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David H. Autor
Nicole Maestas
Kathleen J. Mullen
Alexander Strand

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ABSTRACT

This paper measures the causal effect of time out of the labor force on subsequent employment of Social Security Disability Insurance (SSDI) applicants and distinguishes it from the discouragement effect of receiving disability benefits. Using a unique Social Security Administration workload database to identify exogenous variation in decision times induced by differences in processing speed among disability examiners to whom applicants are randomly assigned, we find that longer processing times reduce the employment and earnings of SSDI applicants for multiple years following application, with the effects concentrated among applicants awarded benefits during their initial application. A one standard deviation (2.1 month) increase in initial processing time reduces long-run "substantial gainful activity" rates by 0.36 percentage points (3.5%) and long-run annual earnings by $178 (5.1%). Because applicants initially denied benefits spend on average more than 15 additional months appealing their denials, previous estimates of the benefit receipt effect are confounded with the effect of delays on subsequent employment. Accounting separately for these channels, we find that the receipt effect is at least 50% larger than previously estimated. Combining the delay and benefits receipt channels reveals that the SSDI application process reduces subsequent employment of applicants on the margin of award by twice as much as prior literature suggests.

David H. Autor
Department of Economics, E17-216
MIT
77 Massachusetts Avenue
Cambridge, MA 02139
and NBER
dautor@mit.edu

Nicole Maestas
RAND Corporation
1776 Main Street
P.O. Box 2138
Santa Monica, CA 90407-2138
Nicole_Maestas@rand.org

Kathleen J. Mullen
RAND Corporation
1776 Main Street
P.O. Box 2138
Santa Monica, CA 90407-2138
Kathleen_Mullen@rand.org

Alexander Strand
Social Security Administration
Office of Retirement and Disability Policy
500 E. St., NW
Washington, DC 20254
Alexander.Strand@ssa.gov

Introduction

An influential body of research analyzes the causal effect of receipt of Social Security Disability Insurance benefits (SSDI) on employment and earnings by comparing the post-application labor force participation of applicants awarded benefits relative to those denied benefits.[1] Implicit in this analytic approach is the assumption that the SSDI determination process affects applicants' labor supply through a single causal channel—the allowance or denial decision. While this channel is undoubtedly important, it is unlikely to capture the total effect of the SSDI on the employment and earnings of disability applicants. A second potential channel, and the focus of this paper, is that the disability determination process itself may directly reduce applicants' subsequent employment and earnings potential by prolonging their time out of the labor force.[2] Due to a combination of strong non-work incentives and substantial waiting times built into the SSDI determination process, workers seeking SSDI benefits may face prolonged periods out of the labor force while awaiting a final disability determination. We refer to this mechanism as the delay channel.[3] If applicants' employment potential decays while they are non-participants in the the labor force, then the observed post-application labor supply of denied and allowed applicants may understate their employment potential at the time of SSDI application. Moreover, if either the rate of deterioration or average SSDI processing time differs between allowed and denied applicants, a comparison of their labor supply following the SSDI determination may not identify the pure effect of the SSDI award on employment outcomes. Though prior literature has posited that the decay channel may be economically important (Parsons, 1991), there is no existing work that empirically identifies this mechanism or estimates its magnitude.

This paper offers the first causal analysis of the effect of SSDI application processing times on

[1] Bound (1989) introduced the empirical approach of using the labor supply of denied SSDI applicants to form an upper bound on the potential labor supply of accepted applicants, an approach recently employed by von Wachter, Song, and Manchester (2011). Bound (1991) and Parsons (1991) debate the validity of this comparison. Several recent papers in this literature, including Chen and van der Klaauw (2005), Maestas, Mullen and Strand (2013), and French and Song (2014) exploit plausibly exogenous variation in SSDI awards to estimate the causal effect of receiving SSDI benefits on labor supply.

[2] A third channel by which the SSDI determination process may impact labor supply is inducement: unemployed workers and those with weak labor force attachment may potentially exit the labor force to apply for SSDI rather than seek employment (Parsons 1980, Black, Daniel and Sanders 2002, Autor and Duggan 2003). Our analysis does not shed light on this channel.

