Why Does Disability Insurance Enrollment Increase During Recessions? Evidence from Medicare*

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Abstract

Social Security Disability Insurance (SSDI) enrollment increases during economic downturns. We use the universe of SSDI beneficiaries joining Medicare 1993–2013 to investigate whether this relationship is driven by changes in health (e.g., recessions make individuals less healthy) or changes in the opportunity cost of applying for SSDI (e.g., poor anticipated earnings make DI relatively more appealing). We find that each percentage point increase in national unemployment around the established date of disability onset corresponds to a reduction in average annual Medicare spending among new SSDI recipients of about $87. To isolate the effect of the opportunity cost channel from changes in health status during recessions, we exploit evidence from a discontinuity in age in the DI determination process. We find that about 71% of the $87 decrease is due to reductions in the opportunity cost of applying for SSDI, while the remainder is due to *improvements* in health.

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1 Introduction

In the past two decades, the share of nonelderly adults enrolled in the Social Security Disability Insurance (SSDI) program has increased from approximately 2.2 percent in 1983 to 4.6 percent in 2013 (Autor and Duggan, 2003; Liebman, 2015). This increase has been attributed to a number of factors, including an increase in qualifying work histories among women, the entry of the Baby Boomers into the highest-disability age groups, changes in screening of applicants, decreased opportunities for low-skilled workers and increases in the generosity of SSDI benefits (Autor and Duggan, 2003; Duggan and Imberman, 2009; Liebman, 2015). Beyond this general trend, previous studies have also noted a strong, negative relationship between SSDI applications and economic conditions, with reductions in state-level employment leading to an increase in SSDI applications (Autor and Duggan, 2003; Maestas, Mullen and Strand, 2015) and awards (Maestas, Mullen and Strand, 2018).

While the countercyclicality in the quantity of SSDI applications and awards has been documented in the literature, little is known about what drives this phenomenon. The literature has suggested two possible channels (Autor and Duggan, 2003; Maestas, Mullen and Strand, 2015; Cutler, Meara and Richards-Shubik, 2012). The first is that recessions worsen health, resulting in more SSDI applicants and recipients. The second is that recessions reduce the opportunity cost of applying for SSDI due to the fact that applicants for SSDI who are currently earning above a relatively low threshold will be automatically rejected from the program. Thus, individuals who become unemployed during a recession have less to lose by applying for SSDI than those who must give up their jobs to do so. Cutler, Meara and Richards-Shubik (2012) call these two channels the "health shocks" and "opportunity cost" channels, respectively. Some studies have documented a relationship between economic conditions and characteristics of SSDI applicants. For example, Coe and Rutledge (2013) find that SSDI applicants during recessions tend to be "younger, better educated, higher income and more likely to have recent work experience." However, this pattern could be consistent with either of these mechanisms.

This paper provides evidence on the relative magnitude of the "health shocks" and "opportunity cost" channels hypothesized to drive countercyclicality in SSDI entry. Because SSDI recipients become eligible for Medicare two years after they become entitled to DI benefits, this paper directly investigates the relationship between economic conditions and the health of new SSDI recipients. We use claims data for the universe of SSDI recipients entering fee-for-service Medicare between 1993 and 2013, who became entitled to benefits two years prior between 1991 and 2011. We examine how health and health care utilization (e.g., spending) vary with economic conditions at the time of DI benefit onset, which reflect the sum of the "health shocks" and the "opportunity cost" channels. To isolate the effect of the "opportunity cost" channel, we exploit evidence from a discontinuity in age in the DI eligibility criteria. Bringing these together, we are able to quantify the extent to which the health shocks and opportunity cost channels contribute to the observed dependence of enrollment on economic conditions.

Our first major result is to show that there is a strong, countercyclical relationship between employment conditions and cohort medical spending. That is, cohorts that enter during good economic times spend significantly more in Medicare than cohorts who enter during bad economic times. To our knowledge this finding is novel to the literature. At a national level, we find that a 1 percentage point increase in unemployment increases the size of the cohort entering that year by around 45,000 individuals and lowers the health care spending of those enrolled by $87 (1 percent).

Our second group of results examines the relationship between cohort spending and age at disability in light of the fact that, as described in detail below, screening criteria become less stringent at age 50 and again at age 55.[1] These age discontinuities are generally based on whether an individual with a particular level of impairment will be declared disabled

[1]These age discontinuities have received little attention in the economics literature. In the only published paper of which we are aware, Chen and Van der Klaauw (2008) use a regression discontinuity design to study the impact of the changes in the stringency of the grid rules on labor supply decisions. The recent working paper of Deshpande, Gross and Su (2019), discussed below, evaluates financial well-being among individuals across this age discontinuity.

depending on their education and work skills. For example, an individual without a high school diploma and past work skills that are not transferable to a new industry will be presumed to be disabled at age 50 but not disabled at age 49.[2] Importantly, the grid rules do not directly consider applicants' health. These so-called "vocational factors" have been shown to play an important role in decisions during economic downturns (Maestas, Mullen and Strand, 2015; Lindner and Burdick, 2013).

We find that the number of entrants into SSDI at age 50 and 55, corresponding to entrants into Medicare at ages 52 and 57, increases by around 25 percent relative to their slightly-younger counterparts. The older individuals are, on average, around 2.4 percent less expensive than those who enter at ages 49 and 54, suggesting, as expected, that relaxing screening criteria results in individuals entering with less need for medical treatment.[3] Indeed, we estimate that the marginal people admitted due to the age discontinuity are around 10 percent cheaper than individuals who would have been admitted even in the absence of the change in the grid rules.

As a final exercise, we combine these two groups of results in order to quantify, for the first time, how much of the increase in enrollment during recessions is driven by health shocks and how much is driven by changes in the opportunity cost of applying. We do so by exploiting the fact that the age discontinuity generates a change in enrollment that is driven only by changes in the opportunity cost of applying, while changes in the unemployment rate (possibly) involve both factors changing. By using the estimates from the age discontinuity to net out the impact of changes in opportunity cost from the overall impact of the recession, we separately identify the impact of these two channels. Overall, we find that a 1 percentage point increase in annual unemployment decreases the average health care spending of the

[2]Social Security Administration regulations prohibit determination of disability status based only on a formula. The grid rules provide suggested determinations, but cases must be decided on an individual basis. Despite this, we find significant discontinuities around these ages in the number of people admitted and their spending.

[3]Although these individuals spend less on health care, this does not necessarily imply that these individuals are less impaired. However, as described below, the changes in the screening criteria suggest that this is the case.

cohort that enrolls during that year by $87, with 71 percent of that decline being driven by decreases in the opportunity cost of applying (i.e., poorer prospects in the employment market) and 29 percent being driven by *improvements* in health. In particular, we rule out the negative relationship between unemployment and health underlying the health shocks channel. One channel through which health improvements could occur is if recessions induce individuals to apply for DI and gain access to health insurance (e.g. Medicare) sooner than they would have otherwise, helping individuals to manage chronic health conditions before they worsen.

In addition to providing estimates of the impact of recessions on the health of recipients and illuminating the channels through which it operates, our findings also contribute to the literature on the relationship between business cycles and health. Despite the folk wisdom that weakening of the economy should worsen health due to decreased income and access to health care, the empirical evidence in support of this hypothesis has been weak, and a series of influential papers by Christopher Ruhm (2000; 2003; 2005; 2012) have found a countercyclical relationship between health (including mortality) and macroeconomic conditions. However, while this relationship has been true historically, a number of studies have shown that the countercylicality of health has decreased over time, and that some outcomes may actually have begun to exhibit procyclical behavior (Ruhm, 2015; Crost and Friedson, 2017; McInerney and Mellor, 2012). As the "health shocks" channel suggests, one way of interpreting the procyclical relationship between unemployment and new enrollment is that recessions worsen health. However, by disentangling the impact of the health shocks and changes in opportunity cost, we are able to establish that the increase in enrollment during recessions involves enrolling individuals who are cheaper on the margin than those already in the program *and* a decrease in the health care spending of those inframarginal recipients who would have enrolled even in the absence of the economic downturn. Thus, our results support the view that health is countercylical, at least for the population and time period we study.

The remainder of the paper proceeds as follows. Section 2 presents background on SSDI, the disability determination process, and Medicare benefits for recipients. Section 3 introduces the data. The main results on the impact of changes in the employment rate and the age discontinuity on health are presented in Section 4, and Section 5 presents our decomposition of the overall effect on spending into the parts driven by changes in opportunity cost and health shocks. Section 7 concludes.

2 Social Security Disability Insurance and Medicare

2.1 Social Security Disability Insurance Determination Process

The Social Security Disability Insurance is a federal program that provides income support to individuals with sufficient work history who are no longer able to work due to a qualifying disability.[4] These benefits continue until the individual is able to work again, although in the vast majority of cases individuals do not return to work after qualifying for SSDI.

Workers become eligible for SSDI benefits (should they become disabled) upon earning sufficient work credits. In 2018, workers earned one work credit for each $1,320 in wages or self-employment income, with a maximum of four credits per year. Eligibility is granted after a worker earns 40 work credits, 20 of which were earned in the most recent 10 years. The work history requirements are relaxed somewhat for younger workers.

Social Security pays monthly cash benefits only to eligible individuals who become totally disabled and meet the following criteria.

1. The individual can no longer do the work they did in their previous job(s), and

2. SSA rules that the individual's disability prevents them from doing other work, and

3. The individual's disability is expected to last longer than one year or result in death.

[4]Background information on the SSDI program taken from https://www.ssa.gov/disability

The disability determination process involves five steps.

Step 1. Is the individual working? Individuals who are working and whose average monthly earnings exceed the substantial gainful activity (SGA) threshold ($1,180 in 2018 for non-blind people) are not considered disabled and are ineligible for benefits. Those who are not working or whose earnings fall below this threshold continue on to step 2.

Step 2. Is the individual's condition severe? In order to qualify as having a severe impairment, the individual's medical condition must significantly limit their physical or mental ability to to basic work activities. At this stage, age, education and work experience are not considered. In addition, the impairment must meet the duration requirement of being expected to last for a continuous period of more than 12 months or result in death.[5]

Step 3. Is the individual's condition on the list of disabling conditions? "Disability Evaluation Under Social Security" is a list of medical conditions, objectively defined in terms of medical findings or test results, such that any individual meeting the criteria for one of the listed conditions is automatically considered to be disabled.[6] In these cases, steps 4 and 5, which ask what kind of work the individual can do, are not relevant. The list of impairments is extensive and includes, for example, conditions of the musculoskeletal system that result in being unable to ambulate effectively (e.g., walk without a walker or walk a block over uneven surfaces), respiratory disorders that reduce the ability to breathe effectively, and cardiovascular diseases that interfere with the ability to engage in activities of daily living. While having one of the impairments on this list automatically qualifies an individual as being severely disabled, being judged to have one of the listed conditions generally involves meeting objectively verifiable criteria (e.g., amputation, medical test values, etc.). Individuals who do not meet these criteria may still be determined to be disabled based on Steps 4 and 5. In particular, it is not uncommon for individuals to have a number of impairments (e.g., respiratory disorders and obesity) that do not individually meet the criteria for disability

[5] 20 C.F.R §404.1520; 20 C.F.R. §404.1509

[6] When this list was published in hard copy, it was known as the Blue Book. The online version is available at https://www.ssa.gov/disability/professionals/bluebook/. See also "Listing of Impairments" 20 C.F.R. §404 Subpart P, Appendix 1.

according to the list of conditions, but in combination result in being disabled based on Steps 4 and 5.

