicants who are not working, as the pool of individuals in the age range that makes them eligible for SSDI but do not work. These individuals may receive income from any number of sources, including from family members. Government programs that target this population include Supplemental Nutrition Assistance Program benefits (food stamps), Medicaid, Temporary Aid to Needy Families (TANF), and a number of other transfer benefits. In the calibration that follows, I consider adult TANF recipients to be the group of individuals that neither works nor receives SSDI.

In what follows I will consider the following population for 2005. I start with the 121 million people in the labor force aged 25-64, derived from the US Bureau of Labor Statistics (2012). In the calibration that According to the BLS Interactive CPS Tables, 67% of all adults aged 16-64 are enrolled in the labor market, and Autor and Duggan (2006) report that 4% of all adults aged 25-64 are on disability. There are 1.3 million recipients of Temporary Assistance for Needy Families (TANF), less than half the number of SSDI beneficiaries. Taking 2% as an upper bound on the number of adults aged 25-64 who are receiving TANF, some rough starting figures for calibrating the Diamond and Sheshinski model could be that P_1 = 93% and P_2 = 6%, so consequently the fraction that neither works nor are enrolled in SSDI is P_3 = 1%. Of course, one would get different population shares by considering the fraction of the population that consists of rejected SSDI applicants. Furthermore, there are roughly ten million adults who receive food stamps, so consideration of this as the alternative benefit would, of course, yield a different answer.

3.2. The elasticity of SSDI participation with respect to the benefit level. A survey by Bound and Burkhauser (1999) summarizes most of the studies of the responsiveness of SSDI participation with respect to the SSDI benefit level. Two tables provide ranges of elasticity estimates for two aspects of participation: the application rate and non-employment. The elasticity of the application rate with respect to the SSDI benefit level ranges from 0.2 to 1.3 – the larger of which come from the structural estimates of Halpern and Hausman (1978) and Kreider (1999). The elasticity of the non-employment rate with respect to the benefit level ranges from 0.2-1, with the highest estimate coming from Parsons (1980).

3.3. The ratio of SSDI benefits to welfare benefits. There are several welfare benefits that one could consider in calibrating the DS model. However, it may be useful to keep a standard outside benefit in mind. In practice, claimants receive some hundreds of dollars when participating in various welfare programs. However, SSDI recipients can receive much more, on the order of two thousand dollars per month. Given this substantial heterogeneity, I will assume that the current starting point is that SSDI recipients receive roughly twice as much in annual income as those who are not working but participating in another welfare program. Additional precision of this parameter would of course be useful, but even a proportionately large perturbation will not affect the optimal drop in consumption.

3.4. Payroll taxes. The DS model specifies that workers create output, some of which the workers keep, and some of which is used to finance the two social insurance programs for the non-employed. There is no distinction between that which is paid by firms and that which is paid by workers because in the DS model, there are no firms. A cursory summary of the social insurance literature indicates that this assumption does not matter, and that the elasticity of labor force participation with respect to the payroll tax rate is quite small regardless of the financing mechanism.

In a study of the employment effects of workers compensation benefits, which are fully financed by employers, Gruber and Krueger (1990) report that employment is not particularly responsive to premium rates, the costs of which are primarily passed on to workers in the form of lower wages. They find a labor force participation rate elasticity of 0-0.2. Anderson and Meyer (1998), considering unemployment insurance, which is financed by employees through payroll deductions, find that the employment rates are essentially not responsive to payroll taxes Leibman and Saez (2006) find that labor supply patterns around OASI/SSDI payroll tax reforms are not consistent with large responses to these taxes.

Gruber (1997) estimates the effects of a 1981 Chilean payroll tax reform on wages and labor force participation for manufacturing. In the study that considered the largest reform in social insurance cost levels, the payroll tax rate for this group went from 30% to 8.5%. The effect was a decrease in wages and no discernable change in labor force participation. Overall, the conclusion of this small literature is that, independent of the finance structure of the benefits, payroll taxes have a very small impact on employment.

While most empirical studies suggest that labor force participation is not responsive to the payroll tax rate, I will assess the effects of assuming different income elasticity of labor force participation parameters as suggested by Gruber and Krueger

(1990), who, while not rejecting that the effect of labor force participation is equal to zero, find an interval of roughly 0-0.2, and also Leibman and Saez (2006), who highlight labor force participation elasticies of 0.2 and 0.5 in their simulations on the OASDI program.

3.5. Payroll tax implications for welfare, SSDI participation. The optimality condition above includes terms that represent the marginal effect of consumption while working on the population share parameters for SSDI and welfare recipients, respectively. In the calibration that I implement below, I rely on upper bounds for these marginal effects, and the logic by which they are derived is as follows. It must be the case that the marginal effect of consumption while working equals the marginal effect on the non-employed states:

$$\frac{\partial P_1}{\partial c_a} = \frac{\partial P_2}{\partial c_a} + \frac{\partial P_3}{\partial c_a}.$$

We can assume that payroll taxes at least weakly encourage individuals to participate in SSDI and welfare, so $\frac{\partial P_2}{\partial c_a} \leq 0$ and $\frac{\partial P_3}{\partial c_a} \leq 0$.