[3] In our administrative sample of SSDI applicants, discussed below, the average time from SSDI application to final determination exceeds one year (14.1 months). Nearly half of SSDI applicants—including those who are ultimately allowed as well as denied—challenge their initial determination and face processing times on average exceeding two years (28.7 months).

the post-application employment and earnings of SSDI applicants. We draw upon a unique Social Security Administration (SSA) workload database containing the universe of SSDI applications receiving initial determinations in 2005 to identify exogenous variation in applicants' initial decision times induced by differences in processing speed among the disability examiners to which they are randomly assigned. The average examiner in our sample spends around three months reviewing a case prior to making an initial determination. However, mean determination times differ significantly across examiners, with the 90/10 range in mean examiner time equal to 1.9 months. The characteristics of applicants assigned to each examiner and geographic variation in processing times explain less than half of the cross-examiner variation, with the remaining variation plausibly attributable to productivity differentials among examiners. After accounting for the Disability Determination Services office (DDS) to which applicants apply and a small number of applicant characteristics used in some offices for initial screening, we cannot reject the hypothesis that applicants are conditionally randomly assigned to examiners within their DDS offices. We show that this examiner-level variation in average processing times significantly affects applicants' total processing time but is uncorrelated with initial allowance decisions (and, ultimately, SSDI receipt). In combination with the random assignment of applicants to examiners within a DDS office, these findings permit us to use examiner-specific mean processing times as an instrumental variable for the realized processing times of the cases to which they are assigned.

Our empirical analysis first explores whether the length of the SSDI determination process affects the subsequent employment of applicants who are awarded benefits at the initial application.[4] Initially allowed applicants are a particularly interesting group because they typically have comparatively high pre-onset earnings, and hence their employment prospects may be relatively sensitive to time out of work. In addition, they face no immediate work disincentives after receiving their disability allowance. Following entitlement, beneficiaries are given a Trial Work Period (TWP) during which they can return to work with no risk of benefits suspension.[5] Exploiting examiner-level

[4]As above, the examiner processing time instrument is uncorrelated with initial allowance rates. Thus, focusing only on initially allowed does not induce selection bias.

[5]The SSDI program allows new beneficiaries to "test" their ability to work by engaging in Substantial Gainful Activity (SGA) without penalty during a combined (not necessarily consecutive) 9-month Trial Work Period (TWP) and 3-month Grace Period, which commence after a 5-month Waiting Period during which beneficiaries must refrain from working more than SGA. Beneficiaries exhausting the TWP and Grace Period then enter a 3-year Extended Period of Eligibility (EPE) during which benefits are paid for months in which earnings are below SGA and not paid when earnings are above SGA. After the EPE, beneficiaries may no longer engage in SGA or their benefits will be suspended; however, they are then eligible for Expedited Reinstatement (EXR) if they become unable to engage in

variation in processing times, we find that longer processing times significantly reduce the employment and earnings of initially allowed SSDI applicants in the years after their determination. Our estimates indicate that a one-month increase in processing time reduces annual post-decision employment rates by 0.4 to 0.5 percentage points (points, for brevity) or 4 to 5 percent and lowers post-decision annual earnings by $130 to $240 or 8 to 13 percent. This employment effect persists for at least six years following the initial disability application (through 2011, the final year we observe), while the earnings impact attenuates in years five and six after application (though it remains significant). Our identification assumptions imply that these persistent employment impacts may be interpreted as the causal effect of additional time out of the labor force on subsequent employment.

Corroborating this interpretation, we next document that the effect of additional processing time on subsequent employment stems entirely from delays that extend the allowance date beyond five months *after* disability onset.[6] This observation is significant because an applicant's benefit payments and Trial Work Period cannot commence until five months have elapsed since the onset of disability. Delays in the application process that do not extend the time to allowance beyond this five month waiting period are therefore infra-marginal: they should have no incentive effect on contemporaneous labor force participation and, under our delay-decay hypothesis, will have no effect on post-allowance employment. This is precisely what we find. We detect no significant impact of variation in processing time on post-award employment of beneficiaries who are notified of their award *during* the waiting period. For those notified after the waiting period, however, each additional month of processing time reduces subsequent employment by 0.4 to 0.6 points, slightly exceeding the effect for the full initially allowed group.

We next broaden the analysis to include all SSDI applicants—those initially allowed and initially denied—and we examine the effects of both processing time and SSDI receipt on their subsequent labor supply. Identification of the causal effect of SSDI receipt requires an additional source of variation that affects the likelihood of receiving an SSDI allowance but is uncorrelated with applicants' health or other unobserved factors affecting labor supply. Following Maestas, Mullen and Strand

SGA. Benefit payments also commence at the end of the Waiting Period. Beneficiaries notified after the Waiting Period has elapsed may receive up to 17 months of back-dated benefits (without interest), so there is little difference in the present discounted value of the benefit stream for applicants notified before or after the Waiting Period. See SSA regulation DI 10105.015 "Retroactivity of Disability Application."

