Mortality Impacts of Disability Insurance Payments: Context and Implications[*]

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Abstract

Previous research has found that Social Security Disability Insurance (DI) income reduces beneficiaries' mortality (Gelber, Moore, Pei, and Strand 2022). A key contribution in this paper is to provide context for these results by further describing the economic and demographic circumstances of DI recipients relative to non-recipients, using restricted-use "gold standard" Survey of Income and Program Participation data linked to Social Security Administration records as well as data from the Consumer Expenditure Survey. We find that DI recipients show important signs of economic disadvantage, particularly in the lower-income groups where DI income has the largest mortality effects. In more preliminary work, we suggest that incorporating the mortality benefits to these lower-income groups can have implications for the analysis of optimal DI benefits, though the implications vary significantly across assumptions and no clear takeaway is possible regarding optimal DI payments.

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I. Introduction

In this paper, we document that U.S. Social Security Disability Insurance (DI) beneficiaries – particularly lower-income DI beneficiaries – suffer from significant economic disadvantage, which we document in new ways using consumption, income, and wealth data. We find that in this highly disadvantaged group, the welfare benefits of increased DI benefits are significant. The most-disadvantaged DI beneficiaries receive significant benefits from DI income through reductions in their mortality risks (Gelber et al. 2022), which, we suggest in more preliminary work, can have implications for their optimal DI benefits under certain conditions.

According to classic public finance theory, the welfare effects of social income insurance programs like Social Security Retirement and Survivors Insurance, Disability Insurance, Workers' Compensation, and Unemployment Insurance are judged by trading off the protections they provide through reducing consumption risk against the moral hazard costs from the resulting reductions in labor supply (Baily 1978, Feldstein 2005, Chetty 2006, Chetty and Finkelstein 2013). In evaluating this tradeoff using data, consumption has generally been measured in a way that excludes health consumption (Gruber 1997, Chetty 2008, Meyer and Mok 2013). If such programs have substantial effects on health, including on mortality in particular, then this could have additional consequences for evaluating their benefits relative to their costs, given the large value of improved health reflected in the value of a statistical life year (VSLY). This is perhaps particularly important for programs that focus on populations in poor health.

Disability insurance programs are a key part of the safety net provided by social insurance, as it protects workers and their families from the major economic risks associated with a permanent disability that prevents or limits work. In the U.S., DI currently insures over 175 million American adults against these risks, and in 2020 paid $144 billion to 10 million disabled workers and their families (Social Security Administration (SSA) 2021). Beneficiaries are heavily dependent on such payments: 80 percent are in households that receive more than half of their income from DI, and 31 percent are in households that had no income other than from DI. While households with DI beneficiaries have a poverty rate of 18 percent, it would be 50 percent if DI income were excluded (Bailey and Hemmeter 2014). DI beneficiaries are also in poor health: approximately 14 percent of those who entered DI between 2006 and 2010 died within four years, a mortality rate that is roughly ten times the rate for working-age adults in the general population (Arias 2014, Zayatz 2015).

Given these characteristics, a fundamental policy question is whether DI income improves the health of those who receive it. This study builds on Gelber et al. (2022), which finds that DI income strongly reduces mortality among lower-income beneficiaries – particularly the lowest-income group. A study using Dutch disability reforms that found opposite-signed effects of DI income on health for men and women (Garcia-Gomez and Gielen 2014). Two studies find negligible impacts (Silver and Zhang 2021; Black *et al.* 2021), though in different samples than the other studies. Other evidence is limited to the larger literature on how income affects health in non-DI contexts.[1] The recent work on the mortality implications of DI promises shed light on the benefits of DI and thus its optimal design, illustrating the broader importance of incorporating the mortality benefits of social insurance programs in considering their optimal design.

The scant evidence on the mortality effects of DI contrasts with the large and growing literature quantifying the costs associated with the reduction in work due to disability insurance.[2] In considering the potential benefits of DI, studies of the welfare effects of DI largely focus on its value for smoothing consumption or reducing income volatility (*e.g.*, Bound, Cullen, Nichols,

[1] A large literature spanning many disciplines has established that there is a strong positive correlation between income and good health, including reduced mortality and morbidity (*e.g.* Kitigawa and Hauser 1973). However, in some cases it has been difficult to establish whether these observed correlations are due to a causal relationship of income being protective of health (Smith 1999, Deaton 2003). For examples of studies that examine the health effects of income from social insurance or transfer programs other than DI, see Case (2004), Jensen and Richter (2004), Snyder and Evans (2006), Salm (2011), Barham and Rowberry (2013), Evans and Garthwaite (2014), Huang and Zhang (2016), Hoynes, Schanzenbach, and Almond (2016), and Hansen, Nguyen, and Waddell (2017). For examples of studies that use other types of income, see Preston (1975), Preston and Taubman (1994), Ettner (1996), Deaton and Paxson (2001), Lindahl (2005), Wilkinson and Pickett (2006), Adda, Banks, and Gaudecker (2009), Akee *et al.* (2013), and Cesarini *et al*. (2015). A related question is how employment or job displacement affects health (Sullivan and von Wachter 2009).

[2] For example, see Bound (1989), Gruber and Kubik (1997), Gruber (2000), Black, Daniel, and Sanders (2002), Autor and Duggan (2003), Chen and van der Klaauw (2008), von Wachter, Song, and Manchester (2011), Weathers and Hemmeter (2011), Campolieti and Riddell (2012), Maestas, Mullen, and Strand (2013), Borghans, Gielen, and Luttmer (2014), French and Song (2014), Gubits, Lin, Bell, and Judkins (2014), Kostøl and Mogstad (2014), Autor, Maestas, Mullen, and Strand (2015), Coile (2016), Moore (2015), and Gelber, Moore, and Strand (forthcoming). For a review of earlier work, see Bound and Burkhauser (1999).

and Schmidt 2004, Chandra and Samwick 2005, Ball and Low 2009, Meyer and Mok 2013, Low and Pistaferri 2015, Deshpande and Lockwood 2021).[3] Chetty and Finkelstein (2013) note the limited attention given to the potential benefits of DI: "One particularly important program that has received relatively little attention in terms of measuring benefits and welfare consequences is disability insurance" (p. 189).