Once we have selected a parameter to represent the elasticity of labor force participation P_1 with respect to after-tax consumption, ε_{P_1,c_a}, then the following relationship must hold for P_2

$$\frac{P_1}{c_a}\varepsilon_{P_1,c_a} \leq \frac{\partial P_2}{\partial c_a} \leq 0 \cdot$$

and likewise for must hold for P_3,

$$\frac{P_1}{c_a}\varepsilon_{P_1,c_a} \leq \frac{\partial P_3}{\partial c_a} \leq 0 \cdot$$

Given that the ratio of income after taxes in support of SSDI and welfare is roughly 98% and the share P_1 is 93%, we can safely use as an upper bound that

$$\varepsilon_{P_1,c_a} \approx \frac{\partial P_3}{\partial c_a}.$$

3.6. The drop in consumption when participating in SSDI. The simplest method of calculating the drop in consumption through program participation is to use the replacement rate. Proportionate drops consistent with the current level of SSDI replacement can be estimated through the actual replacement rate, which span approximately 25% to 60%, as reported in Autor and Duggan (2006).

There is little research to date that attempts to solve for the change in consumption that results from a change in the social security disability insurance benefit level. One paper that comes close to addressing this is presented by Bruce Meyer and Wallace Mok (2007), who examine the change in consumption in the ten years following the onset of disability in the Panel Study of Income Dynamics. They find that the most severely (in the paper's terminology "chronic-severe" – those with persistent disability that precludes many of the Activities of Daily Living from the PSID health supplement) disabled experience a drop in annual income of approximately \$23,000, from an average earnings prior to disability of \$43,000. These individuals receive, on average, \$10,000 per year in government transfers. The expenditures on food drop, for this group, by 20%, and on housing – by 25%. The authors do not provide an estimate of what the drop in consumption would be in the absence of disability insurance, but they do report that the changes in the earnings of other members of the household are estimated to be small and are statistically insignificant, suggesting that the transfers generate dollar-for-dollar increases in household income.

3.7. Risk aversion. Barsky et al. (1997), using survey data from the Health and Retirement Study, find that individual risk preferences are consistent with a rate of relative risk aversion that exhibits substantial heterogeneity, but is on average roughly 4. Cohen and Einav (2007), who find in a dataset of insurance deductible choices a rate of relative risk aversion somewhere between 0.5 and around 50, depending on whether the median or mean risk aversion level is considered, respectively. Chetty (2006b), exploring the relationship between labor supply estimates and expected utility theory, places an upper bound on risk aversion of roughly two. This short survey of estimates the rate of relative risk aversion suggests that there is rather more uncertainty about the level of risk aversion, and thus the value of insurance generally, than the uncertainty regarding the moral hazard cost of providing SSDI benefits. In what follows, I consider risk aversion levels from 1 to 5.

4. Calibration

In this section, I combine the empirical estimates discussed in the previous section with the optimality condition previously derived. The fundamental question is whether the current SSDI benefit regime can be said to be unreasonable, given what we know about the various parameters involved: specifically, the population that works, that participates in SSDI, and that participates in the other benefit, and the elasticity of each share with respect to its primary determinant. Proportionate drops consistent with the current level of SSDI replacement can be estimated through the actual replacement rate, which span approximately 25% to 60%, as reported in Autor and Duggan (2006). Alternatively, it is possible to estimate the drop in consumption through actual consumption data. Using the Panel and the proportionate drop in consumption in selected categories for those who suffer a severe injury, is reported by Meyer and Mok (2006) to be approximately 20%-25%. Of course, this may underestimate the realized drop in consumption experienced by the disabled because the Meyer and Mok (2006) estimates are not limited to SSDI participants. We begin by parameterizing estimate in equation (15).

$$\gamma \frac{c_a - c_d}{c_a} = \frac{\frac{0.93 + 0.06 + 0.01 * 2}{0.93} \varepsilon_{p_2, c_d}}{\left[\varepsilon_{P_1, 1-c_a} - \frac{c_d}{P_1} \frac{\partial P_2}{\partial c_a} - \frac{c_b}{P_1} \frac{\partial P_3}{\partial c_a} + 1 \right]} - \frac{\left[\varepsilon_{P_1, 1-c_a} - \frac{c_d}{P_1} \frac{\partial P_2}{\partial c_a} - \frac{c_b}{P_1} \frac{\partial P_3}{\partial c_a} \right]}{\left[\varepsilon_{P_1, 1-c_a} - \frac{c_d}{P_1} \frac{\partial P_2}{\partial c_a} - \frac{c_b}{P_1} \frac{\partial P_3}{\partial c_a} + 1 \right]} \quad (16)$$

and I propose sets of values of the parameter vector $\{\gamma, \varepsilon_{p_2, c_d}, \varepsilon_{P_1, c_a}\}$ to assess whether the consumption drop $\frac{c_d - c_a}{c_a}$ implied by equation (15) is consistent with either the SSDI scheduled replacement rate or the Meyer and Mok (2007) estimated consumption drop. Tables 2 to 5 present the results of this analysis, showing the optimal proportionate drop in consumption for different values of risk aversion, SSDI participation elasticity, labor supply responsiveness to payroll taxes, and welfare participation responsiveness to benefit levels.

