The Dynamics of Disability: Evidence from a Cohort of Back Pain Patients

Ellen Meara
Ellen.Meara@Dartmouth.edu

Jonathan Skinner
Jonathan.Skinner@Dartmouth.edu

TDI, Dartmouth Medical School, Dartmouth College, and NBER

September 18, 2011: NOT FOR QUOTATION OR ATTRIBUTION

The Social Security Disability Insurance (SSDI) program has been growing rapidly in the past several decades and is projected to run out of money within the decade. In one view, the growth has been generated by the increased generosity of SSDI benefits coupled with sluggish labor markets for lower-educated individuals. In this paper, we develop an alternative model; individuals differ in the extent to which they depreciate their health capital, which in turn can yield higher current wages in some physically demanding jobs. In turn, workers in these jobs end up later in life with poor health and labor market opportunities, and are therefore relatively more likely to apply for SSDI. This model predicts both continued poor health of those applying for SSDI over time, and the critical importance of pain and functioning – rather than just market opportunities – in predicting SSDI applications. We use two data sets, the Health and Retirement Study, and the SPORT randomized clinical trial data on disk herniation (IDH). Among the SPORT patients, nearly everyone is suffering from acute pain at baseline. Over time, a much larger fraction of high school dropouts develop chronic and persistent back pain, which in turn leads to a higher fraction of SSDI applicants. We argue that in a model of endogenous pain and functioning, the design of disability insurance can have a real impact on the health of those workers most likely to apply.

We thank without implicating Joyce DeLeo, Fabio Lange, Joyce Manchester, James Weinstein, and Steve Zeldes for helpful suggestions. Tor Tosteson and Wenyan Zhou provided invaluable assistance in understanding the SPORT data, and Kathleen McGarry kindly lent her expertise with the HRS data. This research was supported by the U.S. Social Security Administration through a grant to the National Bureau of Economic Research as part of the SSA Retirement Research Consortium. The findings and conclusions expressed are solely those of the authors and do not represent the views of SSA, any agency of the Federal Government, or the NBER. Funding for the SPORT study was provided through grant U01 AR045444-11. Skinner also acknowledges financial support from the National Institute on Aging (PO1AG19783).

I. Introduction

The Social Security Disability Insurance (SSDI) program has been growing rapidly in the past several decades and is predicted to run out of money within the decade. The medical model that underlies the current disability system relies on the use of physicians to identify a clinical disorder, determine whether the disorder limits the ability to work, and if so, to award eligibility for SSDI. Once on SSDI, very few exit except through death or transition to Social Security old-age insurance at age 65.

In its earlier years, a larger fraction of SSDI enrollees had clearly delineated clinical disorders such as heart disease or cancer. Between 1996 and 2009, enrollment for workers in SSDI has expanded by 3.4 million people, or a growth of 77%.[1] Of that increase, 1.1 million can be attributed to a greater number of disabled with mental illness, and 1.2 million – a 137% increase – because of increases in musculoskeletal diseases. For these, the "medical model"– the ability to identify the clinical disorder and follow a well-developed protocol to reduce pain, improve function and disability, and (where possible) permit return to work – is not well supported by the clinical literature. It is further difficult to explain the very rapid growth in these two diseases, given the development of new drugs for the treatment of depression and psychosis, and the general decline in the prevalence of blue-collar jobs requiring physical activity.

An alternative explanation for the rising disability rolls has been the increasing generosity of SSDI benefits coupled with sluggish labor markets for lower-educated individuals (Autor and Duggan; 2003, 2006). This explanation is certainly consistent with

[1] These numbers come from the Social Security Administration's *Annual Statistical Report on the Social Security Disability Program, 2009 (published 2010).*

trends in SSDI enrollment across states and time. Yet this economic approach raises concerns about moral hazard, and raising the question , “Are a substantial share of Disability Insurance recipients cheating?” (Autor and Duggan, 2006, p. 85).

In this paper, we consider an alternative economic (and behavioral) model of SSDI applications that differs from the conventional economic model along two basic dimensions. The first is that it allows for a dynamic model with endogenous depreciation of “health capital.” Case and Deaton (2005) developed this model as an alternative variant of the standard Grossman (1972) model where the ravages of middle and old age are kept at bay by buying more medical care. By contrast, Case and Deaton (2005) focus on a different mechanism – that by accepting physically demanding jobs, workers with otherwise poor labor market prospects end up depreciating their health capital, resulting in considerably worse health during middle and later years.

The introduction of a SSDI program which both provides a consumption “floor” during later years and is predicated on poor health, could affect the dynamic choices of how much one can afford to depreciate health capital, whether through job choice or even through consumption choices with adverse health effect, such as smoking. We are not claiming that individuals necessarily depreciate their health “optimally” to qualify for SSDI, given the evidence on decidedly behavioral non-optimal choices, particularly those regarding health and longevity. Nonetheless, we find the model useful if only to focus on hypothesis testing that might allow us to compare whether this dynamic model better predicts micro-level patterns of SSDI applicants observed in the data.

Our empirical work draws on both the longitudinal Health and Retirement Survey (HRS), and the SPORT clinical trial of back pain, with a focus on people with diagnosed cases of disk herniation.   Back pain is a good case study for understanding the growth in enrollment for SSDI because it affects younger workers – the average age of applicants was in their 40s, and because, as noted above, musculoskeletal disease represented 37% of the overall growth in SSDI enrollment since 1996.

Our model can explain a number of empirical regularities that are inconsistent with the standard economic model. For example, standard models would predict that over time, as the SSDI rolls have expanded, there should be increasingly healthy (or "cheating") workers applying. Our model however, allows for endogenous levels of disability that would imply little or no improvement over time in health status among applicants, a result consistent with evidence from the HRS. Similarly, we find in the SPORT data that the decision to apply for SSDI is far more closely related to one's prevailing level of pain than to market opportunities as proxied by education.

This alternative model finds that, like Autor and Duggan, there are large and persistent effects on enrollment and costs of the design of the SSDI system, a point further emphasized by Milligan and Wise (2011). These financial effects would hold particularly in the short-term, when health capital is fixed but jobs evaporate. But the normative implications are quite different; much like Parsons (1991), the pool of SSDI applicants (whether successful or not) respond endogenously to the incentives inherent in the system, thus leading to an increasing pool of workers who end up in middle-age applying for what appears to be a sinecure for life but which does little to repair ongoing and long-term problems with pain, functioning, and depression. Thus there may be even greater potential benefits arising from supported or subsidized employment rather than SSDI insurance requiring many months out of the labor force (Drake et al., 2008).

II. The Model

Economists have argued that rising SSDI caseloads reflect a "broken" system in which DI serves as unemployment insurance because benefit generosity has increased and eligibility has become less stringent. This idea can be captured by a simple one-period model where utility is written:

(1) $$U = H + \varphi(H)\ln(\ell) + \ln(C)$$

where H is health, and φ(H) reflects the marginal value of leisure ℓ relative to consumption C. Note that health affects utility in two ways. The first is that utility depends directly on health, where better health is measured by higher H; we assume that H enters independently of consumption C so that the marginal utility of consumption is independent of health.[2] Second, health affects the relative value of leisure (measured as the fraction of time spent in leisure, so that $0 \leq \ell \leq 1$) compared to working, thus capturing the idea that physical efforts associated with work can exacerbate pain associated with poor health.

The budget constraint for individuals while working is given by

(2) $$C = A + w(H)(1 - \ell)$$

where health H also affects the individual wage. The solution to this maximization problem yields utility $\tilde{U}$. But the alternative to working is to apply for disability insurance, and ignoring for the moment the uncertainty inherent in being approved for SSDI, the successful applicant will experience utility $U^* = H + \ln(B+A)$, where B is the

[2] See Finkelstein et al. (2008) and Viscusi and Evans (1990).

SSDI benefit.[3] Note that SSDI does not have an asset-based means testing, but other welfare programs such as SSI do. Thus the individual solves the problem: $U = \max(\widetilde{U}, U^*)$.

Taking a linear approximation of the resulting solution yields an empirical specification of the form:

(3) $$D^* = \alpha H + \beta R + \varepsilon$$

$$D = 1 \; if \; D* > C, else \; D = 0$$

where D is a categorical variable indicating whether the individual applies for disability, R measures the wage opportunity of working relative to the benefit received under SSDI (w/B), so that $\beta < 0$, and H again measures health status, and those in better health are less likely to apply ($\alpha < 0$). Finally, C reflects the relative generosity of the DI program, and thus the difficulty of being accepted in the program, while the error term ε arises because of randomness in preferences and perceived beliefs about the likelihood of success given that the individual applies, and misspecification introduced by a linear approximation.