Step 4. Can the individual do the work they did previously? In this step, SSA determines whether a severely impaired individual whose impairments do not meet the objective criteria on the list of conditions is capable of doing the type of work they did previously. Individuals who can do such work are determined not to be disabled and their claims are denied.

Step 5. Can the individual do any other type of work? In cases where individuals with severe conditions who do not meet the criteria for disability in step 3 but are not capable of doing the type of work they did previously, SSA asks whether the person could do any other type of work. 70% of individuals 2000-2014 were evaluated under Step 5 (Deshpande, Gross and Su, 2019). An individual is assigned a category of "maximum sustained work capacity": sedentary, light, medium, heavy, or very heavy.[7] In addition, SSA considers the individual's level of formal education and the skills acquired in previous work experience. Together with age, these determine whether the individual is deemed able to transition to other work, and thus is determined to be not disabled. In recent years, around 40 percent of denied applications by workers were denied because the worker was deemed able to do other work (Social Security Administration, 2017). The guidelines for determining disability based on MSWC, education, and previous work experience are expressed in the Medical-Vocational Guidelines, sometimes called the Medical-Vocational Grid Rules due to being presented in tabular form.[8]

[7] Individuals with a MSWC of heavy or very heavy can still be declared disabled if they have non-exertional limitations, such as mental, postural, visual, or environmental conditions that prevent them from working. However, finding that an applicant is capable of sustained heavy or very heavy work generally leads to a finding of not disabled. See Rule 204.00 of 20 C.F.R. §404 Subpart P, Appendix 2.

[8] See "Medical-Vocational Guidelines," 20 C.F.R. §404 Subpart P, Appendix 2.

2.2 Age Discontinuities in the Medical-Vocational Guidelines

The grid rules categorize age based on whether the applicant is age 18-44, 45-49, 50-54 ("closely approaching advanced age"), 55-59 ("advanced age"), or 60 and over ("closely approaching retirement age"). Recommended findings change across these age categories, and, in particular, become somewhat more lenient as individuals cross from age 49 to 50 and from age 54 to 55. For example, the grid rules recommend that an individual without a high school degree and a history of only unskilled labor whose impairment leaves them only capable of sedentary work be found not to be disabled at age 49, but disabled at age 50. Similar age-related discontinuities in the recommendations exist between ages 54 and 55. We have summarized the grid rules in Appendix Table A.1. Importantly, these discontinuities are driven by educational background and work experience, not the individual's degree of impairment. Thus, for example, if an individual is admitted at age 50 due to a change in the grid rules, that individual need not be less healthy than he was at age 49 (when the grid rules would have declared him not to be disabled). We also note that the change in the rules tends to affect individuals at the lower levels of skill and education; individuals with "transferable skills" or a possibility of "direct entry into skilled work" are never disabled under the grid rules.

Deshpande, Gross and Su (2019) exploit the age discontinuity to demonstrate how receipt of SSDI benefits affects poor financial outcomes such as bankruptcy and foreclosure. They use administrative data on all applicants matched to their data in credit and other financial databases. They show that the rate of initial allowances for those being evaluated in Step 5 rises discontinuously from about 15% to 30% at age 50 and to above 50% at age 55.

2.3 Medicare Eligibility for SSDI Disabled Workers

Former workers who are approved for SSDI begin receiving cash payments five months after the onset of their disability; the date of onset of disability is established during the application process via the medical record, and in practice must be after the individual has stopped

working. They then become eligible for Medicare after receiving disability benefits for two years. As a result, workers are automatically enrolled in and begin receiving Medicare in the 30th month after onset of disability. Figure A.1 compares the number of awards to disabled workers reported in the Social Security Administration (2017) in each year 1991 to 2011 (Xs) with the number of disabled individuals joining Medicare two years later (circles). There are at least two reasons why the two series may diverge. Firstly, individuals may die, attain Medicare by turning 65, or recover from their disability during the two year waiting period. In addition, an individual becomes eligible for Medicare in the 30th month after the onset of their disability, which will not commonly coincide with their award date. Still, the figure reassures us that the vast majority of recipients appear in the Medicare dataset.

All disabled former workers receive Medicare hospital insurance (Part A) at no charge. Because Part A does not have a premium, even those who have access to employer-sponsored insurance (via a spouse) enroll in Medicare as a secondary payer for hospitalizations. Medicare Part B covers physician services and is available for an additional monthly premium. Approximately 36% of DI beneficiaries over the sample period are dually-eligible for Medicaid and thus obtain state assistance with cost-sharing (coinsurance and copays) and Part B premiums. All Medicare individuals can choose to obtain the benefits of Part A and B via a Medicare managed care plan (Medicare Advantage). Over the sample period, 17% of DI beneficiaries are enrolled in Medicare Advantage, with the rest enrolled in traditional "fee-for-service" Medicare. We do not observe health care utilization for individuals in Medicare Advantage. In Section **??**, we assess whether the utilization effects of Medicaid enrollment or sample attrition to Medicare Advantage could potentially be driving our results.

3 Data

Our primary data are derived from Medicare administrative claims data. The first element of Medicare claims data we use are enrollment datasets for the universe of Medicare beneficiaries

from 1993 to 2013. We use this enrollment data to form cohorts of disabled beneficiaries based on year of entry (21 cohorts). These data also inform us when a beneficiary has died or exited Medicare. The primary avenues by which non-elderly disabled SSDI recipients leave SSDI are medical improvement (which may be established at a routine audit) or working above the Substantial Gainful Activity (SGA) level. Those who stop receiving DI benefits due to work above the SGA level maintain access to Medicare for nearly eight years, and can buy in or benefit from a state Medicaid buy-in program after that. Death or exiting DI are the only sources of attrition from our panel; individuals are retained in the dataset when they transition to Medicare eligibility due to elderly status.

The primary advantage of Medicare claims data is the rich information on health care utilization. For the universe of fee-for-service[9] Medicare beneficiaries, we observe health care utilization between the years 1999 to 2013 (15 years). Thus, for the earliest cohorts of disabled Medicare beneficiaries, we do not observe any utilization data until their seventh year in the program. We measure health care utilization by total spending – Medicare portion plus beneficiary cost-sharing – for all covered services except outpatient prescription drugs. Outpatient prescription drugs are not covered by Medicare until 2006, so we exclude them for comparability across years. Our measure includes spending on physician visits, inpatient hospitalizations, outpatient services such as imaging or outpatient surgeries, stays in skilled nursing or hospice facilities, and durable medical equipment. We convert all spending values to 2017 dollars using the CPI-U medical inflation rate.

In what follows, we will characterize disabled individuals on the basis of the year they entered Medicare, and assume that the economic conditions two years prior were influential in their decision to enter DI. We use yearly averages of the monthly unemployment rates (U-3) from the Bureau of Labor Statistics for 1991 to 2011. Over this time period, the unemployment rate averaged about 6%, so we occasionally dichotomize years as "high unemployment" if unemployment exceed 6%.

[9]While as stated health care utilization is missing for individuals in Medicare Advantage, we still observe these individuals' Medicare enrollment and thus can include them in our counts of new Medicare entrants.

3.1 Summary Statistics

Table 1 describes our full panel of disabled Medicare beneficiaries. We observe more than 120 million person-year observations, reflecting 15m individuals observed for about 8 years each. Not all observations contain spending information, both because our spending data do not begin until 1999 and because spending information is unobserved if the individual chooses to enroll in Medicare Advantage. Below, we show our sex and age distribution. Individuals in their 50s and 60s comprise more than half of the sample.

Table 2 describes the sample by their year of Medicare entry, or cohort year. The 21 cohorts grow in size over time. They also become somewhat more female (driven by increases in the share of women with sufficient work history to qualify) and older. Individuals in the earlier cohorts are observed in the data for more total years, although we do not begin to observe their spending data until 1999. Average spending varies by a factor of three, although clearly the fact that earlier cohorts are observed further into their elderly years is influential in the average spending. We also show the national unemployment rate in effect at the time each cohort began receiving benefits two years prior. We note three sets of cohorts who entered DI under while unemployment was high relative to surrounding years: 1993-1995, 2004-2005, and 2011-2013. In the next section, we will demonstrate the relationship between the national unemployment a cohort experiences and its size and average spending.

4 Results

4.1 Economic Conditions, DI Entry, and Health Care Spending

We observe cohorts of entering DI recipients entering Medicare from 1993 to 2013, spanning 21 years and 2-3 business cycles. Thus, we first explore how national economic conditions affect DI recipients in Medicare.

Figure 1 shows how the national unemployment rate covaries with the number of new DI

recipients in Medicare after the waiting period between the years 1993 and 2013. The left axis shows the national unemployment rate two years prior to these individuals' Medicare entry (blue solid line). The right axis shows the number of individuals entering Medicare in that cohort (dashed red line). We replicate the finding of countercyclical DI uptake of Autor and Duggan (2003), and note that since relatively few individuals die or recover during the two-year waiting period, using Medicare data does not greatly affect the observed cyclicality. In a simple regression of the 21 data points in this figure, we find that one point of unemployment is associated with an increase in the cohort size of 45,005 individuals, a 7 percent increase from the average cohort size of 630,968.

We extend this graphical analysis to show the relationship between average health care spending for DI recipients entering Medicare in cohort c and national economic conditions at time $c-2$. The first step of this analysis is measurement of average health care spending associated with each entering cohort, which we estimate as the fixed effects of the following regression:

$$y_{it} = \delta_c + \delta_t + \delta_{as} + \varepsilon_{it} \tag{1}$$

The dependent variable in this regression is the health care spending of individual i in year t, where t runs from 1999 to 2013. We regress this individual's spending on various fixed effects: δ_c for her entering cohort c, δ_t for calendar year t, and δ_{as} for each year of age interacted with sex. We include δ_t to account for changes in health care technology, and δ_{as} because we observe earlier cohorts further into their elderly years. We interpret the coefficients on δ_c as the average spending associated with this cohort. For cohort's entering from 1999 to 2013, we exclude their first (partial) year of spending, because otherwise the influence of this partial year dominates the cohort fixed effect for recent cohorts. Standard errors are clustered at the level of the individual to account for serial correlation in spending.