Table 2. Optimal consumption drop with zero payroll tax response

γ: Coefficient of relative risk aversion					
$\varepsilon_{p_2 c_d}$	1	2	3	4	5
0.2	22%	11%	7%	5%	4%
0.5	54%*	27%**	18%	14%	11%
0.8	87%	43%*	29%**	22%	17%
1.1	119%	60%*	40%*	30%**	24%**

Note: table results show the condition for the optimal proportionate drop in consumption for SSDI program participants when labor supply and welfare participation are not responsive to payroll taxes and not very responsive to welfare benefit level, with an elasticity of 0,25. * indicates that benefits are broadly consistent with the range of SSDI replacement rates. ** indicates benefits are broadly consistent with Meyer and Mok's estimates of the decline in consumption after disability.

Table 2 presents the optimal proportionate consumption drops when labor force participation does not payroll taxes $\varepsilon_{P_1, c_d} = 0$. When risk aversion is relatively low, from about 1-2, a moderate range of moral hazard, of approximately 0.5-0.7 is consistent with current consumption drops. However, at higher levels of risk aversion, of 3-5, the benefit rate for SSDI is much too low unless the higher levels of SSDI participation responsiveness are correct.

Table 3 presents the optimal drop in consumption when labor supply is at the high end of responsive to payroll taxes, that is, $\varepsilon_{P_1, c_d} = 0.2$, which is at the high end of the Gruber and Krueger (1990) estimates and a supply elasticity highlighted by Laibman and Saez (2006). In this case, the optimal consumption drop is understandably greater than when raising revenue is costless in itself. In this case, the current level of replacement rates is reasonable for risk aversion levels 2-5. However, if the Meyer and Mok's (2006) estimates are a good estimates of the consumption drop for SSDI participants, then benefit levels are somewhat too high.

Table 3. Optimal consumption drop with large payroll tax response

γ: Coefficient of relative risk aversion					
$\varepsilon_{p_2 c_d}$	1	2	3	4	5
0.2	68%*	34%*	23%**	17%	14%
0.5	113%	56%*	38%*	28%**	23%**
0.8	158%	79%	53%	39%*	32%*
1.1	203%	101%	68%	51%*	41%*

Note: The results show the condition for the optimal proportionate drop in consumption for SSDI program participants when labor supply has an elasticity with respect to payroll taxes of -0.2 and welfare participation is not very responsive to welfare benefit level, with an elasticity of 0.25. * indicates that benefits are broadly consistent with the range of SSDI replacement rates. ** indicates benefits are broadly consistent with Meyer and Mok's estimates of the decline in consumption after disability.

Conclusion

I have demonstrated that, given the range of estimates for various inputs in a simplified version of the Diamond and Sheshinski (1995), the current drop in consumption associated with SSDI participation is not unreasonable. However, if labor supply is very responsive to the SSDI payroll tax rate, and if the realized consumption drop is actually as small as 20-25%, then SSDI benefits are more generous than the DS model suggests is optimal.

This paper's ability to assess the SSDI program's benefit replacement rate is based on a number of simplifying assumptions that are taken from the DS model, respecting that the intent was not to establish and calibrate an optimality condition. The model provides a useful reference point when considering the meaning of moral hazard estimates. Future work should attempt to add realism to the modeling of disability insurance, while remaining close to the integration of empirical estimates. One helpful avenue may be to consider the wide range of benefits and the specific program requirements pursuant thereto, instead of considering a single second benefit for SSDI applicants who do not meet the screening rule's requirements. Furthermore, the DS model, along with most optimal social insurance models, consider agents who do not differ in their utility of consumption. It may be useful for future disability insurance models to consider the relationship between disutility of labor and the marginal utility of consumption.

Furthermore, this paper shows the difficulty that the very wide range of estimates for responsiveness to program participation and risk aversion present when attempting to undertake welfare analysis of the SSDI program. When the low end of estimates of responsiveness is 0.1, and the high end of estimates is around 1, it is difficult to make any distinction between the optimality of, for example, a one-third or two-thirds replacement rate. Hopefully, consideration of the welfare ends of empirical estimates will motivate further empirical work which distinguishes between the high and low estimates of participation responsiveness.

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