This model is shown graphically in Figure 1, where the shaded area represents the distribution of workers (reflecting a positive association between health and wages), and where the line mm' reflects the collection of points for which $R = C/\beta - \alpha/\beta/H$ holds. This line delineates between those who apply for SSDI, to the southwest of the line, and those who do not, to the northeast (Croda and Skinner, 2010). The model is consistent with the empirical results in Autor and Duggan (2003); more generous benefits and an average decline in wages of low-skilled workers, since more generous eligibility rules

[3] Note that leisure drops out since individuals on SSDI are assumed not working, so that the share of leisure is 1.

shift C to the northeast, which would bring in more applicants, while the increase in benefits and stagnation in wages shifts the entire distribution down from the hypothetical distribution in (say) 1990 to that in 2010, as shown in Figure 1, leading again to a larger universe of people who would apply for (and presumably get) SSDI.

This model also has several implications for patterns of disability applications in the micro-level data. First, as benefits rise relative to stagnating wages, shifting the distribution of R relative to H downward (as discussed earlier and shown in Figure 1), the average health status of those applying for SSDI should improve. This is shown by the rightward shift of the center of the segment below line mm', at least for the population of people most likely to be candidates for SSDI, as shown in Figure 1. The intuition is that as more workers "game" the system by applying for SSDI, that these new applicants would be in better health than those applying in the past.

Second, the model implies a tradeoff between health and wages for DI applicants, so that an individual with better relative labor market opportunities would have to be in worse health to apply. Those with higher wages (on the vertical axis) will be on average in worse health for a given C. We consider this hypothesis in the empirical section below. Third, we would expect to find a strong impact of market factors (R) on the likelihood of SSDI applications given exogenous health.

Finally, note that the level of health H enters primarily through its impact on the disutility of working, since H is the same in the scenario where the individual gets disability insurance and when she does not. If in fact the disutility of working is at the forefront of the reason why workers leave the labor force for SSDI, then we might expect that after stopping work, that workers should experience a reduction in work-related pain and discomfort.

Thus far the economic model of disability has focused largely on economic incentives to apply; while health is a conditioning variable, it does not play a central role in explaining levels or trends in SSDI application. But there is increasing recognition that the clinical issues surrounding back pain (and disability more generally) are more complex than simply making economic choices regarding optimal consumption and leisure flows.

For example, most studies do not find that physical tasks are the primary cause for chronic back pain. Even after controlling carefully for differences in occupation, low-education workers in Norway were far more likely to leave the labor force disabled (Hagen, et. al., 2000). Similarly, there is a strong impact of education and income on days lost for homemakers, a difference that seems unlikely to be explained entirely by differences in types of work performed by homemakers with (e.g.) high versus low education (Deyo and Tsui-Wu, 2005). One study of San Francisco transit workers suggest that while job tasks have some impact on spinal injuries, other factors related to stress and psychosocial issues are much stronger predictors of disability (Krause, et. al., 1998).

Since nearly everyone experiences back pain at some point in their life, the real question is what causes short-term acute back pain to transform into long-term chronic back pain? As one article, written jointly by a back specialist and two psychiatrists, explained:

> If life is bleak, particularly life at work, and there is no alternative employment, the next backache is likely to seem more than the proverbial

> "straw"; it is an "injury." No physician, employer, human resource professional, claims adjuster, or worker is likely to realize that the backache is intolerable and disabling because the job is intolerable, unsatisfying, or insecure; the supervisor is insensitive, hostile, or cruel; coworkers are antagonistic; the worker feels undervalued or underpaid; or the worker is overburdened by personal baggage—and sees no way out. "I injured my back" is this semiotic. (Hadler, et al., 2007)

One could fit this quotation in the Procrustean bed of the simple model: there is a disutility associated with work, and that disutility may be associated as much with a hostile workplace as with pain *per se*. If San Francisco trolley drivers in the early 1990s suffered more chronic back pain as the consequence of stress on the job, and much less because of physical tasks, as in Krause et al (1996), then this might be captured simply by introducing heterogeneity in $\alpha(H)$ across occupations and job type.

But there is something more in this description; It's not just that the backache is a "semiotic" or the communication of a profound malaise and fear of future injury, but that the backache also represents real pain and suffering – that is, *endogenous* pain arising from employment. But even this more catholic approach to considering the origins of disability fails to explain the rapid growth in SSDI enrollment, given the lack of evidence for a secular rise in insensitive supervisors, antagonistic coworkers, and undervalued workers.

We therefore turn to a dynamic model of "health capital" accumulation by following the conceptual insights of a model by Case and Deaton (2005). In their model, wages can be augmented by depreciating health capital more rapidly; thus those with less marketable human capital may augment earnings by taking the higher-paid but noisy and physically demanding jobs today. At the same time, they depreciate their health capital, ending up with health that gets worse over time. As Case and Deaton demonstrate, their model is better able to explain the far more rapid deterioration of health with age among those with lower educational attainment.

While Case and Deaton did not focus on the disability program, it is straightforward to extend their model to the "absorbing state" of SSDI enrollment, with parallels to the absorbing state for savings behavior with asset-based means-testing (Hubbard, Skinner, Zeldes, 1995). For simplicity, consider a two-period variant of our earlier model above in Equations (1)-(3):

(4)

$$\widetilde{U} = \sum_{i=1}^{2} \frac{H_i + \varphi(H_i)\ln(\ell_i) + \ln(C_i)}{(1+\theta)^{i-1}}$$

where θ is the time preference rate. Similarly, the budget constraint for the interior solution is given by

(5)

$$C_1 + \frac{C_2}{1+r} = A + \sum_{i=1}^{2} \frac{w_i(1-\ell_i)}{(1+r)^{i-1}}$$

The value of applying for (and getting) SSDI in the second period, U* is given by the same utility function, but the budget constraint is now

$$C_1 = A + w_1(1-\ell_1) - S$$

$$C_2 = S(1+r) + B_2$$

where S is savings between period 1 and period 2, and is restricted to be non-negative (in other words, no borrowing against future earnings or SSDI payments). Once again, the individual is assumed to determine overall utility U = max($\widetilde{U}$, U*), although (as discussed below) we recognize the strong possibility of what might appear to be decidedly sub-optimal choices from an ex post basis.

Thus far the model is not dissimilar from the basic Grossman (1972) health capital model. But suppose further that wages are related to both the level of health H, and to the rate at which it depreciates, δ, as in Case and Deaton (2005), so that $w_i = w(H_i, \delta)$. Furthermore, the ability to augment wages by a more rapid depreciation in health is most prevalent in manual jobs – those involving loud noises, repetition, or heavy physical toil – and thus are most relevant for people with lower educational attainment where physically less demanding jobs at the same wage are not available. In this very simple model, depreciation becomes a choice variable, and while H_1 is assumed to be predetermined, $H_2 = H_1 - \delta$. Furthermore, the optimality condition for δ is given by

(6)

$$w_1'(1-\ell_1) - \frac{w_2'(1-\ell_2)}{1+r} = \frac{C_1}{1+\theta}[1-\psi' \ln(l_2)]$$

where we make the substitution that the money-metric value of one-dollar in period 1 is equal to $1/C_1$.[4] The interpretation is straightforward; on the left-hand side the individual seeks to maximize lifetime earnings by determining the optimal rate of health depreciation, while the right-hand side reflects the overall poorer health that results (the first-term, expressed in terms of first-period consumption) as well as any additional pain and discomfort arising from working (e.g., when $\ell < 1$, this term is positive). The right-

[4] That is, we take the derivative of the utility function in (4) subject to the budget constraint (5) as well as the difference equation that $H_2 = H_1 - \delta$. Note that we assume there is no further depreciation of health at period 2, so that the depreciation rate in the second period is not a choice variable. The shadow price of the budget constraint, λ, is equal to the marginal utility of first-period consumption, or $1/C_1$. In a multi-period model, both health (H) and net assets (A) would be state variables.

hand side of the equation is discounted by θ, and thus could be undervalued in a world of hyperbolic discounting.