Gelber et al. (2022) find that gains in life expectancy represent an important benefit of DI not recognized in previous estimates of optimal disability insurance benefit levels. This paper provides key context for those results. First, to better understand the populations for whom we find the large reductions in mortality from DI benefits, in this paper we document their economic and demographic circumstances. Specifically, in this paper our key contribution is to provide further descriptive evidence on DI recipients and DI non-recipients. We use two sources of data to provide this descriptive evidence. First, we rely on the restricted-use "gold standard" Survey of Income and Program Participation (SIPP)/Social Security Administration (SSA)/Internal Revenue Service (IRS) files made available by the Census Bureau. The "gold standard" SIPP results show that DI recipients show important signs of economic disadvantage, particularly in the lower-income range where we find the largest mortality impacts. Second, we rely on the Consumer Expenditure Survey (CES). The CES results show that the DI beneficiary samples have substantially lower total expenditures than does the non-DI sample, particularly for DI beneficiaries with below-median current income. These provide important context for the results that follow, by demonstrating the significant economic disadvantage of the population that we study. These are also material contributions in their own right, as we provide novel descriptive evidence on consumption, wealth, and income of DI recipients against a background of relatively little exploration of such issues in the academic empirical literature, which has typically focused far more on the causal effects of DI or on optimal DI calculations.

We suggest a further contribution by exploring how optimal social income insurance benefits could be calculated when income insurance affects lifespan (or health more broadly), as measured separately from non-health consumption. Our framework could be relevant in a

[3] Deshpande (2016) also examines how Supplemental Security Income for low-income youth affects income volatility. See Diamond and Sheshinski (1995) for a theoretical exploration of optimal DI.

framework in which individuals are not fully rational in their consumption decisions, *i.e.* they do not equate the marginal utility of health and non-health consumption. Under such conditions, it is possible that the formula for optimal benefits reflects the effect of income on health and the resulting effect on utility, separate from the non-health consumption impacts. Our empirical estimates of the mortality effect of DI help inform this optimal DI calculation. However, this work is preliminary, and unfortunately the results on optimal DI benefits are disparate across specifications.

The remainder of the paper is structured as follows. Section II reviews our work from Gelber et al. (2022). Section III introduces descriptive evidence not in Gelber et al. (2022), specifically showing demographic characteristics of DI recipients near the bend points, and discusses implications for the welfare analysis of DI. Section IV concludes.

II. Gelber, Moore, Pei and Strand (2022)

In Gelber et al. (2022), we estimate the causal effect of income on mortality by using a Regression Kink Design (RKD) applied at three "bend points" in the formula that determines DI benefit amounts. Monthly DI payments – known as the Primary Insurance Amount (PIA) – are a progressive function of a beneficiary's Average Indexed Monthly Earnings (AIME), which are the average of past earnings in Social Security-covered employment over the individual's highest-earning years. As shown in Figure 1, there are two bend points at which the marginal replacement rate discontinuously changes: it changes from 90 percent to 32 percent at the "lower bend point" and from 32 percent to 15 percent at the "upper bend point." In addition to these two bend points, family payment rules create a third bend point where the marginal replacement rate for a family's combined worker and dependent benefits changes from 85 percent to 48 percent of AIME. We refer to this as the "family maximum bend point." We use SSA microdata on all new DI beneficiaries from 1997 to 2009, covering 3,648,988 beneficiaries in the full sample. Our primary outcome is the average annual mortality rate during the first four years on DI.

We find that DI payments reduce mortality among lower-income beneficiaries. At the lower bend point, corresponding to the fourth percentile of AIME among DI recipients where annual DI income is $8,543,[4] we estimate that an increase of $1,000 in annual DI payments decreases beneficiaries' annual mortality rate by 0.23 percentage points. At the family maximum bend point, corresponding to the 30th percentile of AIME where the combined annual DI income to the primary beneficiary and that beneficiary's dependent(s) is $18,972, we estimate that an increase of $1,000 in annual DI payments decreases beneficiaries' annual mortality rate by 0.086 percentage points. These estimates correspond to elasticities of mortality with respect to DI income of -0.56 and -0.57, respectively. Around the upper bend point, corresponding to the 84th percentile of AIME where the primary beneficiary receives $20,777 per year, we find no robust evidence of an effect, though our confidence intervals cannot rule out substantial effects. We perform several robustness and placebo tests to verify that our estimates at the lower and family maximum bend points represent true causal policy effects, as opposed to an underlying non-linearity in the relationship between mortality and AIME.

Our baseline point estimates show that it costs around $50,000 to save an additional life year at the lower bend point, and about $140,000 at the family maximum bend point. This is the same order of magnitude as the VSLY measures from the latest major expert panel (Neumann, Cohen, and Weinstein 2014, Neumann *et al.* 2017) suggests that the mortality benefits of additional DI income at the lower and family maximum bend points is a substantial fraction of the magnitude of the DI payments.

Given the large value of a statistical life year (VSLY), even moderate-sized effects on lifespan can translate into large benefits. As an initial exercise illustrating the potential importance of these effects, we calculate the mortality benefits associated with a given amount of DI expenditure.[5] For illustration we discount expenditures at a three percent real rate, though our calculations are very similar with other discount rates in this range.

Our estimates on the effects by year through Year 16 imply that saving a statistical life year requires around $49,707 in additional expenditure at the lower bend point, and $139,190 at

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[4] All dollar amounts are expressed in 2013 dollars.

[5] If DI payments improve the quality of life as well, then the benefits would be commensurately larger. On the other hand, the VSLY could be lower for those with lower incomes (Viscusi and Aldy 2003).

the family maximum bend point (both $p<0.05$).[6] Neumann, Cohen, and Weinstein (2014) and Neumann *et al.* (2017) have suggested using $100,000 per life year as a benchmark VSLY for the general population, while a Quality Adjusted Life Year (QALY) of $25,000 per life year as a makes sense as a "conservative" estimate for a low-income disabled individual since life quality may be lower and income is lower. Thus, at the lower bend point our estimates show that the cost of saving an additional life year is the same order of magnitude as the VSLY or QALY, while it is at least a substantial fraction of the QALY at the family maximum bend point.[7] At the upper bend point, the point estimate shows that $881,543 in additional expenditure is required to save a statistical life year, but this is insignificant at conventional levels.