Figure 2 reports the cohort fixed effects estimated from this regression, using the dashed red line and the left axis. Across the twenty cohorts entering between 1993 and 2012, average cohort spending ranges from \$13,338 to \$14,414 in constant 2017 dollars. We denote the

unemployment rate two years prior to this cohort's Medicare entry using the solid blue line and the right axis; it is apparent that the two series are negatively correlated. The cohorts that entered in 2002 and 2008 experienced the lowest unemployment of the macroeconomic cycle at the time they were entering DI (in 2000 and 2006 respectively); individuals in those cohorts had relatively high spending in Medicare. The cohort that entered in 2012 was subject to an unemployment rate of 9.6 percent at the time they were entering DI, and subsequently were much less expensive than other cohorts. The twenty data points in the figure suggest that each point of unemployment lowers the average spending for an entering DI cohort by \$87, a decrease of 0.6% percent off the average spending of \$13,785.

Next we then adjust Equation 1 to characterize changes through the full spending distribution for those who began receiving DI benefits in good vs. bad economic times. Following xxx cites, we alter the dependent variable to be an indicator for whether an individual's spending exceeds thresholds throughout the support of the spending distribution. Instead of a cohort fixed effect, we create an indicator highunemp_c that is 1 in for the cohorts entering in 1993, 1994, 1995, 2004, 2005, 2011, 2012, or 2013. These years capture the local maxima of the unemployment series.

$$P(y_{it} > cut) = \beta_{cut}\text{highunemp}_c + \delta_t + \delta_{as} + \varepsilon_{it} \tag{2}$$

In Figure **??**, we show both the distribution of spending among cohorts entering in low-unemployment times (bars) and, in the line, the effect of high unemployment on the probability of exceeding each spending value (in \$200 intervals). As is common health care spending, the distribution is extremely right-skewed. Thus for visibility we have top-coded spending at \$10,000; while this top-code is lower than the mean, only about 25% of person-years exceed it in spending. The shape of the line reveals that those who enter Medicare during times of high unemployment are slightly *more* likely to have any spending and are more likely to spend at very low levels, but are less likely to spend at any level above \$600.

Above about $15,000, the β coefficients become very stable at about -0.002; the lack of change in the coefficients means that the high-unemployment and low-uenmployment distributions are very similar above $15,000.[10] Thus, high unemployment tends to draw in a larger number of individuals with some but moderate amounts of spending, and there is no change in the upper ranges of the distribution.

4.2 Age Discontinuity in Eligibility, DI Entry, and Spending

As described in Section 2, SSDI eligibility increases discontinuously at ages 50 and 55. This discontinuity is evident in our data when we examine the distribution of the age of new Medicare entrants. Figure 4 demonstrates a sharp increase in the number of individuals entering DI at the ages when the vocational grid rules are relaxed (and thus entering Medicare two years later). In Figure 5, we report the average spending of individuals in their first full year of Medicare based on their age at entry. After generally increasing between approximately 35 and 51, average first-full-year spending decreases suddenly for those entering at age 52, and then again at 57, coincident with the increase in the number of beneficiaries entering at those ages.

An advantage of the age discontinuity in DI eligibility is that we know that health status does not change discontinuously at ages 50 and 55. Thus, we can compare the cohort size and health care spending of individuals just above and below the cutoffs, knowing that the primary difference between these individuals is that younger individuals faced a higher opportunity cost of leaving the labor market and submitting a DI application. We consider a bandwidth of two years around each of the Medicare entry age discontinuities, and compare individuals aged 50 and 51 to those 52 and 53, as well as those 55 and 56 to those aged 57 and 58.

$$y_{it} = \alpha \text{older}_i + \beta \text{first discontinuity}_i + \delta_t + \varepsilon_{it} \tag{3}$$

[10] i.e., the effect of high unemployment on the probability that spending exceeds $15,000 is -0.002, and the effect of high unemployment on the probability that spending exceeds $70,000 is also -0.002.

In the above equation, α measures the size of the discontinuity, net of year fixed effects and a separate intercept for the first and second discontinuities. α is equal to -$339, which represents a 2.4% drop in spending off of the average spending in the younger group, $14,233.

The nature of the age discontinuity ensures that all those who would qualify at 49 would also qualify under the rules applied to 50 year olds. Thus, assuming that all the younger individuals are inframarginal, we can infer the spending of the *marginals*, those who join above the discontinuity who would not have joined below it. To do so, we also use the number of individuals entering annually in the sample period below the discontinuity (74,270) and above it (97,900).

$$\begin{aligned} \text{total spending of marginals} + \text{total spending of inframarginals} &= \text{total spending of older group} \\ \text{avg spending of marginals} * 23,630 + \$14,233 * 74,270 &= (\$13,894 - \$339) * 97,900 \end{aligned}$$

Here, we assume that all those who would have joined below the discontinuity still join above it and continue to average $14,233 in spending per year. In order for the average spending among all individuals entering at older ages to fall by $339, the spending of the marginal entrant induced by the eligibility change must equal $12,827.

As we did for recessions, we can demonstrate how the distribution of spending changes for those just before and just after the age discontinuity. The key estimating equation can be altered to show how those just above the age discontinuity differ in the CDF of their spending compared to those just below.

$$P(y_{it} > cut) = \alpha \text{older}_i + \beta \text{first discontinuity}_i + \delta_t + \varepsilon_{it} \tag{4}$$

In Figure 6, we again show the spending distribution among the "untreated" – in this case, the younger population, and the line reflecting the series of β coefficients obtained from estimating Equation 4 on $200 intervals up to $10,000. Again, those in the older group, while spending substantially less overall, are actually a bit more likely to spend at zero or

very low levels. But they are less likely to spend above $2000 and any level thereafter. Again, the coefficients suggest there is little change the spending distribution at high levels.

5 Estimating the Effect of Health Shocks vs. Opportunity Cost Shifts

As mentioned in the Introduction, two possible channels through which economic conditions might affect SSDI enrollment have been mentioned in the literature: recessions could increase the prevalence of disability ("health shocks"), or they could decrease the opportunity cost of applying for DI for individuals with severe conditions who choose to continue working as long as they are employed, but choose to apply for DI if they ever lose their jobs ("opportunity cost"). These channels need not be mutually exclusive.[11] In this section, we explain how comparing the impact on the cohort size and health care spending of DI enrollees of a change in unemployment with that of the age discontinuity allows us to separately identify the impact of health shocks and opportunity cost shifts.

5.1 Conceptual Framework

In order to fix ideas, consider the following simple model. Individuals differ according to their degree of disability d, where higher levels of disability correspond to higher likelihood of being approved for DI, and higher average health care needs and spending. Since healthcare spending may depend on economic conditions, we normalize d to be equal to an individual's expected Medicare spending in typical economic conditions, e.g., when national unemployment is six percent.

While cash DI benefits depend on past work history but not health status, individuals with higher expected health care needs gain a larger benefit from gaining access to Medicare

[11] A third possible mechanism is that DI becomes more likely to approve applicants when job prospects are bad. However, SSA screening criteria are based only on whether an individual has the ability to do a job. They explicitly prohibit evaluation of cases based on the availability of jobs.

through SSDI. Consequently, the benefit, $B(d)$, of being approved for DI under typical economic conditions is a linear function where the positive intercept is equal to the level of cash benefits and the unitary slope reflects the increase in expected Medicare cost as d increases. It is important to note that, although the benefit curve is linear under typical economic conditions by design, changes in economic conditions will shift the benefit curve, and it need not remain linear in this case.

In contrast to the benefit curve, the cost of applying for DI, denoted $C(d)$, is likely to be decreasing in the degree of disability due to the fact that highly disabled individuals are more likely to be judged to be disabled based on categorical grounds (i.e, in Step 3), and have lower labor market earnings. These cases are less likely to involve hearings and appeals after initial denials than individuals whose disabilities are less pronounced. Point E in Figure 8 depicts the equilibrium. Individuals with disability greater than E apply find the expected benefit of applying for DI to be greater than the expected cost, and so they choose to apply. For individuals with disability below E, the expected cost of applying for DI exceeds the benefit, and they choose not to apply.

While this model is very simple, it helps us to generate comparative statics that differentiate between the two proposed channels, opportunity cost and health shocks. Suppose that the only effect of a recession is to decrease the opportunity cost of applying for DI. The effect of this will be to shift the cost curve downward from curve C to curve C', moving the equilibrium point to E'. At this point, more people will be admitted to DI. And, because the marginal admits are all cheaper than those already in the program, the average spending of the cohort will decrease.

In contrast, suppose that the only effect of a recession is to worsen the health of potential applicants. The effect of this will be to shift the benefit curve upward from B to B', moving the equilibrium to point E''. After this shift, more people will enroll in DI. However, the health shock has made all inframarginal recipients (i.e, those to the right of E) more expensive and admitted additional individuals whose medical spending may be less than the

average spending before the shift. So, while total spending necessarily increases, the net effect on average spending is ambiguous. Finally, if the effect of the recession is to shift both the benefit and cost of applying for disability, both curves would shift, and the new equilibrium would be at E'''.

In our analysis, we make use of the age discontinuity in the grid rules to help disentangle the relative importance of changes in the opportunity cost of applying for DI and the impact of health shocks. The key step in our analysis is to net out the change in total health care spending resulting from a recession (i.e., an increase in the national unemployment rate) that part that would have occurred if the change in DI enrollment had been brought about *only* by a change in the opportunity cost of applying for DI. To do so, we first scale the enrollment effect of the recession event and age discontinuity so that they admit the same number of additional people to DI. Effectively, we ask how much does the total cost of Medicare benefits to DI beneficiaries change if one more individual is admitted to DI due to the age discontinuity vs. due to a recession?

Consider Figure 9. Suppose that, initially, d^0 individuals enroll in DI. Next, suppose that an increase in unemployment due to a recession shifts the cost and benefit curves to C^R and B^R, respectively. The equilibrium moves from E to E^R, and DI enrollment increases to d^R. Since the health care spending of a DI enrollee is given by the height of the benefit curve, the recession increases the total health care spending by the difference in the areas below the new benefit curve and between d^0 and d^R, given by the sum of the shaded and cross-hatched areas in Figure 9.

In order to decompose the part of the change in total spending that is due to changes in the benefit curve (i.e., health shocks) from the part that is due to changes in the cost curve (i.e., opportunity cost of applying), consider hypothetical cost curve C^* that results in the same increase in DI enrollment as the one percentage point increase in unemployment. That is, the equilibrium from the original benefit curve B and hypothetical cost curve C^* results in d^R people enrolling in DI. The change in total Medicare spending due to this hypothetical

cost shift is the cross-hatched area.

Since the age discontinuity in the grid rules affects the cost of applying for DI but not the likely benefit, comparing the impact on total health care spending due to admitting $d^R - d^0$ additional people via a recession vs. via the age discontinuity provides a method of separately identifying the cross-hatched and shaded regions in Figure 9, and thereby decomposing the part of the observed change in health care spending that is due to opportunity cost and health shocks.