If the individual anticipates applying for SSDI, this affects (6) in the following way. First, since $\ell_2 = 1$, the second term on the LHS and the second term on the RHS of (6) drops out, meaning that the individual will be more likely to drive down health status in the second period, particularly if θ is large. Whether on SSDI or not, there is a critical negative aspect of depreciating health capital, and that is the decline in second-period utility from pain and discomfort arising from a lower health capital. But the primary difference between the interior (non-SSDI) solution and the SSDI option is the stronger incentive to preserve health capital so as to ensure one's earning capacity in period 2 for the former solution, and the lack of such incentive in the latter. And while we have blurred the distinction between application and acceptance in this model, the likelihood of being chosen for SSDI is higher for worse health status.

The second way in which this model differs from Grossman (1972), as noted by Case and Deaton (2005), is the lack of a medical sector that can magically make whole the depreciated health. For the longer-term chronically ill, there is no number of physician visits or surgical procedures that can cure chronic illness, particularly from work-related depreciation. As Weinstein et al (2006) has shown, there is only a very modest impact of surgery for even well-defined clinical problems such as herniated disks, and even this treatment effect disappears among people receiving workers compensation (Atlas et al., 2009). The majority of back pain has no clear organic cause. Tinnitus, the systematic ringing in the ears resulting from long-term exposure to loud noises, has no current cure. Many with long-term chronic illnesses arising from pain become dependent on opioids, which depreciates health capital further over the longer-term.

One can also view opioid use as a consumption good that provides current (period 1) benefit, but with a longer-term negative impact on period 2 health status. Case and Deaton (2005) extended their model to consumption goods, such as cigarettes, fatty foods, lack of seat belt use, and other health behaviors that may yield current utility flows, but that can have potentially long-term deleterious effects on health status. While we do not model these factors explicitly here, we also recognize this additional dimension of consumption choice for which the provision of SSDI has similar implications.

The model can be illustrated in Figure 2, which shows consumption in periods 1 and 2 on the horizontal and vertical axis, respectively, and where A = 0 so there are no initial assets. Initially we consider an interior solution at point A where it happens that savings is (optimally) zero, so that desired consumption C_1 is equal to earnings $E_1 = w_1(1-\ell_1)$. Planned consumption C_2 is higher than what would be available under an SSDI program, B.

Now consider an alternative scenario where the individual can, by depreciating human capital in the first period, end up on a hypothetical SSDI program in the second period. By depreciating health capital at a more rapid rate, the individual is able to access more earnings in period 1, shown by the curve AD. Note that the line is at least initially outside of the initial budget line; this is because at the initial optimum (A), the marginal returns to first-period wages were higher than the costs to second-period wages given the resulting health costs later on; in other words, the RHS of (6) is positive. Health capital is depreciated more rapidly, resulting in earnings E_1*, and the withdrawal from the labor market in period 2, and the receipt of the SSDI benefit, so that $C_2^* = B$. Even though U* may be to the northeast of $\tilde{U}$, this does not necessarily imply that $U^* > \tilde{U}$, since second period health is lower in the scenario where the individual applies for SSDI.

While the model is set in an optimizing framework, it may be best interpreted in the context of a behavioral model with systematic under-estimates of future health costs, or by unanticipated adverse effects of risky job and consumption choices. That we observe higher rates of long-term chronic pain, opioid dependency, or even acute illness among lower educated workers (as in Cutler, et al., 2011) does not mean that these choices would be preferred in an ex post sense to a different scenario in which there is less prevalence of chronic illness. And certainly, given the higher public cost of SSDI payments, it is unlikely to be preferred in a social welfare function.[5] Nonetheless, there are several implications of the new model that can be tested against the null hypothesis of the standard model in Equations (1)-(3).

First, the aggregate implications of this alternative model are similar to those in Autor and Duggan (2003); both a more generous benefit level (B) and a decline in wages for low-wage workers will tend to increase SSDI enrollment. This holds particularly when there is a cyclical change in wages where one can reasonably hold health levels constant, thus reverting back to our simple model. But several of the micro-level implications are somewhat different.

The second implication is that over the longer-term, as benefits rise relative to stagnating wages, there is a greater incentive for those seeking to either maintain living

[5] Often in models of "commodity egalitarianism," high-income individuals are willing to pay more in taxes so as to ensure higher consumption of certain commodities such as health care (presumably to ensure better health), housing, or food. But in this case, the transfer program yields worse health outcomes.

standards today or become eligible for SSDI in the future by depreciating health, whether through the employment channel or by consuming more goods with adverse long-term health effects. Thus as SSDI application rates rise, health status may not improve for those who apply.

The third implication is that we do not expect the same negative association between health and wages for DI applicants as is implied by the standard model. Again, the incentive to depreciate health capital results in consistently lower levels of health for those who end up applying to SSDI, particularly if wages are sufficiently high that such workers wait longer before applying with further depreciated bodies (e.g., in a hypothetical third period). Similarly, the fourth implication is that we would expect to find that prevalent health – as best measured by active pain – should be the primary (although not the sole) explanation for why people end up applying for SSDI.

Our final implication is that by allowing health H enter in two distinct ways -- the first entering in utility that affects well-being whether at work or not, and the second through the disutility of working relative to leisure – we allow for the possibility that stopping work and going on SSDI can lead to an improvement in well-being as the pains associated with work effort cease. But it also may be the case that these latter effects are small and swamped by the former effects, so that workers apply for SSDI because they have depleted their health capital, leading to continued poor health even after leaving work. This is an empirical question, and while we do not yet have the key hypothesis test, and preliminary results are reported below. We next consider two data sources, the Health and Retirement Study (HRS), and the SPORT back pain study, to test these competing hypotheses

III. Evidence from the Health and Retirement Study

The Health and Retirement Study (HRS) is a nationally based longitudinal study of people age 50 and over. We considered waves from 1992 through 2006, for people aged 50-64.[6] We consider a very simple regression model in which the data are stratified by education (did not complete high school, high-school graduate, some college, college +) and pooled across years. We included integer dummy variables for age, race, sex, and marital status to adjust for changes over time in the composition of the sample, and the composition of the sample in 1992 is held constant throughout the analysis.[7] Individual-level weights are used in the analysis.

Figure 3 shows the percentage of people who report that they had applied for SSDI, by year and education. Clearly those without a high-school education were far more likely to have applied (20 percent in 1992), and this group also experiences the greatest change over time, to just below 30 percent in 2006. Other education groups experienced smaller increases in application rates. Figure 4 reports the fraction of people who said they were in fair or poor health, by education. The highest rate, roughly 80% in fair/poor health, is for those who did not finish high school. Nor did this rate decline over time, particularly during the period 1992-2002 when there was the most rapid growth in SSDI applications among those not completing high school. There is similarly no clear pattern in levels of fair-poor health for the other education groups, except for an apparent jump in

---

[6] Results are currently being updated for 2008.

[7] That is, we begin with the raw means from 1992 and add the year dummy coefficients accordingly.

1998, which is somewhat of a mystery, but coincides with the HRS sample re-design in 1998.[8]

It could also be the case that there has been a secular decline in health more generally, so that those applying for DI would improve *relative* to general population-level health. Figure 4 also shows rates of fair-poor health (with similar age, sex, race, and marital status controls) for those who never applied for SSDI. Again, there does not appear to be any strong secular trend, except for a sudden rise among those without a high-school degree for 2004-06. The reason for this increase is not clear; it could be people who end up applying for SSDI after 2006. But what seems clear is that during the period of time when SSDI applications were rising the most rapidly, from 1992-2002, there was no movement among this education group in the percentage of people reporting fair-poor health, either among those who had (by that year) applied for SSDI, or among those who had not.

IV. Evidence from the SPORT Randomizing Trial of Back Surgery

Between 2000 and 2004, 12 medical centers enrolled nearly 1200 patients into a randomized clinical trial designed to study clinical and some economic outcomes associated with surgery versus alternative treatments for back pain (Weinstein et al., 2006). These data offer a unique setting for the current analyses because everyone in it experiences the same condition, debilitating back pain, for which they are seeking treatment. Furthermore, the study follows individuals three times in the first 6 months and annually for up to 8 years thereafter. Finally, the study includes more complete

[8] This jump appears in the unweighted data and for the crude averages, so it is not an artifact of adjustments.

information on economic outcomes such as work status, the nature of one's work, earnings, and the application for disability benefits than a typical clinical trial. Thus, one can combine detailed clinical indicators with demographic information and economic details to gain a richer picture of how individuals that look clinically similar at baseline proceed towards SSDI application. We take a first look at these data by focusing on educational attainment as a proxy for economic opportunities in the labor force.