[6]Onset date is defined by SSA based on the applicant's allegations, work history and medical evidence. In practice, the onset date is usually the date when the disability began to interfere with work or the date the individual stopped working, whichever is later.

(2013), we use variation in examiner allowance propensity as this second source of variation. The random assignment of applicants to disability examiners with different allowance propensities generates exogenous variation in decision outcomes that is unrelated to unobserved impairment severity or labor force attachment. Exploiting both sources of variation, we find that the impact of waiting time on the full set of applicants—both those initially denied and initially allowed—is somewhat smaller than the effect of waiting time on the initially allowed sample and tends to decline in magnitude several years after the initial determination, though this latter inference is clouded by large macroeconomic shocks that affected the U.S. economy in the later years of our sample.

The existence of an employment decay effect as a distinct causal channel through which the SSDI determination process affects post-application labor supply outcomes—separate from the benefit receipt effect, which has been the sole focus of existing literature—has important implications for the total impact of the SSDI program on available and unrealized work capacity. As we show formally below, studies that estimate the effect of disability allowances on labor supply but do not account for systematic differences in processing time between allowed and denied applicants will generally produce biased estimates of the effect of benefit receipt. The source of this bias is applicant appeals. Because applicants frequently appeal SSDI denials but never appeal SSDI allowances—except to seek an earlier established onset date and hence a higher initial payment—applicants who are randomly assigned to examiners with higher allowance propensities will have higher allowance rates, fewer appeals, and thus shorter processing times than those randomly assigned to examiners with lower allowance propensities (Maestas, Mullen and Strand, 2013).[7] If, as we establish below, waiting time has an independent negative effect on subsequent employment, then conventional two-stage least squares (2SLS) estimates will *underestimate* the causal effect of the disability allowance on labor supply by confounding the positive labor supply effect of disability denial with the negative labor supply effect of additional waiting time.

We find that the bias that arises from ignoring the effect of the decay channel on labor supply is substantial, especially in the short run when the decay effect is strongest. Instrumental variables estimates of the effect of SSDI award on labor supply that do not account for the decay channel imply that the disability award reduces labor force participation by 27 points three years

[7] We document below that examiners with higher allowance propensities are neither systematically faster nor slower than examiners with lower allowance propensities.

following application, and 17 points six years following application, for those on the margin of program entry. Accounting for the delay-decay channel raises this estimate to 48 points in year three post-application, and 25 points in year six (though the difference between the two estimates—not controlling for endogenous processing time and controlling for endogenous processing time—is not statistically significant at year six).

On net, our results imply that neither the recent nor established SSDI literature has fully captured the labor supply impacts of the disability system on applicants and beneficiaries. While prior literature has posited that the decay channel may be economically important, no prior paper has provided direct estimates of this causal pathway. Moreover, due to the confounding of allowance odds and processing times, existing literature has underestimated the labor supply effects of SSDI awards on beneficiaries. Accounting for both mechanisms provides a more complete—and economically more sizable—picture of the aggregate labor supply impacts of the Social Security Disability Insurance program. Combining the labor supply decay effect with new estimates of the benefit receipt effect that are purged of waiting time bias suggests that the SSDI program effect on employment is 100 to 140 percent larger than previous estimates have suggested for applicants on the margin of SSDI receipt .

Our findings finally contribute to a longstanding and active literature on duration dependence in unemployment (Kroft, Lange, and Notowidigdo 2013, Davis and von Wachter 2011, Ljungqvist and Sargent 1998, and Blau and Robins 1990). While our results pertain most directly to the labor force participation of disability applicants rather than unemployed workers, one can interpret our findings more broadly to indicate that involuntary time out of the labor force exerts an adverse causal effect on subsequent employment of workers with marginal employment prospects. We hypothesize that this decay channel operates through deteriorating human capital, but it may also plausibly be explained by workers losing their taste for employment during periods of non-participation, or by employers discriminating against workers who have experienced extended spells of unemployment (as in Kroft et al., 2013). Our results may also be relevant to current SSA initiatives that aim to increase return to work rates among SSDI beneficiaries by reducing the large financial penalty for those who work in excess of SGA.[8] If, as our results imply, the work capacity of beneficiaries

[8]For details of SSA's Benefits Offset National Demonstration (BOND) initiative, see http://www.ssa.gov/disabilityresearch/offsetnational.htm. See also Weathers and Hemmeter (2011).