This exercise relies on a comparison of the marginal individuals induced to join by two situations that reduce opportunity costs. The first situation is a reduction in opportunity cost due to the age discontinuity, and the second situation is a reduction due to a recession. The policy change at the age discontinuities make clear that the marginal individuals for that case are in their fifties, qualifying via the vocational grids rather than a listed impairment (as described in Step 3 in Section 2), and at lower levels of education and skill (because outcomes do not change at 50 or 55 for higher levels of skill and education). Several other studies show that it is precisely such individuals whose DI enrollment is most sensitive to recessions. Cutler, Meara and Richards-Shubik (2012) demonstrate that individuals 15-49 demonstrate no or nearly no cyclicality in DI awards; all the cyclicality is attributable to those 50-64. Maestas, Mullen and Strand (2018) show that nearly all of the change in DI claiming during the Great Recession is driven by individuals evaluated under the vocational grids; there is little change among individuals qualifying via a listed impairment. Finally, Autor and Duggan (2003) provide evidence of greater DI cyclicality among those without a high school degree, a group whose outcomes change at the age discontinuity.

Using our data, we develop further evidence that the two groups are comparable. One such piece of evidence is that those above the age discontinuity account for more than two-thirds of the overall cyclicality into DI. As we saw in Section 4.1, one percentage point of unemployment is associated with 45,000 more individuals entering Medicare due to DI two years later. Of these, 31.4K are aged 52 or above; only 13.6 are below the age discontinuity.

Secondly, we can directly compare how the two treatments – high unemployment and the age discontinuity – alter the spending distributions. Figure 7

5.2 Decomposition

We now decompose the impact of a 1 percentage point increase in unemployment into the parts of the change in total spending due to changes in opportunity cost and due to health shocks. For the initial calculation, we use the impact of the unemployment change on the entire age distribution. In the next, we limit the analysis to those age groups in the neighborhood of the age discontinuities (ages 50-53 and 55-58) as a robustness check.

In our analysis, we found that a typical DI cohort has 630,968 members and an average spending of $13,758 per person, yielding a total annual health care spending of the cohort of approximately $8.681B. Further, we found that a 1 percentage point increase in national unemployment increased cohort size by 45,005 people and decreased average spending by $87 per person, resulting in an average spending per person of $13,671 and a total annual spending of approximately $9.241B. Thus, the 1 percentage point increase in national unemployment increases total expenditure on the disabled by around $560M.

The question at hand is how much of that $560M increase would have occurred if the only impact of the recession had been to shift the opportunity cost of applying. To decompose total spending, suppose that an additional 45,005 individuals were added to DI via the age discontinuity. Our analysis of the age discontinuity found that the spending of a marginal person admitted to DI because of the age discontinuity was $12,827. Thus, total Medicare spending would increase from a baseline of $8.681B to $\$9.258B = \$8.681B + \$12,827 * 45,0005$.

Note that our estimate of total spending if it had been generated only by an opportunity cost shift (i.e., the cross-hatched area in Figure 9) is *larger* than what we observed arising from a recession in the data. Thus, the impact of health shocks on spending is actually negative: what we observe is consistent with the increase in unemployment coinciding with

positive health shocks (i.e., a reduction in health care spending), not negative ones. To put the numbers in perspective, we estimate that the average Medicare spending per enrollee would be $13,696 if the enrollment increase had been caused only by a change in opportunity cost. Thus, of the observed decrease in average spending due to a 1 percentage point increase in unemployment of $87, we estimate that about $62 (71 percent) was due to changes in opportunity cost and the remaining $25 (29 percent) was due to *improvements* in health.[12]

5.3 Decomposition Using Only Individuals Near the Age Cut-offs

A natural concern with the computation in the previous subsection is that we are comparing the impact of the age discontinuity, which affects only individuals near age 52 and 57 with the impact of the recession on individuals of all ages.[13] Using only individuals ages 50-53 and 55-58 as a comparison yields similar results, although with fewer individuals in these age groups the estimates become more imprecise.

An average DI cohort has 183,649 individuals in these age groups, and average annual spending on individuals of these ages of $14,876. This implies total annual spending on this cohort of $2.732B. Repeating the analysis of Section 4.1 for only individuals age 50-53 and 55-58, we find that increasing national unemployment by 1 percentage point increases the average DI cohort size by 15,446 people and reduces average Medicare spending by $178. Thus, a 1 pp increase in unemployment would increase average cohort spending to

$$(183,649 + 15,446) * (\$14,876 - \$179) = \$2.926,$$

for a difference of $194M.

Again, the question is how much of this change can be attributed to opportunity cost shifts vs. health shocks. As before, the spending of a marginal DI recipient who joins due

[12] Appendix Figure A.2 reproduces Figure 9 for the case where benefit function B shifts downward, as in the case where the recession improves health.

[13] Recall that individuals appear in the Medicare data roughly two years after they enter DI, so that ages 52 and 57 correspond to entering DI at 50 and 55, which is when the age discontinuities occur.

to the age discontinuity is $12,827. The impact on total spending if the enrollment change had been caused by the age discontinuity is therefore given by initial cohort spending plus the marginal spending of 15,446 additional individuals, each of whom spends $12,827. This gives a total spending of

$$\$2.732B + 15446 * \$12827 = \$2.930B.$$

As in the case of the analysis using all age groups, we once again find that our estimate of total spending if it had been caused only by the age discontinuity is larger than what we estimate would arise from a 1 percentage point increase in unemployment. Thus, as above, we find that in order to explain the data, any health shocks arising from the recession would have to lead to spending reductions, which is inconsistent with the health shocks story. Once again computing average spending, we find that a 1 percentage point increase in unemployment would reduce the average spending of DI enrollees in these age groups by around $178, from $14,876 per year to $14,698 per year, while if the enrollment change had happened only because of the age discontinuity, average spending would have decreased by $159 to $14,717. Thus, in this case we find that 89 percent of the observed decrease in average spending was due to changes in opportunity cost, while 11 percent was due to improvements in health. These numbers are broadly consistent with our findings for the full population. In particular, we once again find no evidence that unemployment leads to DI increases via the health shocks channel.

6 Robustness and Confounders

6.1 Confounders

In this section, we explore the possibility of confounding from two sources: dual eligibility for Medicaid and sample attrition due to Medicare Advantage.

Individuals who are dually eligible for Medicaid do not pay cost-sharing amounts, and thus Medicaid status may increase overall spending (Vabson, 2018). It is possible that Medicaid status could vary with either of our two sources of variation, and thus alter our interpretation of our findings. For example, if those who enter when unemployment is low are more likely to have Medicaid, the higher spending among this group could be in part attributable to Medicaid enrollment. Similarly, the lower spending of those who enter just above the age discontinuity could be attributable to higher rates of Medicaid, if indeed they differ in Medicaid status. However, Appendix Figures A.3 and A.4 repeat earlier figures for Medicaid enrollment. Appendix Figure A.3 estimates Equation 1 where y_{it} is an indicator for Medicaid enrollment and graphs the cohort fixed effects. Medicaid status is monotonically falling across cohorts by year of entry and does not show any cyclicality.[14] Appendix Figure A.4 shows there is no change in Medicaid enrollment across the age discontinuity.

Because we do not observe spending for those in Medicare Advantage, covariation between Medicare Advantage and either recessions or the age discontinuity would also pose a problem. Appendix Figures A.5 and A.6 address whether this concern. While there are two peaks in cohort's average Medicare Advantage enrollment, the first occurs in an economic expansion and the second during a local unemployment peak. The lower panel reassures us there is no difference in Medicare Advantage enrollment above vs. below the age discontinuity.

7 Conclusion

This paper presents a first set of findings on the factors that drive increased SSDI enrollment during recessions. Using administrative Medicare data, we document that SSDI cohort size increases during recessions and that these cohorts have lower average spending than cohorts who join during periods of low unemployment. We compare changes in cohort spending across the business cycle to changes in cohort spending that occur on either side of ages

[14]The decline in Medicaid enrollment across cohorts is largely a function of demographics – Medicaid enrollment declines with age among the disabled, and more recent cohorts are older.

50 and 55, ages at which DI eligibility thresholds are exogenously relaxed. This allows us to decompose cohort spending across the business cycle into the component driven by the opportunity cost of applying and the effect of recessions on health. Our estimates imply that about half of the decrease in Medicare spending that occurs for cohorts enrolling during recessions can be attributed to change in the opportunity cost of applying for SSDI, and the other half is due to improvements in health during the recession.

Our results are inconsistent with the hypothesis that worsening health during recessions drives SSDI take-up. Instead, our findings suggest that SSDI may be helping individuals to smooth consumption in response to temporary, medium-run shocks to employment conditions, a role that contrasts with SSDI's aim of protecting individuals from permanent shocks to their ability to work. These results suggest that offering other social programs like short-term disability better designed to cover medium-run shocks may do better at targeting the types of shocks that induce fluctuations in enrollment into SSDI during recessions.

References

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

Chen, Susan, and Wilbert Van der Klaauw. 2008. "The work disincentive effects of the disability insurance program in the 1990s." *Journal of Econometrics*, 142(2): 757–784.

Coe, Norma B, and Matthew S Rutledge. 2013. "How Does the Composition of Disability Insurance Applicants Change Across Business Cycles?" Boston College Center for Retirement Research Working Paper No. 2013-5.

Crost, Benjamin, and Andrew Friedson. 2017. "Recessions and health revisited: New findings for working age adults." *Economics & Human Biology*, 27: 241–247.

Cutler, David M, Ellen Meara, and Seth Richards-Shubik. 2012. "Unemployment and disability: Evidence from the Great Recession." National Bureau of Economic Research.

Deshpande, Manasi, Tal Gross, and Yalun Su. 2019. "Disability and Distress: The Effect of Disability Programs on Financial Outcomes." National Bureau of Economic Research.

Duggan, Mark, and Scott A Imberman. 2009. "Why are the disability rolls skyrocketing? The contribution of population characteristics, economic conditions, and program generosity." In *Health at older ages: The causes and consequences of declining disability among the elderly*. 337–379. University of Chicago Press.

Liebman, Jeffrey B. 2015. "Understanding the increase in disability insurance benefit receipt in the United States." *Journal of Economic Perspectives*, 29(2): 123–50.

Lindner, Stephan, and Clark Burdick. 2013. "Characteristics and Employment of Applicants for Social Security Disability Insurance over the Business Cycle." *Center for Retirement Research at Boston College Working Paper*, 11.

Lindner, Stephan, Clark Burdick, and Javier Meseguer. 2017. "Characteristics and Employment of Applicants for Social Security Disability Insurance over the Business Cycle." *The B.E. Journal of Economic Analysis & Policy*, 17.

Maestas, Nicole, Kathleen J Mullen, and Alexander Strand. 2015. "Disability Insurance and the Great Recession." *American Economic Review*, 105(5): 177–82.

Maestas, Nicole, Kathleen J. Mullen, and Alexander Strand. 2018. "The Effect of Economic Conditions on the Disability Insurance Program: Evidence from the Great Recession." National Bureau of Economic Research.

McInerney, Melissa, and Jennifer M Mellor. 2012. "Recessions and seniors' health, health behaviors, and healthcare use: Analysis of the Medicare Current Beneficiary Survey." *Journal of health economics*, 31(5): 744–751.