The SPORT data include 1,195 adults enrolled in the clinical trial. We include individuals regardless of their treatment assignment. For our purposes, the random assignment to treatment is not important, as it would not explain differential SSDI application across groups. Of these original 1,195 individuals, we excluded 78 observations because individuals were age 65 or older or because they had already started the DI application process at baseline. We dropped an additional 28 individuals with missing information on the key variables in our models. For our final sample of 1,089 individuals, we observed them for an average of 8 follow-up surveys (including those that took place at 6 weeks, 3 months, and 6 months after baseline).

Table 1 shows characteristics of the SPORT sample, separately for those that ever applied to SSDI in the eight years of follow-up versus those that never applied. Nearly 9 percent of the sample applied for SSDI before the 8 year follow-up. This sample is notable because it is younger than those commonly used to study disability, with an average age of 43 years for applicants and 40 years for the remaining adults. The share of individuals of Black race is twice as high among applicants, 10.6 percent, than among non-applicants. Applicants, relative to non-applicants, were much less likely to have continued beyond high school; 42.6 percent versus 21.9 percent had a high school degree or less education. Applicants were heavier 3 points on the BMI, and much more likely to smoke (40.4 percent versus 22.4 percent). Even at baseline, measures of functional status, bodily pain, and mental health were worse for applicants relative to non-applicants. Applicants also had higher rates of co-morbid illness at baseline including depression, stomach disorders, hypertension, bowel disorders, and diabetes.

A key measure that we use to quantify functional disability arising from back pain is the

Oswestry index. Similar in content to standard measures of activity limitations, it differs because it asks questions about the extent to which back pain interferes with everyday activities such as dressing, walking, lifting, sitting, standing, sleeping, and social activities. The resulting questions are converted (with equal weights) into a 100 point or % scale, with higher scores indicating worse pain and function. In practice, it is rare to see a score above 60, with scores of 40 and higher indicating severe limitations.

Figure 5 demonstrates differences in DI application rates by education as well as the Oswestry score at the time of application (reported in the follow up survey in which a respondent first indicates he/she applied for DI). The figure shows the dramatic difference in rates of DI application across education groups. High school dropouts are about 16 percentage points more likely to apply at some point in the 8 years of follow-up than college graduates (among whom 3.7 percent apply at some point). In contrast to the striking difference in application rates, the rates of reported pain and functional limitation are nearly identical across education groups. This contradicts what one would expect from standard models of disability application which would imply better health among individuals with low market opportunities, as proxied for here by education.

If applicants have similar health states at the time of application regardless of education level, it is natural to ask how individuals in this cohort of patients fare over time, and whether this differs across education groups. Figure 6 displays the average Oswestry score by education level and follow-up survey over time. Three points stand out. First, the scores at baseline, while higher for less educated groups, do not differ very much. This supports our contention that we are looking at a group of patients with a relatively homogeneous and disabling (if only temporarily) clinical condition at baseline. Second, recovery (a drop in Oswestry scores) occurs rapidly in the first 6 months after baseline, although scores flatten out from follow-up surveys at one to eight years. (That is, low-education workers are far more likely to transition from acute to chronic lower back pain.) Finally, the recovery is more dramatic for higher education groups than for low education groups. At some level, differences in application for DI likely relate to these differences in rates of recovery across education groups.

Figure 7 examines how different features can explain differences in DI application by education. We estimate simple linear probability models of DI application as a function of demographics and an increasing set of controls to see how market opportunities (education level) affect the probability of application. The basic specification, the bars at the left of the figure, show rates of DI application by education, adjusted for age and its square, dummies for year of enrollment in SPORT, dummies for survey follow-up, race, gender, and Hispanic ethnicity. Each set of bars adds additional sets of variables that might explain educational differences.

The second set of bars in Figure 7 add the following baseline health variables: the Oswestry score at baseline, Short Form -36 health survey scores, both the physical composite and mental composite score, and dummies for the presence of any of the following health conditions at baseline: hypertension, heart disease, cancer, stroke, depression, (non-back) joint problems, diabetes, lung disease, stomach disorder, and bowel disorder, and a control for whether patients received back surgery. With these baseline health controls, we observe a modest decline in the magnitude of effects of education on DI application. Specification 3 adds the contemporaneous Oswestry score, SF-36 physical and mental scores, whether patient currently smokes, and whether patient is obese (BMI>30). With these health variables, the education differential (dropouts versus college graduates) is cut in half compared with the basic specification. Clearly, much of the difference in rates of DI application relate either to the severity of health conditions for less educated workers, or, as Figure 6 implies, the failure to recover among less educated workers.

The final specification adds indicator variables for 6 categories of annual earnings (salaried workers), 5 categories of wages (hourly workers) and whether lifting is very important or somewhat important for one's job. Given our model and the implication that low-skilled workers may be spending down health capital rapidly, we take these contemporaneous earnings measures as potentially endogenous. They do relate strongly to DI application, and educational differences in DI receipt are further attenuated – largely by lifting requirements -- with these economic variables. However, we view these as pathways on the way to application for DI (low-skilled workers may reduce hours or switch jobs as their health deteriorates). The main finding from Figure 5 is that contemporaneous health, or changes in health over time among back patients, differ across education level, and this can explain at least half of the difference in DI application rates between less and more educated workers.

V. Discussion and Conclusion

In this paper, we have revisited the puzzle of why enrollment in the SSDI program has been growing so rapidly and seemingly without moderation. Autor and Duggan (2003; 2006) have argued persuasively that much of the growth in SSDI enrollment is the consequence of higher relative benefits under the SSDI program relative to stagnating wages for lower-educated people, along with a porous application process. Although we find evidence that the health implications of standard models of DI application (that applicants should be healthier over time, and among low education applicants), are not confirmed in the data, we do not think this contradicts in any way the main insights of these models, that economic conditions and rising benefit generosity increase rates of application among low-skilled workers.

While this standard approach is successful in making aggregate predictions, we argue that it is less successful in matching micro-level patterns observed in both the HRS and the SPORT data. Our model differs by drawing from previous literature, including Case and Deaton (2005), in placing the role of health – and more specifically, pain and bodily discomfort – back into the center of decisions on whether (and when) to apply for a disability program. We argue that the predictions arising from our model do a good job of fitting several empirical micro-level facts. The key contribution is to consider the endogeneity of health and bodily functioning in the presence of an "absorbing state" such as the SSDI program which appears to provide rest and succor for the individual suffering from pain.

What is perhaps most notable about the empirical results in this paper is how unhappy those applying for or receiving SSDI appear. There is a consistently high level of poor functioning that persists beyond the acute phase disproportionately for those with low educational attainment; more than one-quarter of high-school dropouts with disk herniation end up applying for SSDI within 8 years.

This paper has also focused in more detail on bodily pain and discomfort. Often "health" has been measured using diseases known to the respondent, such as hypertension and diabetes (e.g., Banks, et. al., 2006), but these are "silent killers." But there is an increasing recognition among economists about the importance of pain (Krueger and Stone, 2008; Kahneman and Krueger, 2006). Pain may arise from biological dysfunction such as wound or bone break, but in practice the link between pain and organic injuries, particularly those arising from long-term occupational stress (both physical and mental) are tenuous at best. For example, those without any clinical evidence of causal back disorders may be immobilized by severe pain (Chou et al., 2007). The converse is true as well; roughly half of people not in pain show objective signs of spinal abnormalities based on their MRIs (Jensen, et. al., 1994). In other words, the "medical model" of health care – find the problem and fix it – does not apply well for musculoskeletal disease, nor for mental illness.

One of the few studies to consider the association between pain and disability was Kapteyn, Smith, and van Soest (2006), who find that people "troubled with pain" are far more likely to report a disability that prevents them from working, which in turn substantially raises the likelihood of leaving the labor force. Atlas and Skinner (2010) also used an earlier survey of Maine patients with disk herniation, and found that those with lower educational attainment were far more likely to transit from acute to long-term chronic pain, with a commensurate increase in the likelihood of applying for disability insurance. Our results are consistent with the view that pain or depression, coupled with job tasks, can explain a large fraction of the steady-state variation across education groups in the likelihood of applying for SSDI, at least for back pain.