continues to decline as they remain out of the labor force, a relaxation of work *disincentives* while receiving SSDI benefits may be insufficient to return long-term beneficiaries to work. Our findings suggest that modifications to the disability determination process that increase applicants' labor force participation while the determination is ongoing may be more effective in increasing longer-term employment among this population. Given that nearly 25 million Americans applied for SSDI benefits in the past ten years—with nearlythree million applications filed in 2010 alone at the height of the Great Recession—even modest improvements in the incentive effects of the determination process could have economically significant aggregate benefits.[9]

The paper proceeds as follows. The next section discusses relevant features of the SSDI system and details our research database. Section 2 lays out our identification strategy. Section 3 presents estimates of the labor supply effects of processing delays, both for initially allowed applicants and for the full sample of allowed and denied applicants. Section 4 documents that previous estimates of the benefit receipt effect are confounded with the effect of delays on subsequent employment, and shows that purging this confound substantially increases the estimated discouragement effect of benefits receipt on labor supply. Section 5 concludes.

1 Data Sources and Sample Characteristics

We make use of a unique workload management database called the Disability Operational Data Store (DIODS) which temporarily stores information about the universe of initial and reconsideration disability decisions that are recorded in the National Disability Determination Service System. The main advantage of the DIODS over SSA administrative data sources used in prior literature is that it includes alphanumeric codes linking applicants to the disability examiner who was (conditional on observable characteristics) randomly assigned to evaluate their case. Our sample contains data on all initial medical determinations (that is, excluding technical denials) made in 2005. We restrict the sample to primary claimants (i.e., excluding dependents) for adults ages 18-64 assigned to examiners handling at least 30 such cases in 2005 (and fewer than 900 cases to rule out training cases).[10] The DIODS contains applicant characteristics, notably impairment type (i.e., broad body system affected as well as somewhat finer diagnosis codes), which can factor into examiner assignment at some DDS

[9]Statistics available at http://www.ssa.gov/OACT/STATS/dibStat.html, accessed 9/22/2014.
[10]Examiners decided 145 cases on average in 2005.

offices.[11] Linking the DIODS to SSA's "831" research files (derived from Form SSA-831 which summarizes the result of the disability determination for applicants) allows us to observe cases of alleged terminal illness (TERI), which are flagged for priority processing, sometimes by examiners who specialize in such cases. Conditional upon these two variables—broad impairment type and TERI—it is our understanding from interviews with SSA DDS offices that SSDI applications are randomly assigned to examiners within a DDS office (see Maestas, Mullen and Strand, 2013, for more details). We verify below that the data are consistent with random assignment of applicants to examiners within DDS offices.

In addition to the outcome of the initial disability determination, the DIODS includes application filing date, date of receipt at the regional DDS office (after being forwarded from the local field office), date of the initial determination and, for initially allowed applicants, the disability onset date. We measure examiners' average processing time using recorded time at DDS, equal to date of initial determination minus date of receipt at DDS.

Denied applicants can appeal their initial determination up through four levels: reconsideration, where the application is returned to the original DDS office in most states[12]; a hearing before an administrative law judge (ALJ); a review by an SSA Appeals Council; and finally Federal Court. At any stage in the appeals process the applicant can present new evidence. Because appealing an initial denial can add several months and in many cases years to the time of final decision, some applicants who appeal may simultaneously submit a new application ("reapplication").

To measure applicants' total processing time, we employ several data sets. We observe reconsiderations and reapplications using a DIODS extract and 831 files, respectively, including decisions through 2006. We observe ALJ hearings through November 16, 2012 using data from the Case Processing and Management System (CPMS). Although we are unable to directly observe cases that proceed to the Appeals Council and/or Federal Court, we can observe date of benefit receipt for

[11] For the most part, we avoid using diagnosis codes in the analysis because the codes themselves are determined by the examiner and as such may be correlated with examiner allowance propensity. However, because some DDS offices assign new examiners homogenous caseloads as part of their training we include the 20 most common diagnosis codes (with at least 10,000 cases and with significant numbers of both positive and negative determinations). Examples of these conditions are: back disorders, affective disorders, osteoarthritis, disorders of the muscle, ligament and fascia, and diabetes.