Ruhm, Christopher J. 2000. "Are recessions good for your health?" *The Quarterly journal of economics*, 115(2): 617–650.

Ruhm, Christopher J. 2003. "Good times make you sick." *Journal of health economics*, 22(4): 637–658.

Ruhm, Christopher J. 2005. "Healthy living in hard times." *Journal of health economics*, 24(2): 341–363.

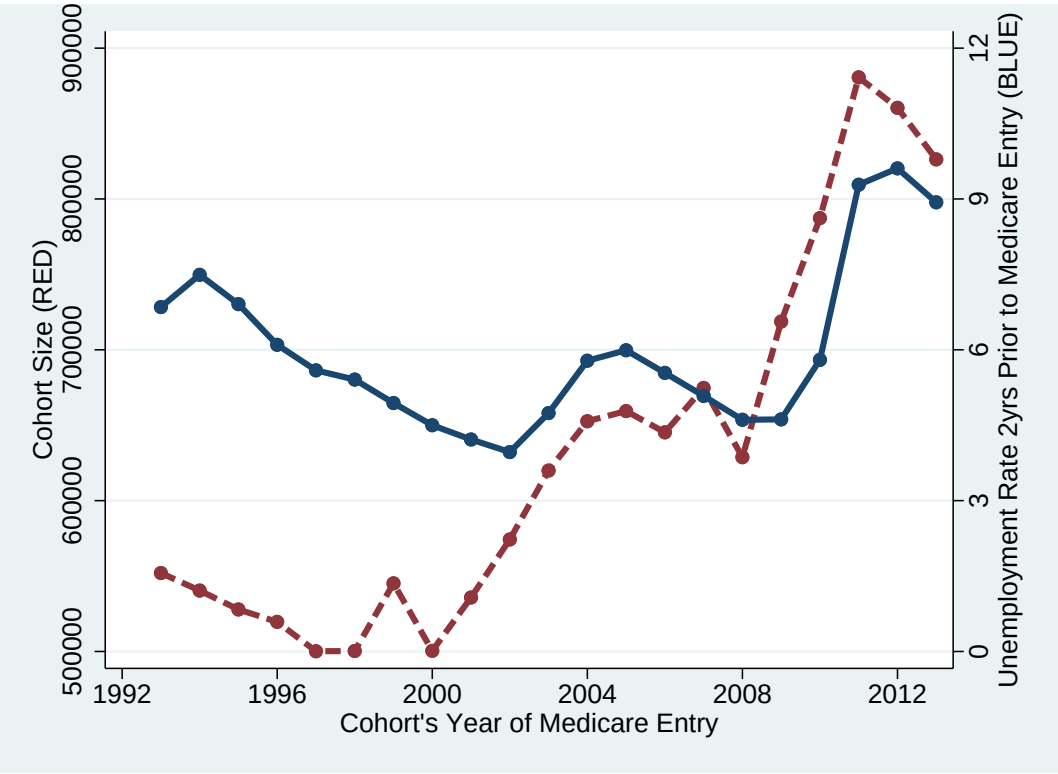
Ruhm, Christopher J. 2012. "Understanding the relationship between macroeconomic conditions and health." *The Elgar companion to health economics*, 1.

Ruhm, Christopher J. 2015. "Recessions, healthy no more?" *Journal of health economics*, 42: 17–28.

Social Security Administration. 2017. "Annual statistical report on the social security disability insurance program, 2016." Social Security Administration, Office of Retirement and Disability Policy, SSA Publication No. 13-11826, Washington, DC.

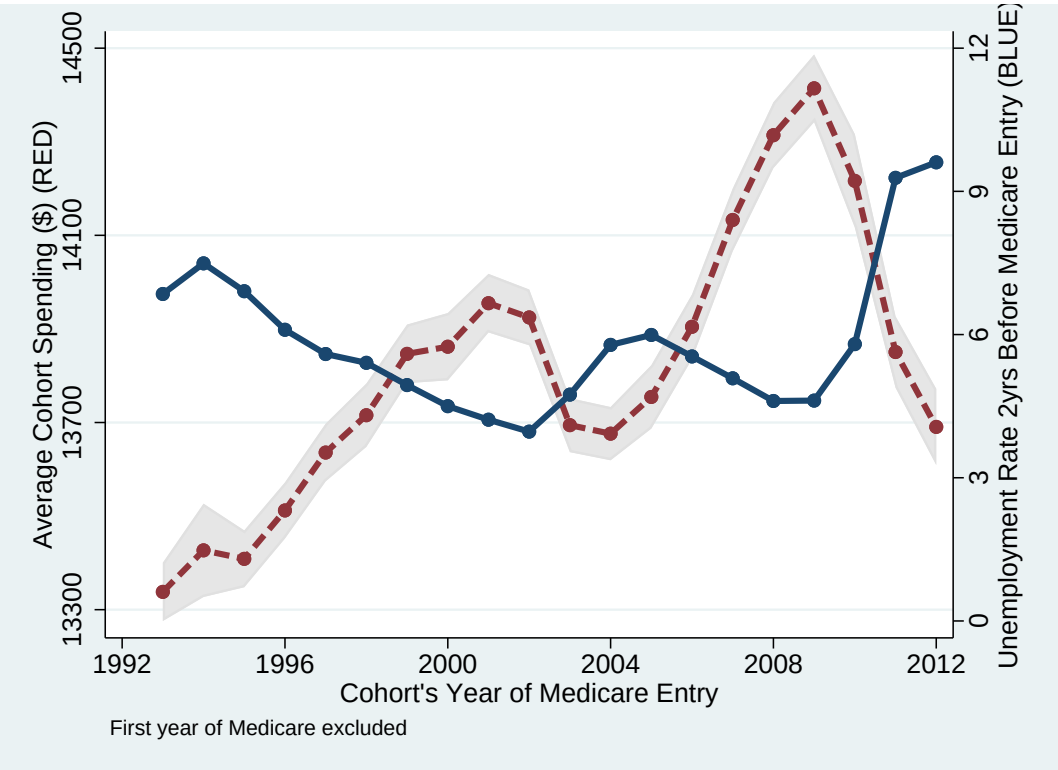
Vabson, Boris V. 2018. "Cost Sharing Among Those Who Can't Pay: Evidence from Medicaid Disenrollments." Stanford Institute for Economic Policy Research.

Figure 1: National Unemployment Rate and Number of Disabled Medicare Entrants



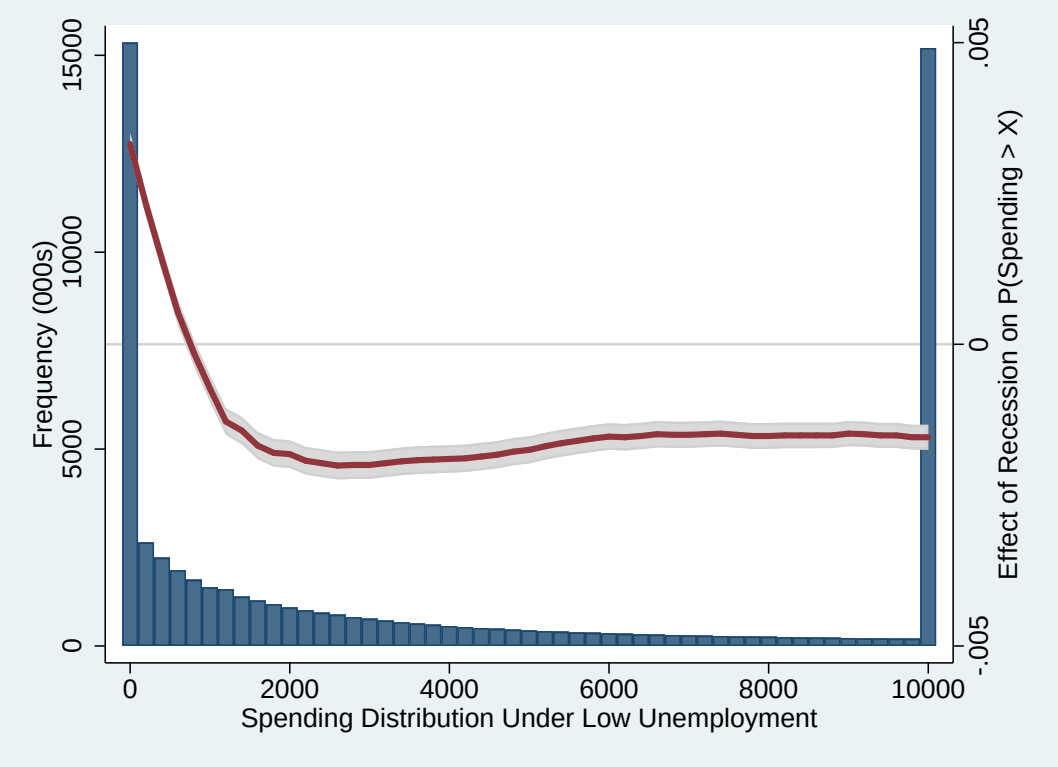
Red dashed line reports number of new disabled Medicare entrants 1993 to 2013. Blue solid line reports national unemployment rate two years prior to each cohort's Medicare entry.

Figure 2: National Unemployment Rate and Average Spending by Year of Medicare Entry



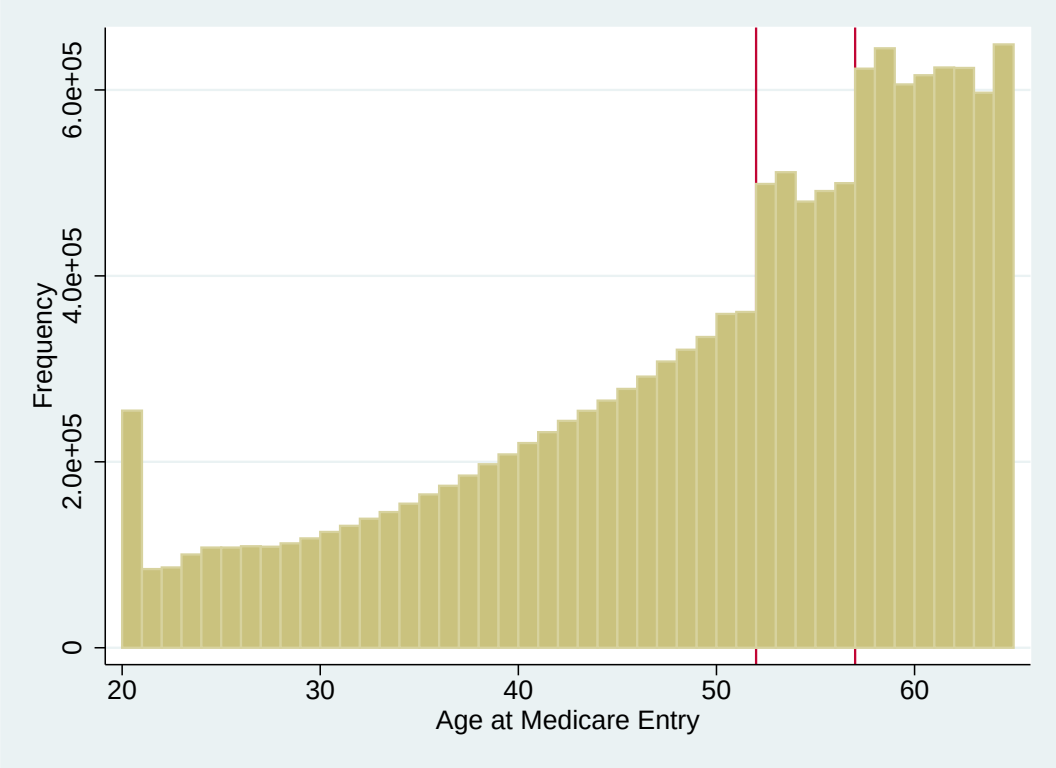
Red dashed line reports average health care spending (δ_c from Equation 1) associated with cohorts entering Medicare 1993 to 2012. Blue solid line reports national unemployment rate two years prior to each cohort's Medicare entry.