Thus the real difference in the implications of this model from Autor and Duggan (2003, 2006) is that in the long-term, SSDI applicants may not be the healthier workers seeking an easy transition into retirement, but are instead are depressed and experiencing pain, perhaps even as a consequence of positioning themselves to apply for SSDI. Thus creating a more stringent SSDI application process could create real difficulties for workers who have already experienced a rapid depreciation in health and rise in the degree of bodily pain.

These results may appear to be in contrast to a recent study by Song and Manchester (2011), who find that during the recent recession, SSDI applications rose rapidly, as did rejection rates. In the context of the two-period model, these applications would correspond to unanticipated changes in market opportunities, but where the health stock could reasonably be interpreted as being held constant, thus reverting to our standard (one-period) model that would imply stronger economic effects in deciding whether to apply or not. In practice, applications are likely to reflect both long-term trends and short-term economic conditions.

One concern is that people applying to SSDI might justify their application by overstating “true” pain and lack of functioning, so it is the act of reporting that is endogenous, not pain *per se*. However, there is modest evidence for this explanation from the economics literature (e.g., Benitez-Silva, et. al., 2004). Nor was the questionnaire distributed by the Social Security Administration, but was instead administered through the patients’ hospital and designed to measure outcomes following surgical interventions. In the clinical and neurological literature, there is an increased recognition that organic signs of injury are not necessary for real pain to occur (Chou et. al., 2007). Instead, this new view recognizes the central role of the brain in generating pain in the absence of a specific injury (Melzack, 1993; Apkarian, Baliki, and Geha, 2009).

In this more speculative framework, pain and an inability to work may respond to psychosocial factors or even economic factors that are likely to be associated with education. One example came from the repetition strain injury (RSI) epidemic in Australia, which caused severe pain and long periods of recovery across several regions before suddenly disappearing in the late 1980s (Gawande, 2002). By the same token, network effects could lead to the propagation of either behaviors or perceived pain that is transferred across neighborhoods or regions (Glaeser, Sacerdote, and Scheinkman, 1996; 2003). The best evidence of such network effects comes from Rege, Telle, and Vortruba (2008) who show that the probability of applying for disability insurance rises sharply when one’s neighbor has lost her job and is receiving disability payments.

It is important to stress once again that the structure of SSDI programs have a critically important role in determining rates of applications and enrollment, as was demonstrated clearly in a cross-country study of disability programs (Milligan and Wise, 2011). Yet little is understood about the real welfare effects of disability programs that require applicants to leave their work for a lengthy period and to signal pain and suffering in order to apply. Clearly, the welfare implications of supported employment programs that try to maintain human (and health) capital while working (e.g., Drake et al., 2008) in contrast to the traditional SSDI program, could well differ in a world with endogenous health depreciation and long-term pain and disability.

References

Apkarian, AV, Y. Sosa, S. Sonty, RE Levy, R. Harden, et al., “Chronic Back Pain is Associated with Decreased Prefrontal and Thalamic Gray Matter Density,” *Journal of Neuroscience* 24, 2004: 10410-10415.

Apkarian, A. Vania, Marwan N. Baliki, and Paul Y. Geha, “Toward a Theory of Chronic Pain,” *Progress in Neurobiology* 87, 2009: 81-97.

Atlas, Steven J., and Jonathan Skinner,“Education and the Prevalence of Pain,” in D. Wise (ed.) *Research Findings in the Economics of Aging*. University of Chicago Press, 2010.

Autor, David H. and Mark G. Duggan, “The Rise in the Disability Rolls and the Decline in Unemployment.” *Quarterly Journal of Economics,* 118:1, February 2003: 157–206.

Autor, David H. and Mark G. Duggan, “The Growth in the Disability Insurance Roles: A Fiscal Crisis Unfolding,” *Journal of Economic Perspectives* 20(3), Fall 2006: 71-96

Balaki, M, DR Chialvo, DR Geha, et al., “Chronic Pain and the Emotional Brain: Specific Brain Activity Associated with Spontaneous Fluctuations of Intensity of Chronic Back Pain,” *Journal of Neuroscience*, 26, 2006: 12165-12173.

Benitez-Silva, Hugo, Buchinsky, Moshe, Chan, Hiu Man, Cheidvasser, Sofia and Rust, John P., "How Large is the Bias is Self-Reported Disability?" *Journal of Applied Econometrics* 19, 2004: 649-670.

Bound, John, “The Health and Earnings of Rejected Disability Insurance Applicants,” *American Economic Review* 79(3), June 1989: 482-503.

Bound, John, "The Health and Earnings of Rejected Disability Insurance Applicants: Reply," *American Economic Review* 81(5), December 1991: 1427-1434.

Case, Anne, and Angus Deaton, "Broken Down by Work and Sex: How Our Health Declines," in D. Wise (ed.) *Analyses in the Economics of Aging*. University of Chicago Press and NBER, 2005.

Casey, Corinna Young, Melanie A. Greenberg, Perry M. Nicassio, R. Edward Harpin, David Hubbard, "Transition from Acute to Chronic Pain and Disability: A Model including Cognitive, Affective, and Trauma Factors," *Pain* 134, 2008: 69-79.

Chou R, Qaseem A, Snow V, Casey D, Cross JT, Shekelle P, Owens DK. "Diagnosis and treatment of low back pain: A joint clinical practice guideline from the American College of Physicians and the American Pain Society," *Annals of Internal Medicine* 147, 2007:478-91.

Cutler, David, and Adriana Lleras-Muney, "Education and Health: Evaluating Theory and Evidence," NBER Working Paper No. 12352, July 2006.

Deyo, R. and Y. Tsui-Wu, "Functional Disability due to Back Pain: A Population-based Study Indicating the Importance of Socioeconomic Factors," *Arthritis and Rheumatism* 2005. **30**: 1247-1253.

Drake, Robert E., Jonathan Skinner, Gary R. Bond, and Howard H. Goldman, "Social Security And Mental Illness: Reducing Disability With Supported Employment," *Health Affairs*, May/June 2009, 28:3761-3770. *doi:10.1377/hlthaff.28.3.761*

Finkelstein, Amy, Erzo F.P. Luttmer, and Matthew J. Notowidigdo, "What Good is Wealth Without Health? The Effect of Health on the Marginal Utility of Consumption," NBER Working Paper No. 14089, June 2008.

Glaeser, Edward., Bruce Sacerdote, and Jose Scheinkman, "Crime and Social Interactions," *Quarterly Journal of Economics*, 111, 1996: 507-548.

Glaeser, Edward., Bruce Sacerdote, and Jose Scheinkman, "The Social Multiplier," *Journal of the European Economic Association*, April-May 2003.

Gluck, J. and A. Oleinick, "Claim Rates of Compensable Back Injuries by Age, Gender, Occupation, and Industry," *Spine*, 23(14), July 15, 1998: 1572-1587.

Hadler NM, Tait RC, Chibnall JT, "Back pain in the workplace," *Journal of the American Medical Association*, 297(14), April 11, 2007: 1594-6.

Hagen, K., et al., "Socioeconomic Factors and Disability Retirement from Back Pain: A Population-Based Prospective Study in Norway 1983-1993," *Spine*, 2000.

Hubbard, R. Glenn, and Stephen Zeldes, “Social Insurance and Precautionary Saving,” *Journal of Political Economy* 103(2), April 1995: 360-99.

Jensen, Maureen C., Michael N. Brant-Zawadzki, Nancy Obuchowski, Michael T. Modic, Dennis Malkasian, and Jeffrey S. Ross, "Magnetic Resonance Imaging of the Lumbar Spine in People without Back Pain," *New England Journal of Medicine*, 331(2), July 14, 1994: 69-73.

Kahneman, Daniel, and Alan B. Krueger, “Developments in the Measurement of Subjective Well-Being,” *Journal of Economic Perspectives*, 20(1), Winter 2006: 3-24.

Kapteyn, Arie, James Smith, and Arthur van Soest, “Dynamics of Work Disability and Pain,” Working paper, the Rand Corporation, March 2006.

Krause, N., et al., “Psychosocial Job Factors, Physical Workload, and Incidence of Work-Related Spinal Injury: A 5-Year Prospective Study of Urban Transit Operators,” *Spine*, **23**(23), 1998: 2507-2516.

Krueger, Alan B., Daniel Kahneman, David Schkade, Norbert Schwarz, and Arthur A. Stone, “National time accounting: the currency of life,” in Alan B. Krueger (ed.) *Measuring the Subjective Well-Being of Nations: National Accounts of Time Use and Well-Being*, forthcoming, 2007.