III. Additional Context on DI Recipients and Non-Recipients from Gelber, Moore, Pei and Strand (2022) and Beyond

For further context on these estimated impacts, it is useful to describe the samples further. Table 1 shows summary statistics, reprised from Gelber et al. (2022). In the full sample, we have data on 3,648,988 observations. Average PIA is $1,360. PIA is a monthly measure of DI payments, so that $1,360 in monthly payments translates into an annualized benefit of $16,315. Annual mortality rates in the four years after first receiving DI range decline over time, with 7.0 percent dying in the first year after program entry and 2.6 percent dying in the fourth year. Average age when applying is 48.6, and 53.1 percent of the sample is male. For approximately half of the sample, the primary disability is either a musculoskeletal condition (29.7 percent) or mental disorder (20.1 percent), with neoplasms (cancer) (11.6 percent) and cardiovascular conditions (largely heart disease) (10.3 percent) also common.

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[6] This $139,130 million at the family maximum bend point is calculated using the combined payments to the primary beneficiary and the dependent; assuming it is only the benefits to the primary beneficiary that reduce that beneficiary's mortality, then saving a statistical life year requires around $92,794 in additional expenditure at the family maximum bend point.

[7] For context, Almond, Doyle, Kowalski, and Williams (2010) estimate that saving a statistical life through greater Medicaid spending costs around $550,000, or less than the $2.7 million value of a statistical life calculated in Cutler and Meara (2000). However, this is a substantially different context than ours, for example because the policy variation relates to publicly provided medical care, as opposed to additional income in our setting.

The table also shows the summary statistics for samples around each of the bend points. Those around higher bend points have higher mean PIA. The lowest mortality rates are observed for the family maximum BP sample; beneficiaries must have a dependent to be included resulting in this relatively young sample. Figure 2 (reprised from Gelber, Moore, and Strand 2022) shows that the lower, family maximum, and upper BPs correspond to the 4th, 30th, and 84th percentiles of the AIME distribution, respectively.[8]

Tables 2 and 3 provide additional context that does not appear in Gelber et al. (2022); these two tables constitute the primary contribution of this paper, specifically providing further evidence on the circumstances of DI recipients around the bend points. In Table 2 we use data from the Survey of Income and Program Participation (SIPP), linked by the Census Bureau to administrative data on program participation and income from the Social Security Administration and the Internal Revenue Service (SIPP/SSA/IRS files). We use the 1996, 2001, 2004 and 2008 SIPP panels, each representative of the U.S. civilian, non-institutionalized population, and the restricted-use "gold standard" SIPP/SSA/IRS files (discarding data that are missing or imputed). Specifically, we generate our results using the Census Bureau's "Completed Gold Standard Files" and do not use respondents with imputed data.

All respondents are aged between 21 and 61 in the first month that the SIPP was conducted. The samples around each of the bend points are based on DI payments reported in the administrative data. For each SIPP panel (1996, 2001, 2004 and 2008), we take respondents at different sections of the cumulative distribution function of DI payments that match the locations of the bend point samples in the SSA administrative data: the lower bend point sample is between 0.6% and 11.8% of DI payments; the family maximum bend point sample is between 12.9% and 47.6% of DI payments (and conditional on having dependent children under 18 years old); the upper bend point sample is 76.6% and 91.6%. The fraction married and the average number of children is higher for the family maximum sample than the other two groups, which reflects the presence of dependents for the family maximum sample. The number of respondents who meet this criterion relative to DI beneficiaries with dependent payments suggests we are

[8] An AIME at the 30th percentile of the distribution for the full population (combining both those with and without dependents) puts beneficiaries with dependents at the family maximum BP.

slightly overstating the number of SIPP/SSA/IRS respondents who are actually subject to the family maximum bend point; unfortunately, direct information on dependent DI payments is not available in the SIPP/SSA/IRS files. Dollars are converted to 2013 values.[9]

DI recipients as a whole show important signs of economic disadvantage; for example, across the three bend points, DI income is the only source of income for between 40 and 50 percent of recipients. Focusing on medians to reduce the influence of outliers, measures of households' resources are generally much larger for respondents assigned to the upper BP region than the other two bend points. This is true for both overall current income and various measures of assets, including human capital, home ownership, and overall wealth. Most measures indicate those at the lower BP have somewhat lower economic resources than those at the family maximum BP; however, those at the family maximum BP are younger, helping to explain why other measures such as net wealth are slightly lower here than at the lower BP.[10]

For further context that also does not appear in Gelber et al. (2022), we use data from the Consumer Expenditure Survey (CES). Table 3 shows the summary statistics for DI recipient and non-recipient households. DI beneficiaries are not directly identified in the CES. However, Moore and Ziebarth (2014) show that Social Security payments are nearly always to DI beneficiaries when everyone in the household is aged under 60. Note that the CES does not necessarily capture all forms of household expenditure. For discussion of the measurement issues associated with the CES, see Meyer and Sullivan (2011) and Bee, Meyer and Sullivan (2015).

The summary statistics in Table 3 show that the DI beneficiary samples have substantially lower total expenditures than does the non-DI sample, particularly for DI beneficiaries with below-median current income. However, relative to the non-DI sample, health expenditures are substantially higher among DI beneficiaries (consistent with Ganong and Noel 2017).

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[9] Note that the linked data contain a limited number of variables from both the SIPP and SSA administrative data files; please see https://www.census.gov/programs-surveys/sipp/guidance/sipp-synthetic-beta-data-product.html.
[10] Around the lower BP, many will be ineligible for Medicaid due to their assets exceeding the limit (despite having low assets relative to other groups).

Given this context – demonstrating the significant economic disadvantage of the population we study – it is perhaps unsurprising that this population experiences significant reductions in mortality from increased DI benefits. Next, we turn to the implications of mortality effects for setting optimal DI benefits, showing that these reductions in mortality imply higher optimal benefits.