Figure 3: Distribution of Spending and Change in Distribution Associated with High Unemployment



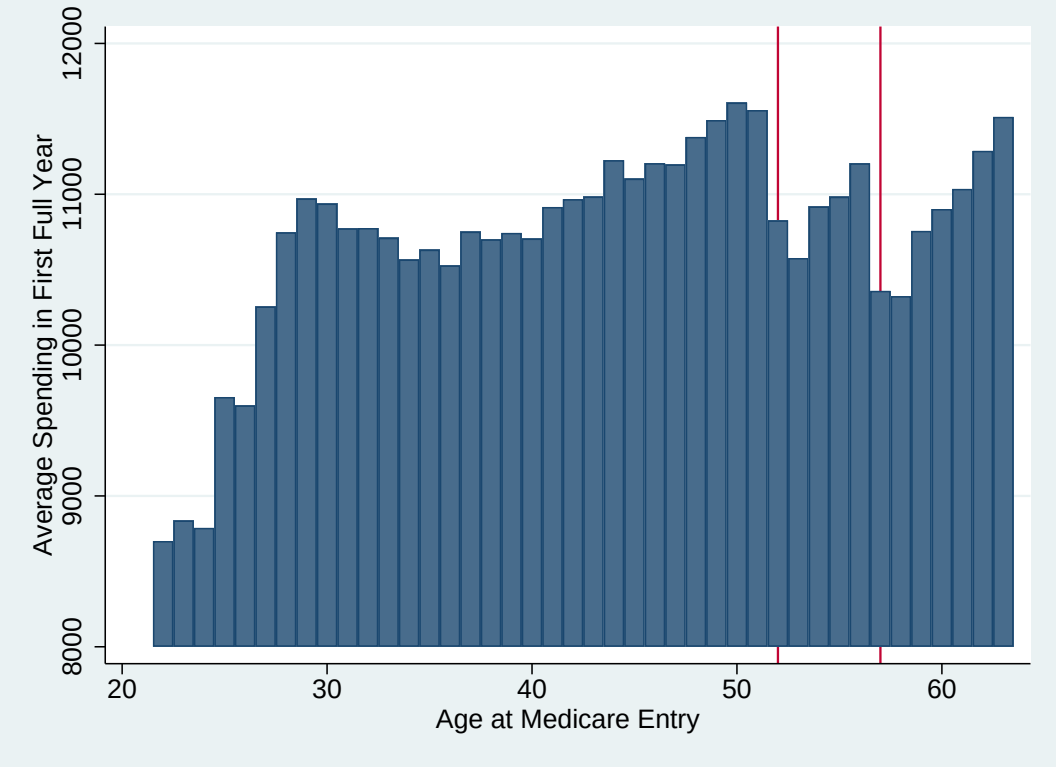
The bars on this figure represent a histogram of annual spending among disabled individuals who entered DI under low unemployment, topcoded at $10,000 and binned in $200 intervals. The red line, measured on the right-hand axis, represents the β_{cut} coefficients estimated from Equation 2, reflecting the change in the probability of exceeding the values measured along the x-axis associated with entering DI under high unemployment.

Figure 4: Number of Disabled Medicare Entrants by Age at Entry



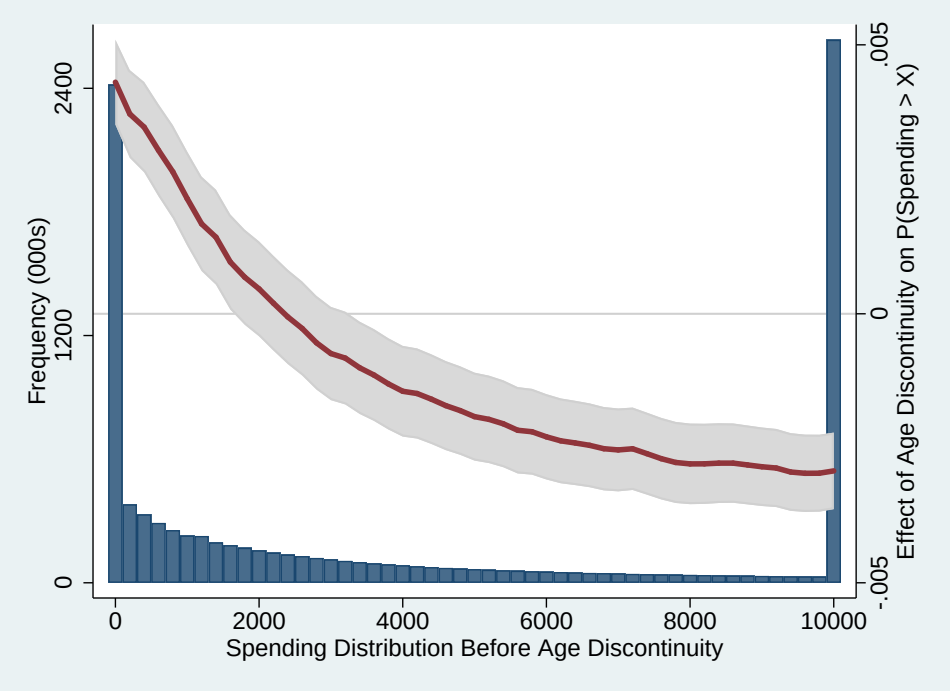
This histogram reports the number of newly disabled Medicare beneficiaries 1993-2013 entering at each age. Those who enter prior to age 20 are included in the bar at age 20. Red lines at age 52 and 57.

Figure 5: Spending of Disabled Medicare Entrants in First Full Year by Age at Entry



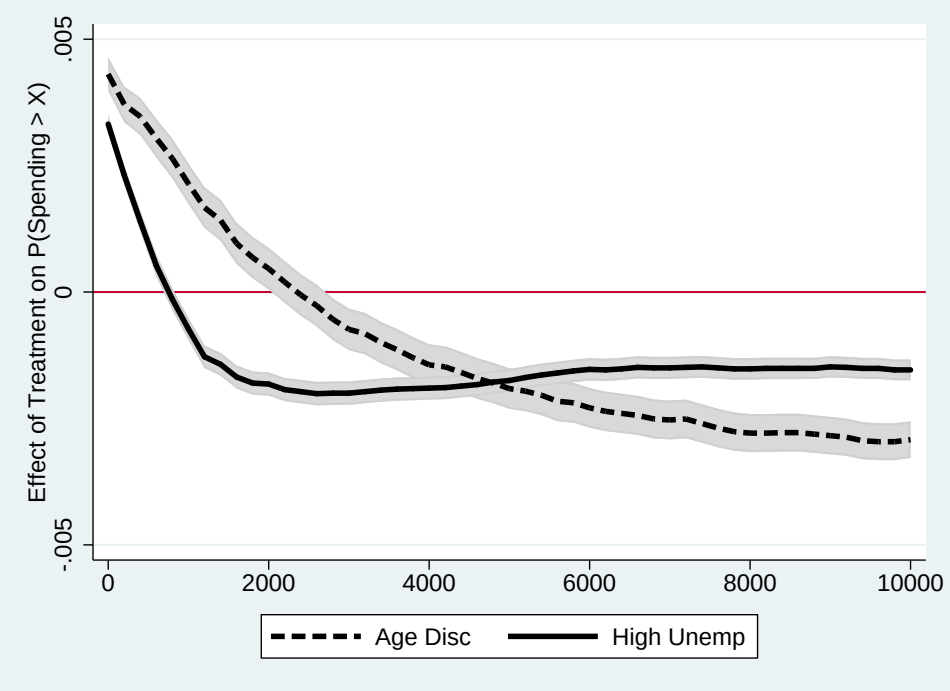
This figure reports the average unadjusted spending of newly disabled Medicare beneficiaries 1999-2013 by age at entry. Spending is collected from the first full year of Medicare eligibility after entry. The figure omits those who join at age 21 or before. Red lines at age 52 and 57.

Figure 6: Distribution of Spending and Change in Distribution Associated with the Age Discontinuity



The bars on this figure represent a histogram of annual spending among disabled individuals who entered DI below the age discontinuities, topcoded at $10,000 and binned in $200 intervals. The red line, measured on the right-hand axis, represents the β_{cut} coefficients estimated from Equation 4, reflecting the change in the probability of exceeding the values measured along the x-axis associated with entering DI above the age discontinuities.

Figure 7: Change in Distribution Associated with High Unemployment and the Age Discontinuity



This figure depicts two series of β_{cut} coefficients, for the case of high unemployment and the age discontinuities. Each β_{cut} coefficient represents the change in the probability of exceeding the values measured along the x-axis associated with entering DI in times of high unemployment or above the age discontinuity.