Krueger, Alan B., and Arthur A. Stone, "Assessment of pain: a community-based diary survey in the USA," *The Lancet*, 371(9623), May 3, 2008: 1519-1525.

Melzack, Ronald, “Pain: Past, Present, and Future,” *Canadian Journal of Experimental Psychology* 47(4) 1993: 615-629.

Milligan, Kevin, and David Wise, “Social Security and Retirement Around the World: Mortality and Health, Employment, and Disability Insurance Participation and Reforms: Introduction and Summary,” NBER Working Paper No. 16719, January 2011.

Moore, Timothy J., “The Employment Effects of Terminating Disability Benefits: Insights from Removing Drug Addictions as Disabling Conditions,” Working paper, University of Maryland, July 2011.

Parsons, Donald O., “The Health and Earnings of Rejected Disability Insurance Applicants: Comment,” *American Economic Review* 81(5), December 1991: 1419-1426.

Rege, Mari, Kjetil Telle, and Mark Vortruba, “Social Interaction Effects in Disability Pension Participation: Evidence from Plant Downsizing,” working paper, Case Western Reserve University, June 2008.

Song, Jae, and Joyce Manchester, “Unemployed and Disabled: Evidence from Applicants for

Social Security Disability Insurance," Presentation at the American Economic Association Meetings, Denver, January 2011.

Viscusi, W. Kip, and William N. Evans, "Utility Functions that Depend on Health Status: Estimates and Economic Implications," *American Economic Review*, 80(3), June 1990: 353-374.

Weinstein JN, Tosteson TD, Lurie JD, Tosteson AN, Hanscom B, Skinner JS, Hanscom B, Abdu BA, Hilibrand AS, Boden SD, Deyo RA, "Surgical vs nonoperative treatment for lumbar disk herniation: the Spine Patient Outcomes Research Trial (SPORT): a randomized trial," *JAMA* 296 (20), 2006a: 2441-50.

Weinstein JN, Lurie JD, Tosteson TD, Skinner JS, Hanscom B, Tosteson AN, Herkowitz H, Fischgrund J, Cammisa FP, Albert T, Deyo RA, "Surgical vs nonoperative treatment for lumbar disk herniation: the Spine Patient Outcomes Research Trial (SPORT) observational cohort," *JAMA* 296 (20), 2006b: 2451-9.

Figure 1: Graph Showing the Distribution of Wages (Relative to SSDI Benefits) and Health Status

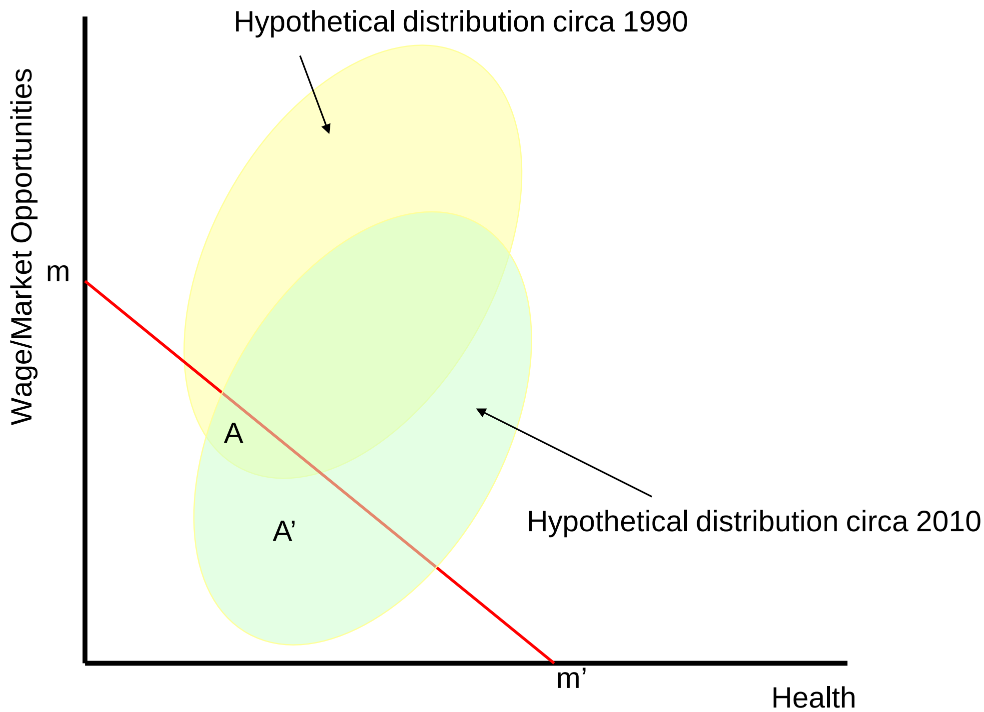


Figure 2: Consumption Choices With and Without the SSDI Option

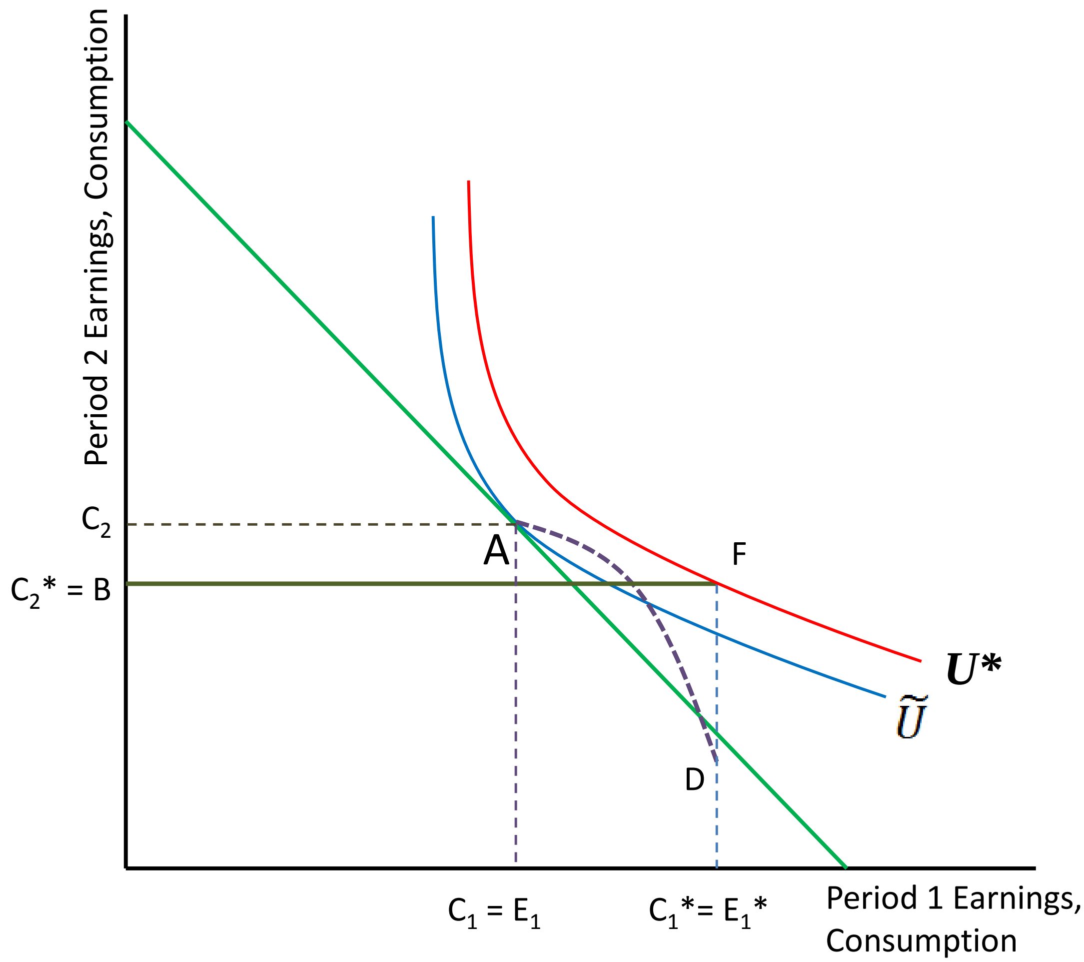


Figure 3: Fraction of Population Who Had Applied for SSDI at Some Point in the Past