IV. Possible Implications for Welfare Analysis

Drawing on the calculations in Section II of the benefits associated with a given DI expenditure as well as the descriptive picture painted in Section III, we can suggest implications for setting optimal DI benefits by exploring the Baily-Chetty framework for optimal social income insurance to take account of health effects in settings in which individuals are not optimizing with respect to health and non-health consumption. In the traditional Baily-Chetty formula for optimal social insurance, social income insurance benefit levels are set to balance the gains from a reduction in consumption risk against the losses due to moral hazard in labor supply. However, in implementing the Baily-Chetty formula, consumption has generally been measured in a way that excludes health consumption (on UI, see Gruber 1997 and calibrations relying on it including Chetty 2008; on DI, see Meyer and Mok 2013). Social insurance benefits may additionally affect health consumption, which can be measured separately from non-health consumption – for example, in our context we measure the effect of DI benefits on mortality. Not only DI but also other social income insurance programs, such as unemployment insurance (UI) or workers' compensation, could affect health.

To illustrate how incorporating health separately from non-health consumption can influence the formula for optimal social insurance when individuals do not rationally equate marginal utilities, we begin by reviewing the derivation of the classic Baily-Chetty formula, based on the exposition in Chetty (2006). Next, we explain how this formula could be altered when DI benefits can affect health.

The Baily-Chetty framework assumes an individual faces a risk: there are two states, high (*h*) and low (*l*). In the UI context in which the Baily-Chetty model was originally exposited, the high state represents the employed state, while the low state represents the unemployed state. In the DI context that we study in this paper, the individual is not disabled in the high state, while the individual experiences a disability in the low state. We let w_i be the individual's income in state i, where $i \in \{l,h\}$, c_i represents consumption in state i, and A is wealth. Utility is a strictly concave function $u(c;i)$, where utility is allowed to be state-dependent due to its dependence on i. The individual controls probability of being in the bad state by exerting effort e at a cost $\psi(e)$, where e is scaled so that the probability of being in the high state is given by $p(e) = e$.

In our context, we can assume that the DI system pays a constant benefit b, financed by a constant lump sum tax $t(b)$ in the high state. The government's balanced budget constraint is: $e*t(b) = (1-e)*b$.

Agents maximize expected utility, taking b and $t(b)$ as given:

$$\max_e eu(A + w_h - t(b); h) + (1 - e)u(A + w_l + b; l) - \psi(e) \qquad (1)$$

The government's problem is to maximize the agent's indirect expected utility $V(b,t;i)$, subject to the government's budget constraint:

$$\max_b V(b, t; i) \text{ s.t. } e(b)t(b) = \big(1 - e(b)\big)b \qquad (2)$$

The first order condition is:

$$\frac{\frac{\partial u}{\partial c_l} - \frac{\partial u}{\partial c_h}}{\frac{\partial u}{\partial c_h}} = \frac{\varepsilon_{1-e,b}}{e} \qquad (3)$$

This equation provides an exact formula for the optimal benefit. It shows that the marginal benefits of extra consumption in the low state (left hand side) equal the marginal costs of transferring the dollar due to behavioral responses (right hand side). This is the traditional way of conceptualizing the benefits and costs of social insurance (Feldstein 2005, Chetty and Finkelstein 2013): the optimum balances protection (benefits) and distortion (costs). Note that this formula has typically been written in the case of state-independent utility, where the derivatives are instead written as $u'(c_l)$ and $u'(c_h)$ – rather than the partial derivatives $\frac{\partial u}{\partial c_l}$ and $\frac{\partial u}{\partial c_h}$, respectively – because utility does not additionally depend on the state *i*.

Equation (3) shows a number of intuitive features. First, optimal benefits are decreasing in the elasticity ε: loosely speaking, increases in ε will require increases in $\frac{\partial u}{\partial c_l}$ relative to $\frac{\partial u}{\partial c_h}$, thus requiring decreases in benefits in the low state. Second, Baily-Chetty derive a Taylor series approximation to this formula that equates the consumption drop due to the low state multiplied by the coefficient of relative risk aversion, to the elasticity of the probability of the low state with respect to benefits. This illustrates that the more risk averse people are, the higher optimal benefits in the low state should be. Loosely speaking, this can be seen already in (3): as utility becomes more concave, $\frac{\partial u}{\partial c_l}$ rises relative to $\frac{\partial u}{\partial c_h}$ (holding c_l and c_h constant), implying that low state benefits must rise to equate both sides of the expression. The Baily-Chetty Taylor series approximation also shows that as the consumption drop due to the low state increases, optimal low state benefits must increase. Loosely speaking, again this can be seen in (3): as c_l falls relative to c_h, $\frac{\partial u}{\partial c_l}$ rises relative to $\frac{\partial u}{\partial c_h}$, implying that benefits must rise in the low state to equate both sides of the expression.

When individuals also derive utility from health, which social insurance income can affect, and they do not equate marginal benefits rationally, this formula could be modified. We postulate that individuals derive utility $U=u(c,H)-\psi(e)$ from both non-health consumption *c* and health *H* (as well as effort *e* as above), which in our context reflects lifespan but that could also encompass other aspects of health such as the quality of life. Health is modeled as a single composite commodity encompassing reflecting the influence of the individual's various choices, including investment in health capital, claiming of social insurance programs, and so forth. Other assumptions are as above in the Baily-Chetty context. We hypothesize that individuals may not be optimizing, in the sense that they may not be equating the marginal utility of health and non-health consumption. We can then derive a formula in which we allow the value of life – as estimated in studies of the value of a statistical life year – to drive our calibration of optimal DI benefits, rather than the more typical approach of basing this on data on non-health consumption.

Agents now maximize a modified version of (1) incorporating health as an argument in utility:

$$\max_e eu(A + w_h - t(b), H) + (1 - e)u(A + w_l + b, H) - \psi(e) \quad (4)$$

The government still maximizes the agent's indirect utility *V(b,t)* subject to the government's budget constraint (2) and now taking as given that the agent maximizes (4). The first order condition is now given by:[11]

$$\frac{\frac{\partial u}{\partial c_l} + \frac{\partial u}{\partial H_l}\frac{\partial H_l}{\partial b}}{\frac{\partial u}{\partial c_h} + \frac{\partial u}{\partial H_h}\frac{\partial H_h}{\partial b}} = 1 + \frac{\varepsilon_{1-e,b}}{e} \quad (5)$$

This is similar to the Baily-Chetty formula (3) above, with a few key similarities and differences. As in the Baily-Chetty formula (3), and due to similar reasoning as above, in (5) optimal benefits are still decreasing in the elasticity ε, and increasing in the consumption drop due to the low state as well as the concavity of utility.