Figure 8: Conceptual Framework

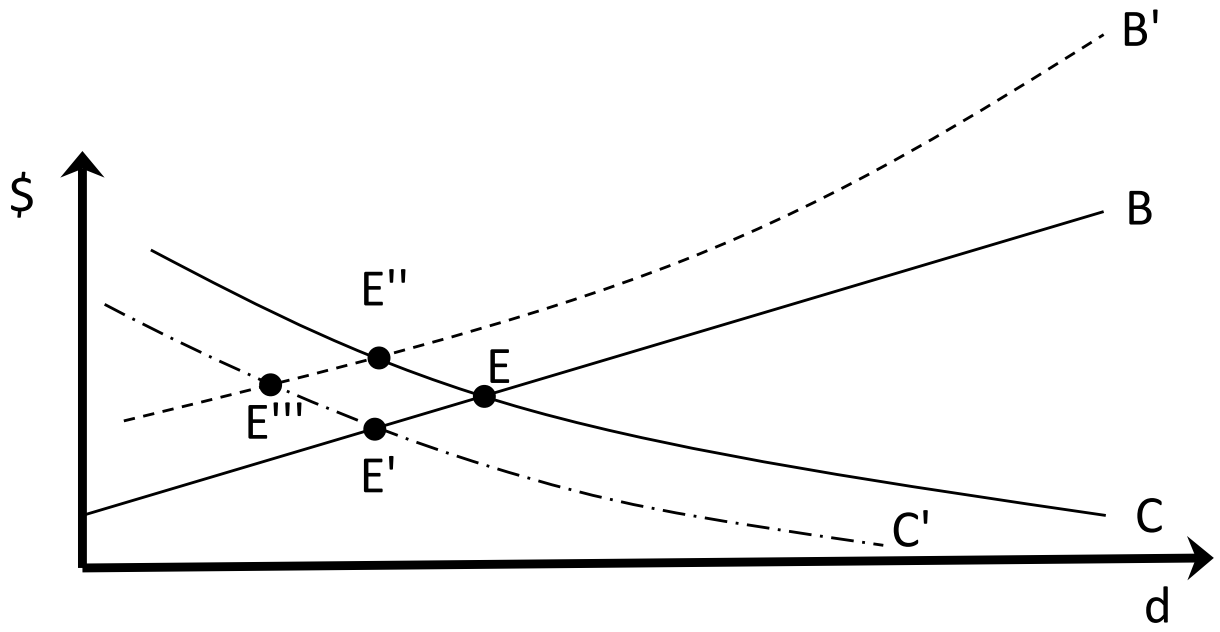


Figure 9: Decomposition of the Impact of Health Shocks and Opportunity Cost Shifts

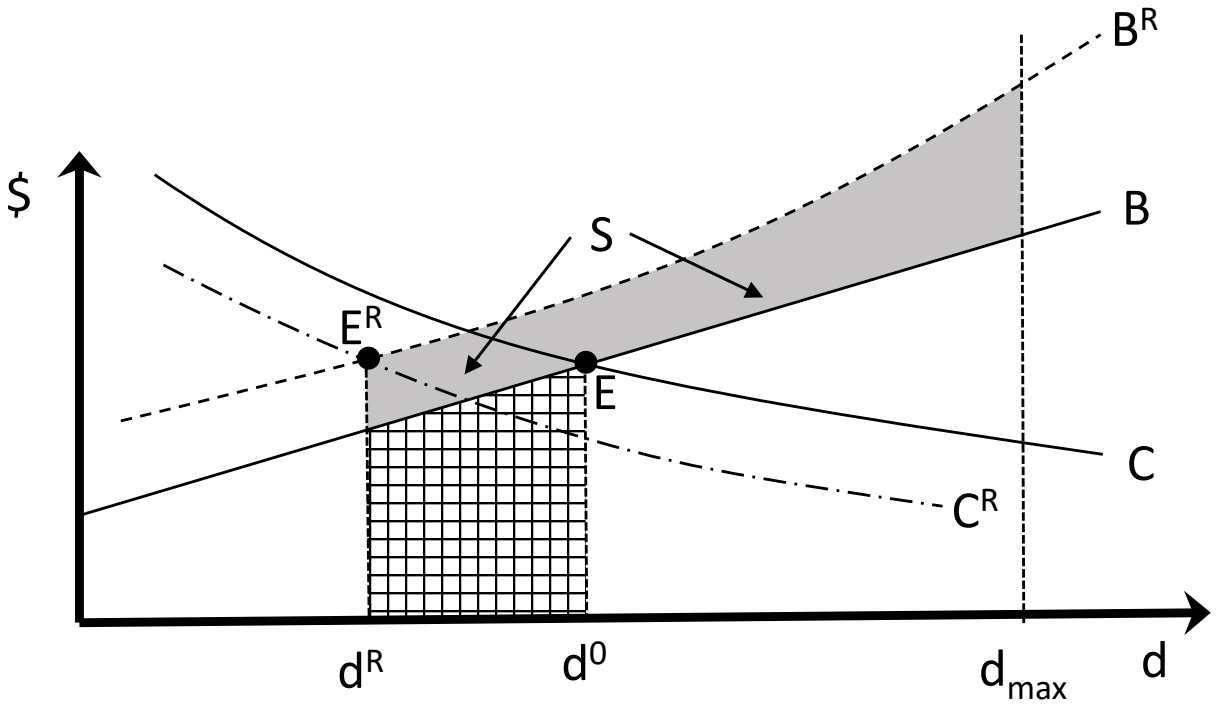


Table 1: Summary Statistics: Full Panel of Disabled Medicare Beneficiaries Entering 1993-2013

Number of person × year observations	121,671,408
Number of persons ever observed	14,756,803
Number of years observed in Medicare	8.25
Number of person × year observations with known spending	90,621,944
Number of years with known spending	6.14
Share female	0.48
Share Age <30	0.05
Share Age [30,39]	0.10
Share Age [40,49]	0.18
Share Age [50,59]	0.29
Share Age [60,69]	0.32
Share Age >=70	0.07

Table 2: Summary Statistics by Year of Medicare Entry, 1993-2013

Cohort Year	Number of Entrants	Share Female	Age at Entry	# of Years in Data	# of Years w/ Spending	Mean Spending (2017$)	Nat'l Unemp 2yrs Prior
1993	573,728	0.42	47.91	14.77	7.70	16,536	6.85
1994	561,930	0.42	47.86	14.29	7.99	16,436	7.49
1995	549,089	0.43	48.18	13.83	8.32	16,210	6.91
1996	541,170	0.45	48.63	13.47	8.72	16,102	6.10
1997	521,306	0.46	48.90	13.12	9.18	15,983	5.59
1998	521,112	0.46	49.03	12.61	9.63	15,804	5.41
1999	558,167	0.48	48.68	12.05	10.15	14,145	4.94
2000	523,630	0.48	49.32	11.50	9.69	14,453	4.50
2001	560,720	0.48	49.34	10.84	9.13	14,402	4.22
2002	599,442	0.48	49.23	10.22	8.56	14,029	3.97
2003	644,899	0.48	49.29	9.56	7.93	13,477	4.74
2004	678,028	0.47	49.59	8.84	7.22	13,035	5.78
2005	685,117	0.47	49.88	8.09	6.51	12,605	5.99
2006	671,450	0.48	50.16	7.30	5.76	12,308	5.54
2007	701,492	0.48	50.04	6.50	5.16	11,750	5.08
2008	654,847	0.48	50.25	5.63	4.44	11,770	4.61
2009	745,929	0.48	49.89	4.76	3.80	11,003	4.62
2010	813,799	0.48	49.66	3.87	3.11	10,091	5.80
2011	906,792	0.46	50.01	2.94	2.34	8,956	9.28
2012	885,759	0.47	50.55	1.98	1.58	7,752	9.61
2013	850,740	0.48	51.04	1.00	0.82	5,397	8.93

Appendix A: For Online Publication Only

In this Appendix, we provide more detail on SSDI administrative rules, data construction, and robustness checks for the analysis.

Table A.1: Age Discontinuities in the SSA Vocational Grids

MSWC	Education	Previous Work Experience	Outcome
Sedentary	Illiterate	Unskilled or none	Not disabled at 44, disabled at 45
Sedentary	Less than HS grad	Unskilled or none	Not disabled at 49, disabled at 50
Sedentary	Less than HS grad	Nontransferable skills	Not disabled at 49, disabled at 50
Sedentary	Less than HS grad	Transferable skills	Not disabled
Sedentary	HS grad – no direct entry into skilled work	Unskilled or none	Not disabled at 49, disabled at 50
Sedentary	HS grad – no direct entry into skilled work	Nontransferable skills	Not disabled at 49, disabled at 50
Sedentary	HS grad – no direct entry into skilled work	Transferable skills	Not disabled
Sedentary	HS grad – provides for direct entry into skilled work	Unskilled or none, nontransferable skills, or transferable skills	Not disabled
Light	Illiterate	Unskilled or none	Not disabled at 49, disabled at 50
Light	Less than HS grad	Unskilled or none	Not disabled at 54, disabled at 55
Light	Less than HS grad	Nontransferable skills	Not disabled at 54, disabled at 55
Light	Less than HS grad	Transferable skills	Not disabled
Light	HS grad – no direct entry into skilled work	Unskilled or none	Not disabled at 54, disabled at 55
Light	HS grad – no direct entry into skilled work	Nontransferable skills	Not disabled at 54, disabled at 55
Light	HS grad – no direct entry into skilled work	Transferable skills	Not disabled
Light	HS grad – provides for direct entry into skilled work	Unskilled or none, nontransferable skills, or transferable skills	Not disabled

Notes: "MSWC" signifies Maximum Sustained Work Capacity. "HS grad" signifies high school graduate. Individuals with MSWC medium or above are excluded; there are few to no age discontinuities for these groups.

Figure A.1: Comparison of Number of Newly Disabled in Medicare and in SSA Annual Statistical Report

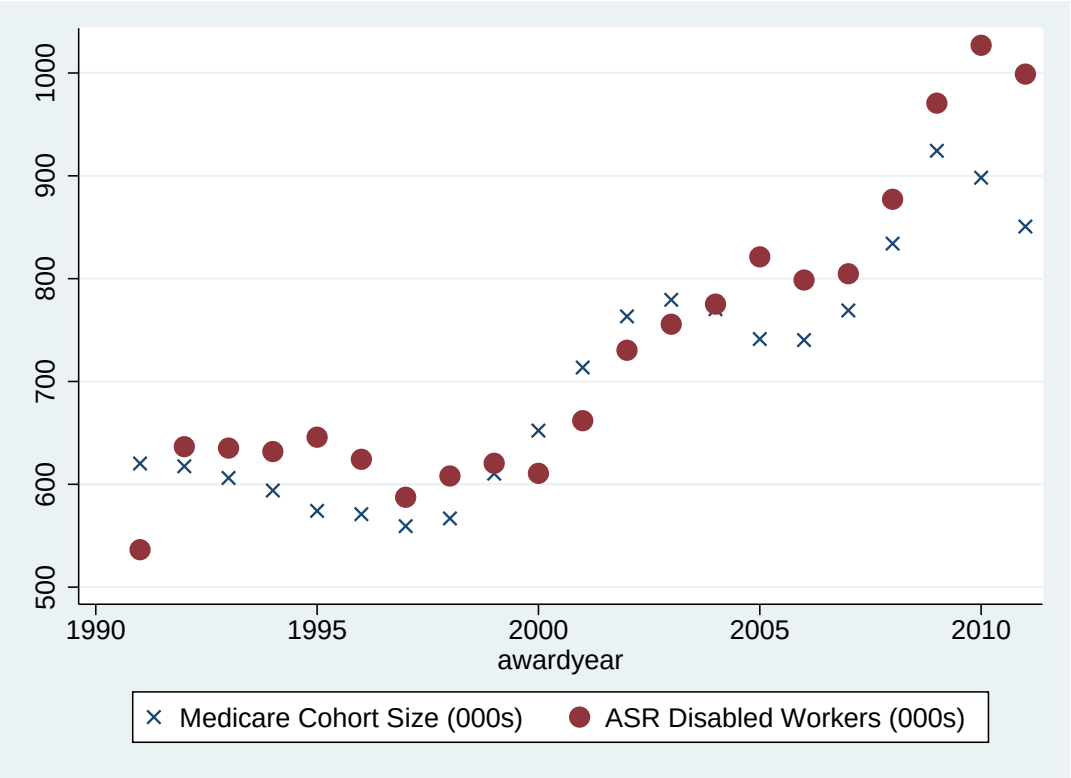


Figure describes number of new awards reported in the Annual Statistical Report (Social Security Administration, 2017) for years 1991 to 2011 (circles) and number of new disabled entrants into Medicare two years later (Xs).