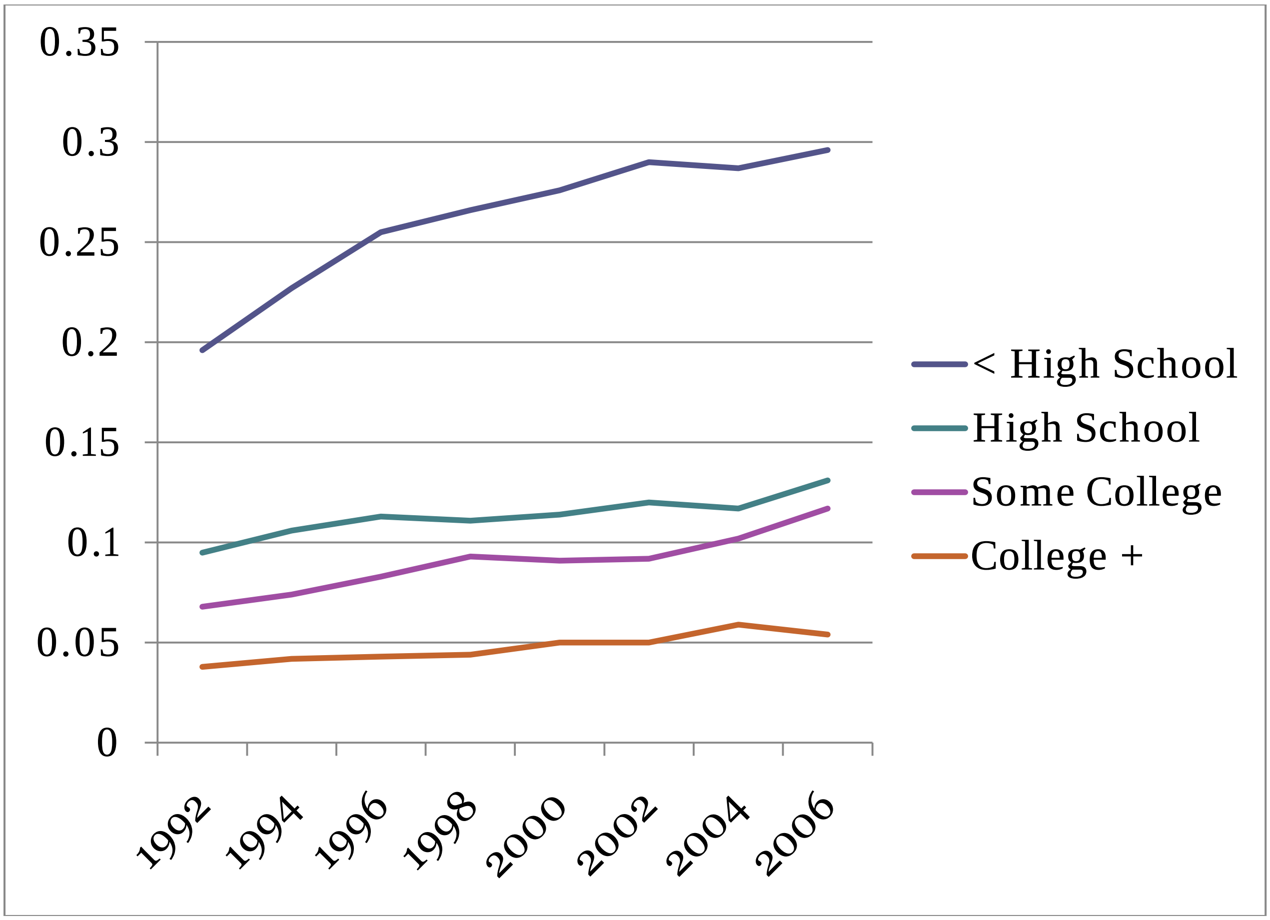
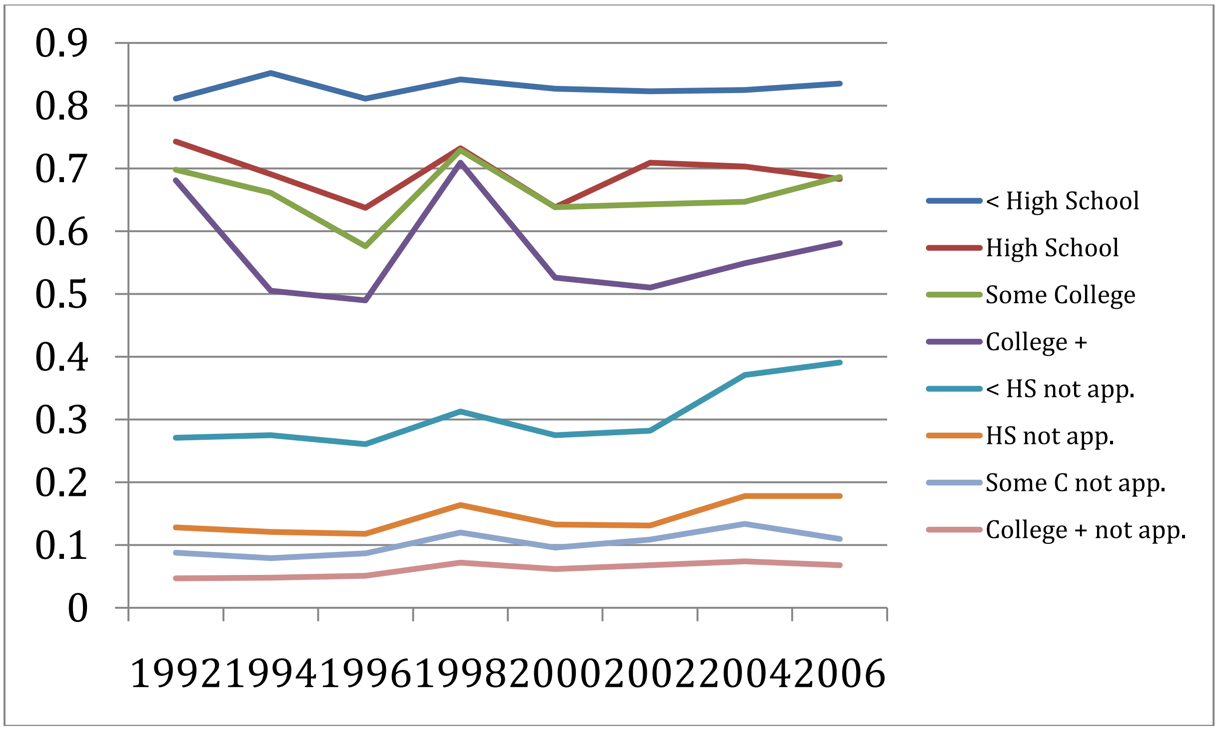


Figure 4: Share of Individuals who had Applied (and Those who Hadn't Applied) Reporting Fair/Poor Health, by Education, 1992-2006



Note: The top four categories are for those who had applied for SSDI, the bottom four for those who had not applied.

Figure 5: Percentage Who Apply to SSDI, and Oswestry Score at Application, by Education