Relative to (3), in (5) the terms $\frac{\partial u}{\partial H_l}\frac{\partial H_l}{\partial b}$ and $\frac{\partial u}{\partial H_h}\frac{\partial H_h}{\partial b}$ appear in the numerator and denominator of (5). These have straightforward intuitive interpretations. $\frac{\partial u}{\partial H_i}\frac{\partial H_i}{\partial b}$ represents the partial effect on utility of an increase in health H_i in state *i,* decomposed into the partial effect of benefits on health $\frac{\partial H_i}{\partial b}$ and the partial effect of health on utility $\frac{\partial u}{\partial H_i}$. Loosely speaking, the larger that the partial effect of income on utility through the health channel $\frac{\partial u}{\partial H_i}\frac{\partial H_i}{\partial b}$ is in the low state relative to the high state, the larger the numerator grows relative to the denominator, and therefore the higher that benefits must be in the low state. This applies, therefore, to each

[11] We suppress arguments of the *u*() function for notational convenience.

constituent part of $\frac{\partial u}{\partial H_i}\frac{\partial H_i}{\partial b}$: loosely speaking, the larger that the partial effect of health on utility $\frac{\partial u}{\partial H_i}$ grows in the low state relative to the high state, and/or the larger that the partial effect of income on health $\frac{\partial H_i}{\partial b}$ grows in the low state relative to the high state, the larger optimal benefits will be.

In terms of the formula for benefits (5), our study therefore provides the first estimates of the key empirical parameter $\frac{\partial H_l}{\partial b}$, the effect of benefits on health in the low (in our case, disabled) state. The larger that this grows, the larger that optimal benefits in the low stat will be. Since our estimates show that this parameter can be large in our DI context, and the VSLY is large, it raises the possibility that incorporating the effect of benefits on health will make a large difference to the optimal level of DI benefits.

Other parameters have been estimated or approximated in previous work. $\frac{\partial u}{\partial c_l}$ and $\frac{\partial u}{\partial c_h}$ can be parameterized through common assumptions on the utility function, as in empirical implementations of the Baily-Chetty formula above, for example by assuming a constant relative risk aversion, state-independent form for utility. The consumption drop due to the low state can be estimated empirically, as we discuss below. Others have estimated the effect of income on health in the US population not restricted to those on DI, which can be seen as similar to $\frac{\partial H_h}{\partial b}$ particularly if the sample is limited to the non-disabled (though a small enough fraction of the US population has a disability that this is likely to be well approximated by the effect of income on health in the full population).[12]

To put $\frac{\partial u}{\partial H_i}$ in a form that can be implemented empirically, note that $\frac{\partial u}{\partial H_i}$ can be re-written as $\frac{\partial u}{\partial H_i} = \frac{\partial u}{\partial c_i}\frac{\partial c_i}{\partial H_i}$. In the context in which H represents lifespan, $\partial c/\partial H_i$ (holding utility constant) reflects the willingness to pay for increments in lifespan, *i.e.*, the value of a statistical life year (*e.g.*, Hammitt 2007).

[12] See Evans and Garthwaite (2014) and the references therein.

Thus, an empirically implementable form for (5) can be written as:

$$\frac{\frac{\partial u}{\partial c_l} + \frac{\partial u}{\partial c_l}\frac{\partial c_l}{\partial H_l}\frac{\partial H_l}{\partial b}}{\frac{\partial u}{\partial c_h} + \frac{\partial u}{\partial c_h}\frac{\partial c_h}{\partial H_h}\frac{\partial H_h}{\partial b}} = 1 + \frac{\varepsilon_{1-e,b}}{e}$$

or, if H_i reflects a measure of lifespan (years of life) as in our context:

$$\frac{\frac{\partial u}{\partial c_l}(1 + QALY_l\frac{\partial H_l}{\partial b})}{\frac{\partial u}{\partial c_h}(1 + QALY_h\frac{\partial H_h}{\partial b})} = 1 + \frac{\varepsilon_{1-e,b}}{e} \qquad (6)$$

Therefore, in the spirit of Meyer and Mok (2013), we can use this formula to find optimal DI benefits. Meyer and Mok (2013) find that over the long run 12% of the population suffers a disability, implying $e = 0.88$. They also suggest a baseline elasticity of $\varepsilon_{1-e,b} = 0.49$ (though note that if income effects are important in DI, as shown in Gelber, Moore, and Strand (forthcoming), the relevant compensated elasticity would be lower). As Meyer and Mok (2013) argue, assuming constant relative risk aversion state-independent utility, this implies that DI benefits are currently too low.

Under the above baseline assumptions and values of the e and $\varepsilon_{1-e,b}$ parameters, we can calculate the optimal consumption ratio $\frac{c_l}{c_h}$ that would be implied when we take into account the mortality benefits of the program. To incorporate the mortality benefits of the program using our modified formula (6), we need several more parameter values. It is necessary to know the values of $QALY_l$ and $QALY_h$. In our baseline we assume $QALY_l = \$50{,}000$ and $QALY_h = \$100{,}000$, following the suggestions in Neumann, Cohen, and Weinstein (2014) and Neumann *et al.* (2017). For illustrative purposes we can also assume log utility.

Further, we need not only our empirical estimates of the mortality effect of the program $\frac{\partial H_l}{\partial b}$, but also estimates of the mortality effect of income in the non-DI population that is taxed to provide DI benefits, $\frac{\partial H_h}{\partial b}$. Our formula therefore underscores the potential relevance of this parameter, which has not been estimated in previous work to our knowledge.

Our results are summarized in Table 4. Unfortunately, the results are disparate across different assumptions. As a start, we can assume that the effect in the general US population $\frac{\partial H_h}{\partial b}$ is equal to our point estimate of the effect at the family maximum bend point – the 30th percentile of AIME. We can then calculate, under the baseline point estimates and other assumptions described above, that the optimal consumption ratio $\frac{c_l^*}{c_h^*}$ at the lower bend point is 0.87. In other words, optimally consumption would drop by around 13% in the disabled state relative to the non-disabled state. Intuitively, income transfers in the disabled state for those at the lower bend point are so valuable that these individuals should be almost fully insured against disability.