Figure A.2: Decomposition of the Impact of Health Shocks and Opportunity Cost Shifts
The Case of Negative Health Shocks

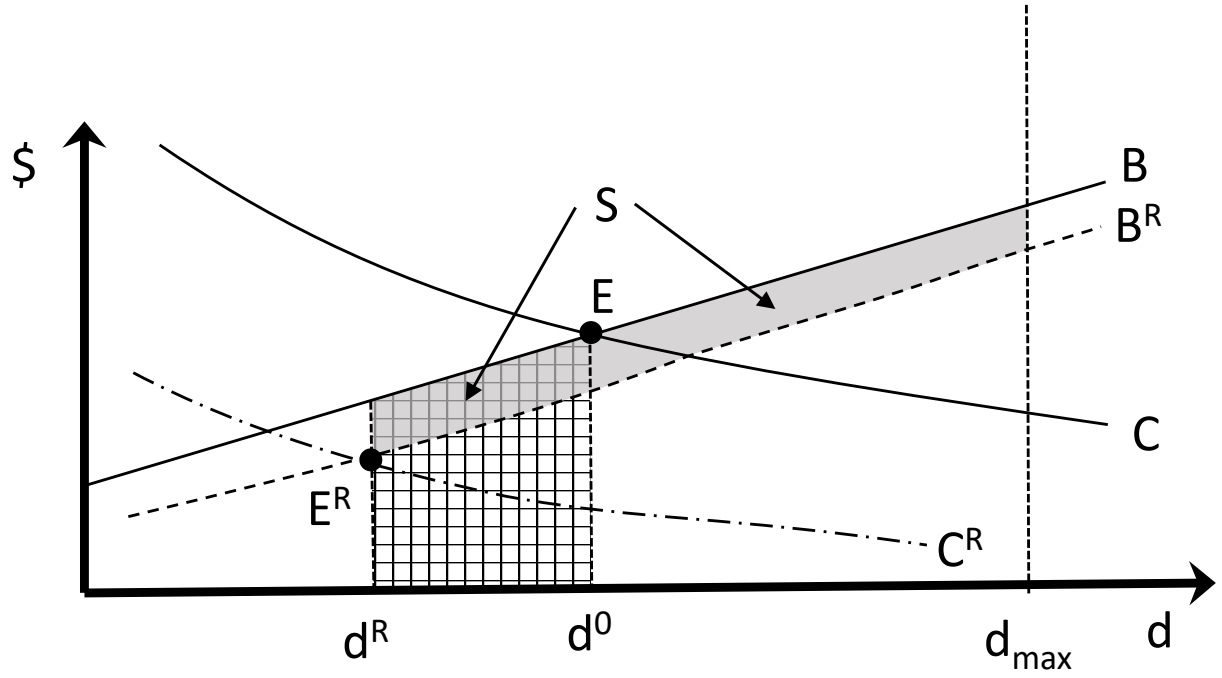
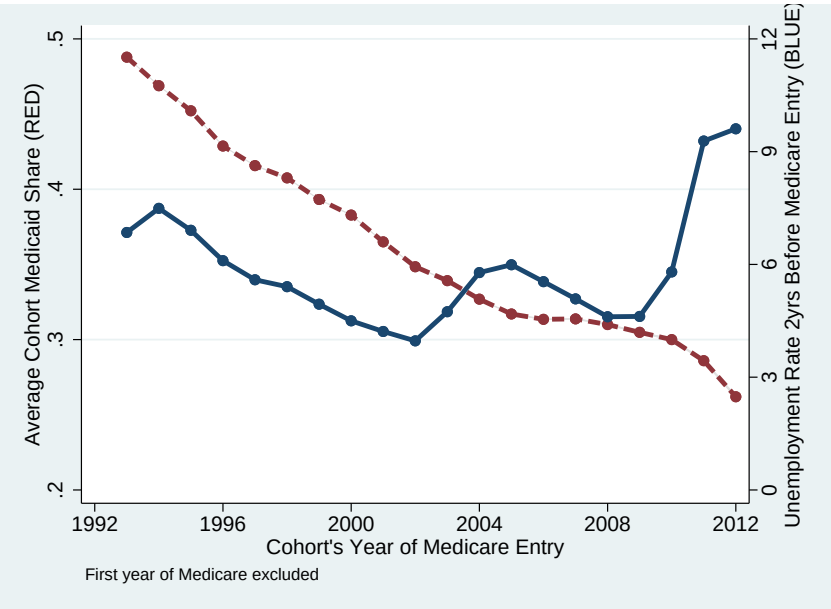
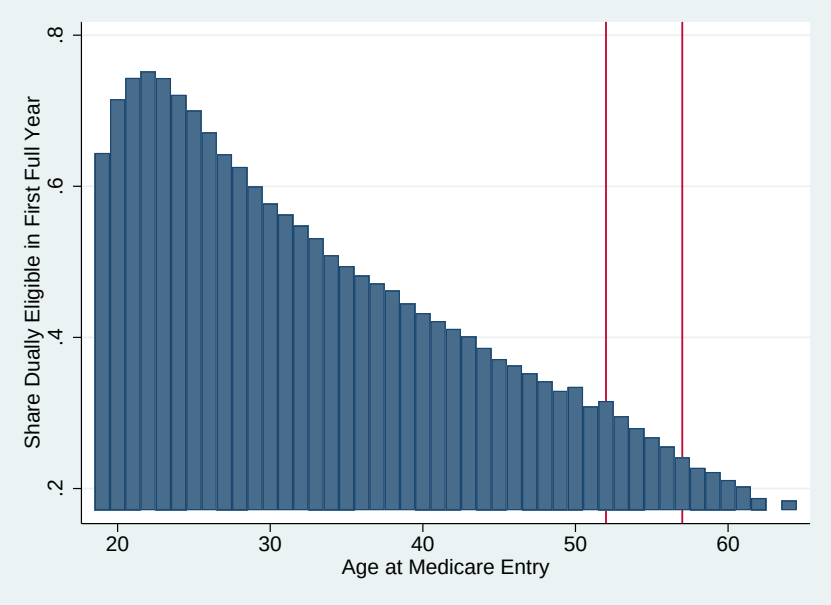


Figure A.3: Medicaid Enrollment Across Cohorts



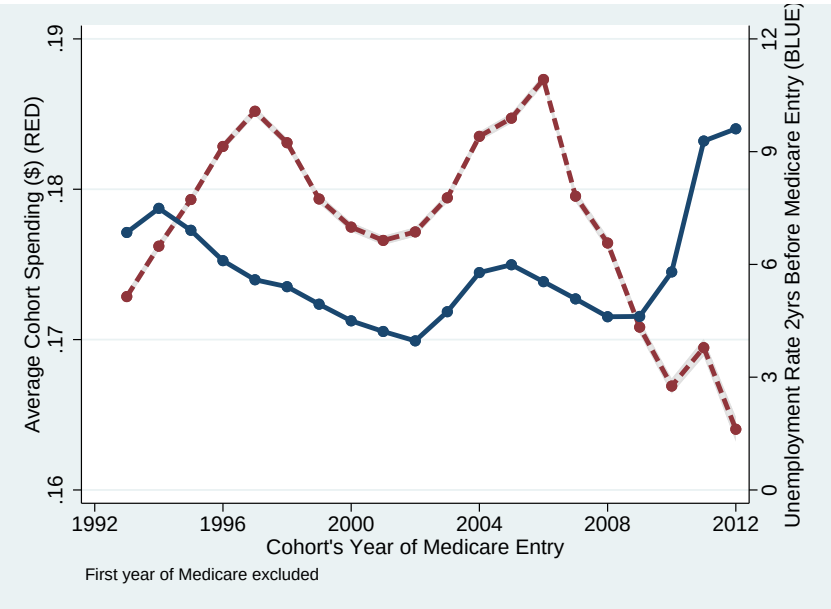
Red dashed line reports average Medicaid enrollment (δ_c from Equation 1) associated with cohorts entering Medicare 1993 to 2012. Blue solid line reports national unemployment rate two years prior to each cohort's Medicare entry.

Figure A.4: Medicaid Enrollment Across Age at Entry



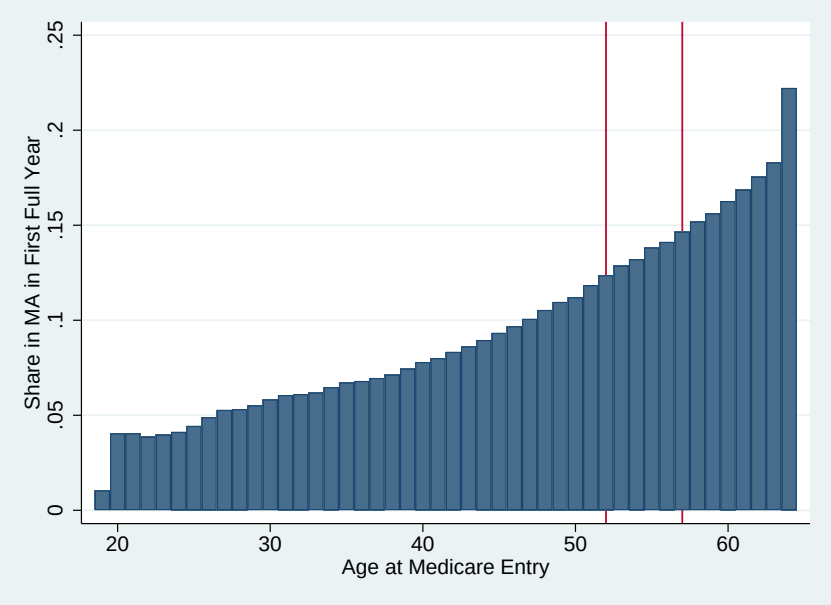
The height of the bar measures Medicaid enrollment status for newly disabled Medicare beneficiaries 1993-2012 in the individual's first full year based on their age at Medicare entry. Red lines at age 52 and 57.

Figure A.5: Medicare Advantage Enrollment Across Cohorts



Red dashed line reports average Medicare Advantage Enrollment (δ_c from Equation 1) associated with cohorts entering Medicare 1993 to 2012. Blue solid line reports national unemployment rate two years prior to each cohort's Medicare entry.

Figure A.6: Medicare Advantage Enrollment Across Age at Entry



The height of the bar measures Medicare Advantage enrollment status for newly disabled Medicare beneficiaries 1993-2012 in the individual's first full year based on their age at Medicare entry. Red lines at age 52 and 57.