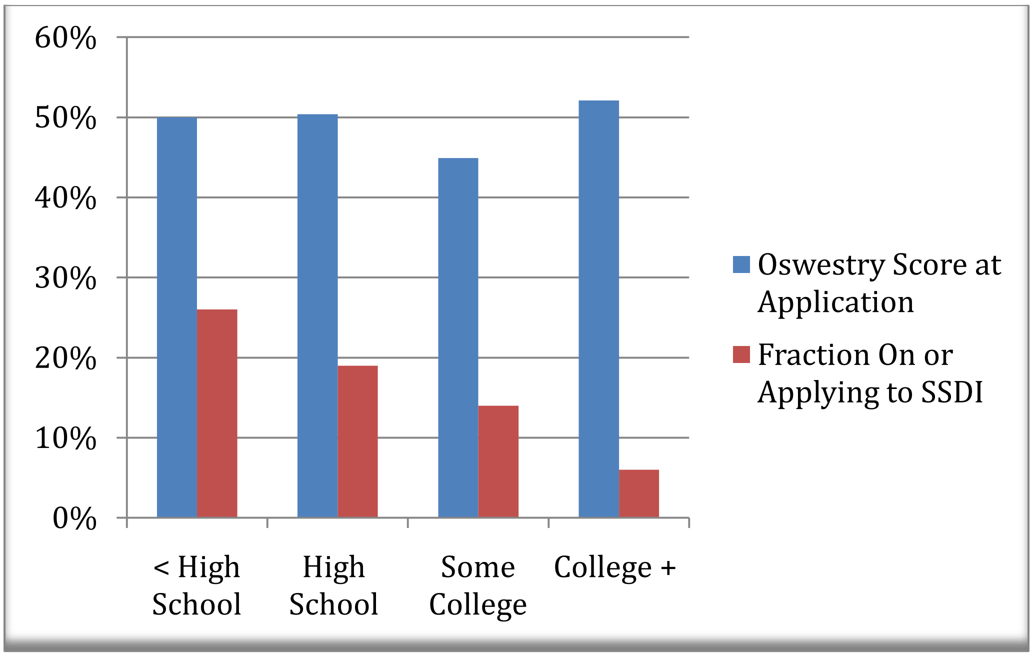
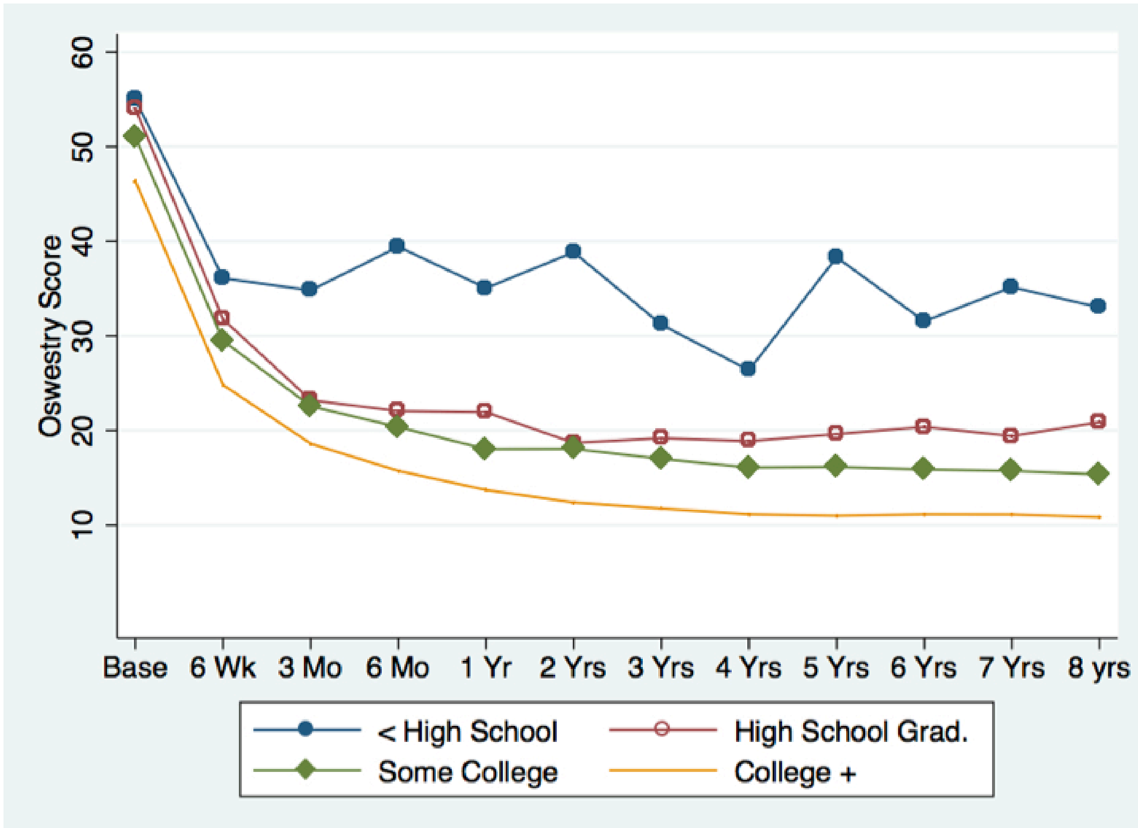
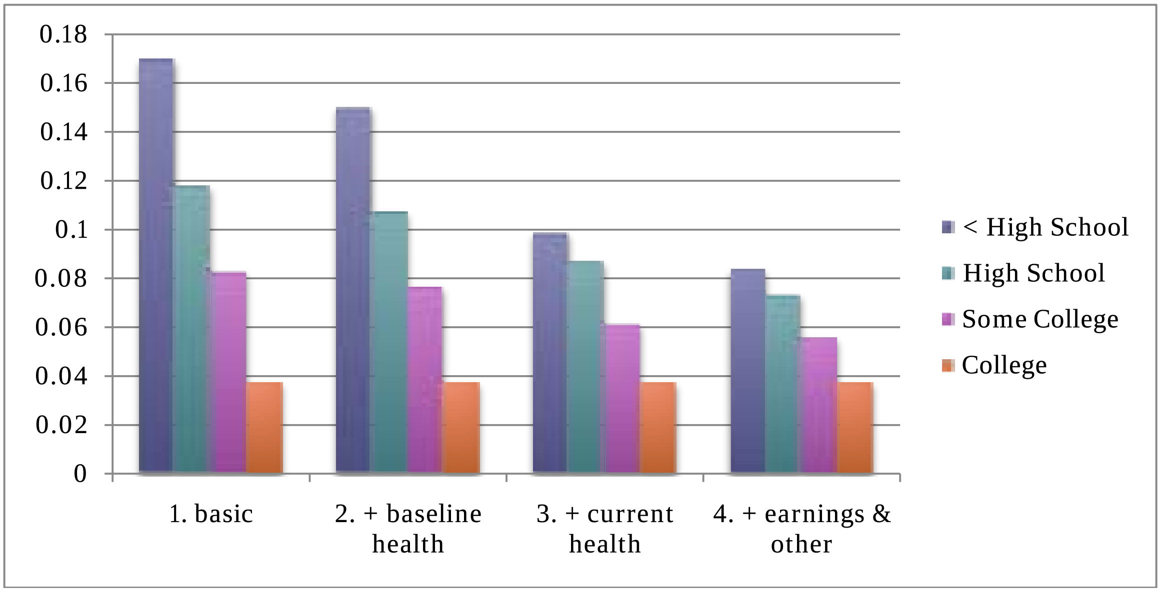


Figure 6: Oswestry Disability Index Relative to Baseline, by Education



Note: Higher scores indicate more adverse functional limitations related to back pain.

Figure 7: Regression Estimates of Educational Differences in Applying for SSDI in SPORT



See text for description of covariates.

Table 1: Sample Characteristics in the SPORT, Share of sample or Mean (SD)

	Applied to SSDI N=94 (8.6%)	Never applied to SSDI N=995 (91.4%)
Age	43.40 (10.20)	40.20 (9.97)
Female	0.415	0.427
Hispanic ethnicity	0.032	0.028
Race		
White	0.809	0.880
Black	0.106	0.053
Other race	0.085	0.066
Marital Status		
Divorced/widowed	0.223	0.089
Married	0.670	0.716
Single	0.106	0.195
Eduction		
< High School	0.043	0.020
High School Degree	0.383	0.199
College attendee	0.362	0.267
College degree or more	0.819	0.514
Had job at baseline	0.819	0.912
Usual earnings at baseline		
< $10,000	0.138	0.080
$10,000-$19,999	0.149	0.068
$20,000-$34,999	0.202	0.184
$35,000-$49,999	0.191	0.184
$50,000-$75,000	0.106	0.178
>$75,000	0.021	0.175
not sure or refused	0.191	0.131
Current smoker	0.404	0.224
Body Mass Index (weight in kg)/height in m^2)	30.7 (6.6)	27.7 (5.4)
Oswestry disability index (higher = worse)	59.0 (16.0)	48.3 (21.4)
SF-36 measures (higher values are better)		
Bodily Pain	20.0 (15.4)	27.9 (20.2)
Physical functioning	24.7 (18.8)	39.4 (25.8)
Physical composite score	26.7 (7.3)	31.0 (8.5)
Mental composite score	40.1 (11.7)	45.8 (11.3)
Comorbidity at baseline		
Depression	0.245	0.108
Joint problem (non-back)	0.187	0.160
Hypertension	0.181	0.120
Stomach disorder	0.170	0.102
Bowel disorder	0.106	0.056
Lung disease	0.074	0.030
Diabetes	0.074	0.030
Heart disease	0.043	0.042
Stroke	0.000	0.002