We can also explore the results under a range of alternative assumptions. For example, if we assume $QALY_l = \$30{,}000$ (consistent with severe disability in this very low-income group), then we would calculate $\frac{c_l^*}{c_h^*}$ at the lower bend point is 0.55, implying that optimal DI replacement rates would be much lower.

On the other hand, if we assume that $\frac{\partial H_h}{\partial b}$ is lower than the effect we estimate at the family maximum bend point – which appears reasonable since the family maximum bend point recipients have lower income and wealth than the population as a whole, as indicated in Table 2 – we would estimate higher optimal replacement rates. For example, if $\frac{\partial H_h}{\partial b}$ is 90% as large in the population as a whole than at the family maximum bend point, then we would calculate $\frac{c_l^*}{c_h^*} = 0.96$ when $QALY_l = \$50{,}000$ and $\frac{c_l^*}{c_h^*} = 0.71$ when $QALY_l = \$30{,}000$. This is one sense in which the descriptive results presented earlier provide important context for the optimal benefit calculations: they provide context to assess whether the estimate of $\frac{\partial H_h}{\partial b}$ from the family maximum bend point is likely to be an over-estimate or under-estimate of the true effect in the population as a whole; since the descriptive results indicate that individuals at the family maximum bend point are more disadvantaged than the population as a whole, it suggests that the estimates at the family maximum bend point may be an over-estimate of this effect in the population as a whole, because the mortality-income relationship is concave (Preston, 1975; Chetty *et al.*, 2016).

Across Table 4, the results are rather sensitive to the assumptions on the parameters driving the calculations. We conclude that further work to estimate such parameters may be needed.

In assessing the implications of our findings, it is worth noting that in a model in which individuals are rational, the marginal utility of consumption (relative to the numeraire) should be equalized across all goods. Thus, in a rational model the optimal DI benefit derived from the analysis of other types of consumption (e.g. Meyer and Mok 2013, Low and Pistaferri 2015) should be exactly the same as the optimal DI benefit derived from an analysis of the mortality implications. However, individuals may not be placing as much weight on mortality considerations as the rational model would imply.

V. Conclusion

A key policy question regarding DI is the extent to which disability insurance payments affect mortality. Our evidence in Gelber, Moore, and Strand (2022) demonstrates that DI payments reduce mortality, particularly in the lowest-income groups. These results imply that among the lowest-income groups we study, the outlay associated with saving a life-year through additional DI payments is the same order of magnitude as the benefits of the program at the lower and family maximum bend points. The lifespan gains can therefore be a substantial factor in driving the benefit-cost calculations.

In this paper we make a number of contributions relative to the evidence presented in Gelber et al. (2022). Our primary contribution is that we show here, using the gold standard SIPP and CES, that the DI population – particularly in the lower-income groups where Gelber et al. (2022) find the largest mortality benefits of DI income – suffers significant economic disadvantage. Given this context, it is perhaps unsurprising that this group also experiences a significant reduction in mortality from additional DI income.

We further find in this paper that due to this significant reduction in mortality in this disadvantaged group, adding mortality considerations to the standard welfare analysis of DI makes an important difference to our understanding of optimal DI benefits. However, the results are rather sensitive to specification.

Our mortality effect estimates do not necessarily generalize to non-DI populations. DI recipients have particularly high mortality rates, particularly in the lowest-income groups where we find the biggest mortality effects, and their mortality probability might be particularly affected by transfer income. Further work could further explore the demographic and economic characteristics of DI recipients and non-recipients, and further explore the welfare implications of taking DI mortality benefits into account under alternative assumptions. Further literature will continue to add to our knowledge about the effects of DI income on mortality, and the associated benefits relative to costs, in other contexts.

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Table 1. *Summary Statistics*

	Lower bend point		Family max. bend point		Upper Bend point		Full sample	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Demographic Information								
Age when applying for DI (years)	46.9	9.72	40.8	8.04	50.7	7.16	48.6	8.61
Fraction male	0.231	0.421	0.502	0.500	0.720	0.449	0.531	0.499
Fraction black	0.120	0.325	0.165	0.371	0.122	0.327	0.135	0.341
Program Information								
Primary Insurance Amount (PIA)	$675	$126	$1,091	$141	$1,845	$135	$1,360	$480
- Annualized PIA	$8,105	$1,514	$13,098	$1,691	$22,134	$1,614	$16,315	$5,764
Fraction allowed DI via a hearing (after an initial denial)	0.317	0.465	0.324	0.468	0.247	0.432	0.283	0.450
Fraction by disability type:								
Musculoskeletal cond.	0.308	0.462	0.262	0.439	0.293	0.455	0.297	0.457
Mental disorders	0.237	0.425	0.281	0.450	0.166	0.372	0.201	0.401
Other disabilities	0.455	0.498	0.457	0.498	0.541	0.498	0.502	0.500
- Cancers	0.103	0.303	0.098	0.297	0.130	0.337	0.116	0.320
- Circulatory conditions	0.077	0.267	0.072	0.259	0.125	0.331	0.103	0.304
Cumulative Mortality Rates								
1st year after entry	0.062	0.241	0.052	0.222	0.081	0.272	0.070	0.256
2nd year after entry	0.097	0.300	0.080	0.271	0.125	0.331	0.110	0.313
3rd year after entry	0.124	0.329	0.100	0.300	0.160	0.366	0.140	0.347
4th year after entry	0.146	0.353	0.116	0.321	0.190	0.392	0.166	0.372
Observations	412,124		287,723		546,776		3,648,988	

Notes: "SD" denotes the standard deviation. The lower bend point sample includes DI beneficiaries within $400 of the lower bend point; the family maximum bend point sample includes DI beneficiaries with dependents within $700 of the kink induced by the family maximum schedule; and the upper bend point sample includes DI beneficiaries within $650 of the upper bend point. These samples are the same as those considered in our regressions.

Table 2. *Economic Characteristics of DI Beneficiaries near the Bend Points*

	Lower bend point			Family maximum bend point			Upper bend point		
	Median (1)	Mean (2)	SD (3)	Median (4)	Mean (5)	SD (6)	Median (7)	Mean (8)	SD (9)
Demographic Information									
Fraction married	1	0.654	0.478	1	0.731	0.445	1	0.634	0.484
Number of children	2	2.010	1.428	3	2.687	1.362	2	1.592	1.307
Fraction w/o high school	0	0.230	0.423	0	0.151	0.359	0	0.058	0.232
Wealth (including housing)									
Home ownership rate	1	0.669	0.473	1	0.696	0.462	1	0.847	0.361
Housing wealth	$19,708	$80,866	$130,927	$29,021	$61,157	$100,676	$45,233	$80,591	$97,855
Non-housing wealth	$9,701	$69,896	$162,893	$14,368	$88,865	$248,411	$31,894	$116,614	$249,652
Total net wealth	$55,457	$150,762	$231,191	$51,120	$150,022	$294,987	$104,169	$197,205	$295,596
Income and income support									
Total income in first month of SIPP	$904	$1,482	$1,766	$1,460	$1,808	$1,598	$3,350	$3,723	$2,644
Fraction receiving food stamps	0	0.073	0.261	0	0.109	0.312	0	0.009	0.081
Food stamp income in 1st SIPP month	0	$21	$100	0	$23	$79	0	$2.00	$21
AFDC/TANF recipient rate	0	0.012	0.108	0	0.001	0.017	0	0.002	0.022
AFDC/TANF income in 1st SIPP month	0	$2.35	$22	0	$0.70	$10	0	$0.68	$8
Fract. of households w/ only DI income	1	0.502	0.503	0	0.403	0.492	0	0.418	0.495
Observations		81			101			115	

Notes: "SD" denotes the standard deviation.

Table 3. *Summary Statistics for the Consumer Expenditure Survey*

Dependent variable	Respondents receiving DI income			Respondents not receiving DI income
	All	Below-median income	Above-median income	
	(1)	(2)	(3)	(4)
Total expenditures	$8,686.72	$5,722.35	$11,901.09	$11,546.30
	(8,863.33)	(5,592.25)	(11,137.75)	(10,460.05)
Food	$1,230.86	$1,006.70	$1,085.66	$1,521.17
	(794.67)	(671.81)	(746.09)	(1,273.32)
Housing	$2,525.16	$1,770.90	$3,343.03	$3,469.89
	(2,400.98)	(1,781.23)	(2,884.96)	(3,602.42)
Utilities	$708.38	$589.24	$837.57	$732.28
	(483.69)	(435.87)	(539.96)	(516.30)
Home furnishings	$329.88	$194.60	$476.56	$428.86
	($875.94)	(634.57)	(1,122.15)	(1,296.06)
Apparel	$318.23	$203.46	$442.68	$436.14
	(641.47)	(430.36)	(837.28)	(1,115.77)
Transportation	$2,270.78	$1,420.77	$3,192.48	$2,251.51
	(5,787.11)	(3,945.94)	(75,570.43)	(5,389.00)
Health care	$626.75	$478.85	$787.12	$507.27
	(792.68)	(626.22)	(973.62)	(814.21)
Entertainment	$367.84	$222.64	$525.28	$639.84
	(581.33)	(333.73)	(772.42)	(1,575.40)
Personal care	$61.46	$38.85	$85.86	$79.40
	(85.11)	(54.00)	(109.96)	(107.09)
Miscellaneous	$118.35	$109.86	$127.55	$108.37
	(834.03)	(1,033.97)	(540.95)	(1,085.14)
N	673	337	336	19,136

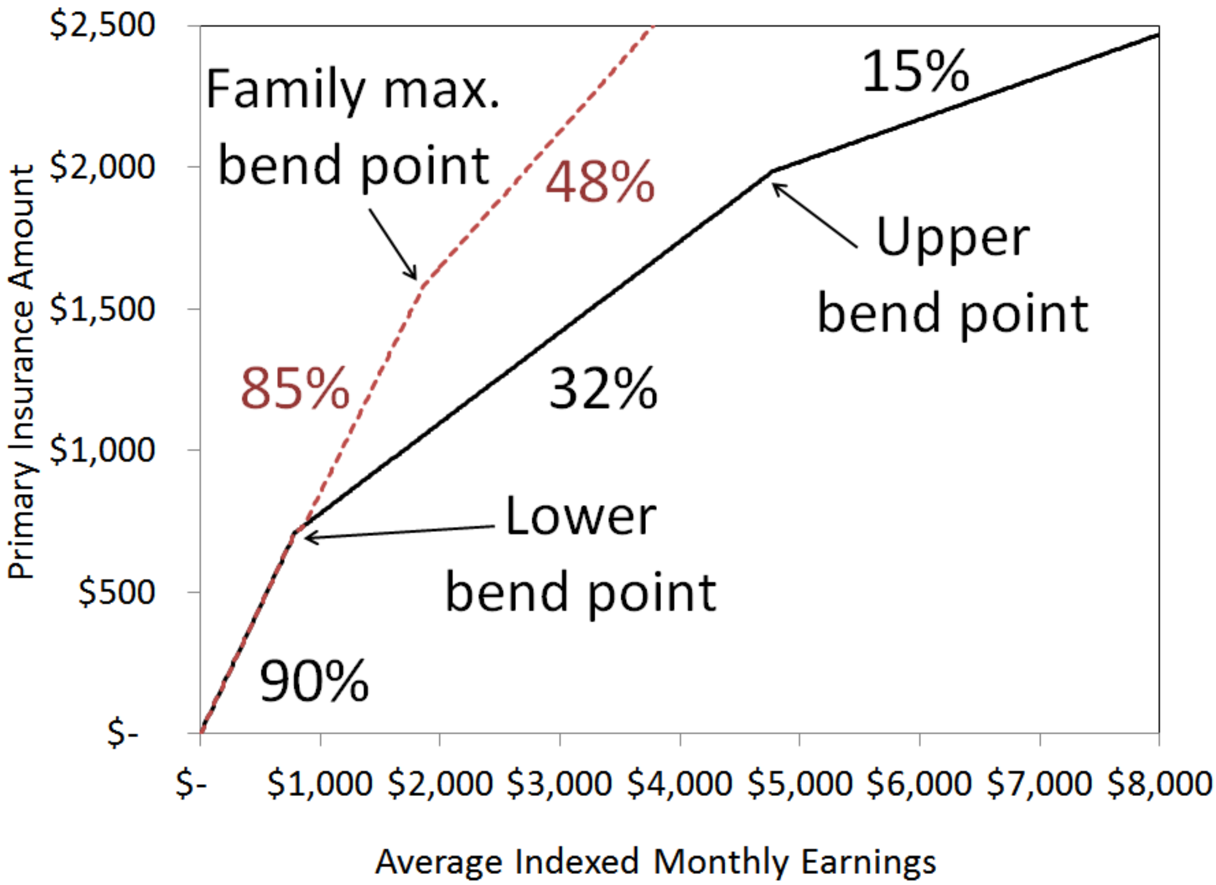
Note: The data are from the Consumer Expenditure Survey from 1986 to 2012, covering all individuals aged 21 to 61. Expenditures refer to real total expenditures last quarter.

Table 4. *Optimal Consumption Ratio* $\frac{c_l^*}{c_h^*}$ *Under Alternative Assumptions*

Assumption on $QALY_l$	$\frac{\partial H_h}{\partial b}$ equal to value at the family max bend point	$\frac{\partial H_h}{\partial b}$ equal to 90% of value at the family max bend point
$QALY_l = \$50{,}000$	$\frac{c_l^*}{c_h^*} = 0.87$	$\frac{c_l^*}{c_h^*} = 0.96$
$QALY_l = \$30{,}000$	$\frac{c_l^*}{c_h^*} = 0.55$	$\frac{c_l^*}{c_h^*} = 0.71$

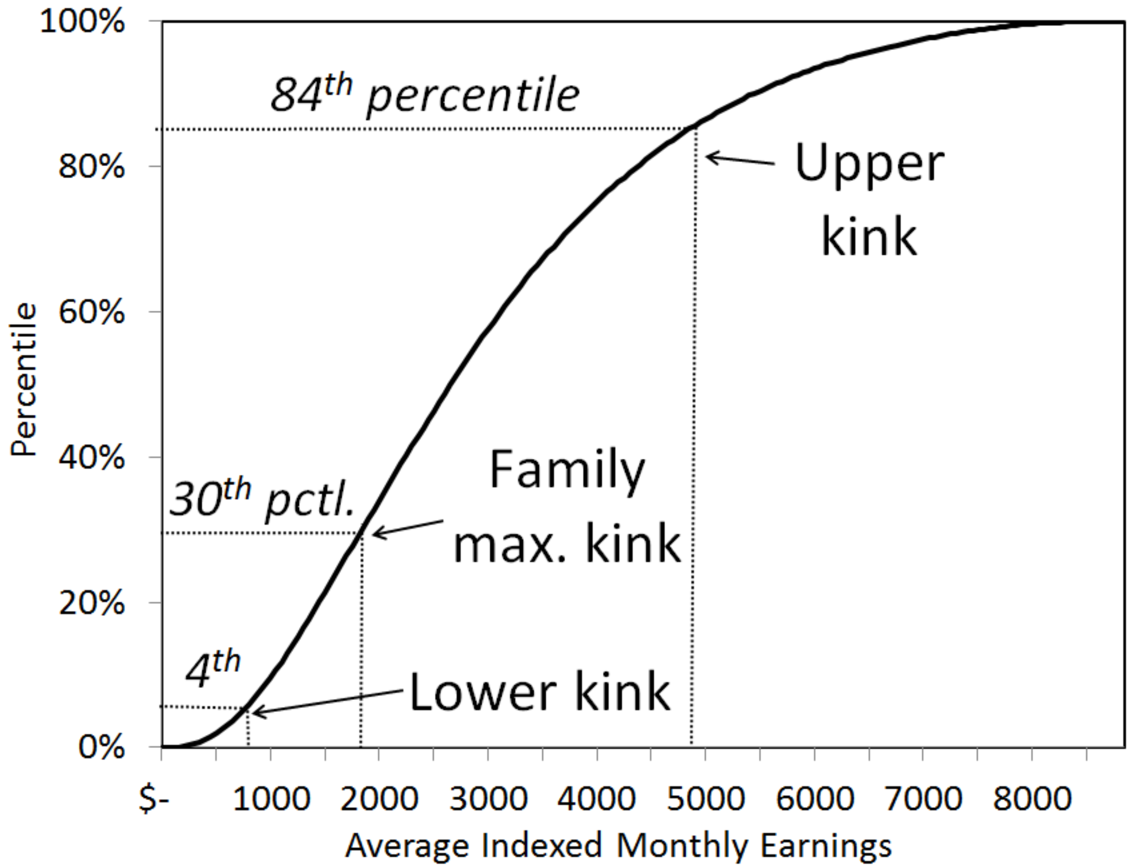
Notes: please see the main text in Section IV for an explanation of these results.

Figure 1. *Relationship of Primary Insurance Amount to Average Indexed Monthly Earnings*



Notes: The solid black line displays the relationship between Average Indexed Monthly Earnings (AIME) and the Primary Insurance Amount (PIA) for beneficiaries. The red dashed line shows the maximum family benefits that can be paid to beneficiaries and their dependents. The family maximum bend point occurs when the binding rule changes from family payments not being larger than 85 percent of AIME to the one that it may not be larger than 150 percent of PIA. This means that the marginal rate changes from 85 percent to 48 percent of AIME (which is equal to 150 percent of the 32 percent replacement rate). The 150 percent rule applies to AIME values higher than this bend point, so at the upper bend point the marginal rate for the family maximum changes from 48 percent (150 percent of 32 percent) to 22.5 percent (150 percent of 15 percent). An AIME at the 30th percentile of the distribution for the full population (combining both those with and without dependents) puts beneficiaries with dependents at the family maximum bend point.

Figure 2. *Cumulative Distribution Function of the Average Indexed Monthly Earnings of new Disability Insurance Beneficiaries*



Notes: The source is SSA administrative records on new DI beneficiaries from 2001 to 2007. See the text for sample restrictions and Table 1 for the characteristics of this full sample.