[12] In 1999, the reconsideration step was eliminated in ten "prototype" states (Alabama, Alaska, California (Los Angeles North and Los Angeles), Colorado (West), Louisiana, Michigan, Missouri, New Hampshire, New York and Pennsylvania). Despite this, we found that mean total processing times were virtually identical in prototype and non-prototype states, largely because more applicants in the prototype states initiated appeals.

cases that were ultimately allowed using data from the Payment History Update System (PHUS) coupled with the Master Beneficiary Record (MBR) to verify that the payments were SSDI payments. We observe these payments through 2011. We measure applicants' total processing time by calculating time from filing date to the last observed decision. We consider any new application filed within one year of the last observed denial (e.g., at the ALJ) to be a continuation of the previous claim (reapplication) and add processing time for that or any following decisions to the applicant's total processing time. For applicants receiving SSDI benefits whose last decision was observed as a denial, we use time to benefit receipt date (inferring that the applicant was allowed through one of the "higher appeals" levels).[13]

Finally, we observe labor market outcomes by linking our sample to the Detailed Earnings Record (DER) that gives uncapped annual earnings from box 5 (Medicare wages and tips) of individuals' W2 tax forms. We observe earnings up to and including 2011. In order to ensure that the earnings records represent a full year of potential work, we link to the date of death information in the Numerical Identification System (NUMIDENT) and restrict the sample to applicants who were alive through the end of the calendar year in which earnings are observed.

1.1 Sample characteristics

Table 1 presents summary statistics on the sample, overall and separately for initial and final allowance decisions.[14] After applying our sample restrictions, we observe SSDI applications for just over one million individuals in 2005.[15] Average examiner processing time is just under three months and does not differ systematically across applicant groups according to case disposition (columns 2 - 5): those initially allowed, those initially denied, those finally allowed, and those finally denied. Approximately one-third of applicants are initially allowed benefits, although more than two-thirds

[13]According to the Office of Disability Program Management Information, for around two percent of claims, the last determination is a denial at the appeals council or federal court levels. For these and any claims in process more than seven years after the initial determination, we will underestimate true processing time.

[14]Finally allowed includes applications that were either initially allowed or allowed on appeal or reapplication. Finally denied includes applications that were initially denied but not appealed and applications that were denied after all appeals.

[15]Our sample statistics differ from SSA official statistics for three reasons: first, we exclude technical denials, which did not receive a medical determination; second, we drop approximately 108,000 applicants who died within two years of their initial decision (8% of all medical determinations); third, we drop approximately 187,000 applicants who previously applied for or received SSDI or SSI benefits. The last restriction excludes cases from SSA's "Special Disability Workload" outreach initiative which identified SSI recipients who had worked enough to become insured for SSDI. (Note that, while the medical and vocational criteria are the same for both programs, unlike SSDI, SSI recipients who earn more than SGA retain their eligibility for SSI and receive reduced benefits.)

are observed to receive SSDI benefits by the end of 2011. Sixty-four percent of initially denied applicants continue their claim by either pursuing an appeal or submitting another application. Of these, the vast majority (more than 95 percent) pursue an appeal and 70 percent of these are successful at the next stage (reconsideration or ALJ if the applicant lives in a prototype state).[16] Approximately half of SSDI claims are concurrent with claims for Supplemental Security Income (SSI), which pays additional benefits to disabled individuals with limited income (counting SSDI) and assets.

Applications are assigned to examiners and evaluated according to the same medical and vocational criteria for concurrent and non-concurrent applications. Fewer than 1 percent of applications are flagged as high priority terminal illness cases, and these cases have disproportionately high (initial) allowance rates. The average applicant is 46.5 years old at the time of the initial determination and has low pre-onset earnings—$22,308 (in 2008 dollars) averaged over the 3-5 years prior to initial determination. Earnings and employment (measured as earning more than $1,000 per year) are even lower three and six years after initial determination, and are declining over time.

A central takeaway from Table 1 is that the primary driver of total processing time is whether or not an applicant pursues an appeal. Initial time at the DDS office averages 2.8 and 3.0 months respectively for applications that were initially allowed and initially denied. In contrast, average processing time is just over 28 months for applicants who pursued an appeal or reapplication (and this is slightly *underestimated* for the finally denied, since we do not observe denials at higher levels of the appeals process). On average, applicants who ultimately received benefits had longer processing times (15.3 months) than applicants who did not (11.6 months, as of the end of our followup period). This is because among the ultimately denied applicants only about a third continued their claim after the initial level compared with half of ultimately allowed applicants.

Table 2 presents average cumulative application processing times by administrative review level. It takes about one month on average for an application to be transmitted from the originating field office to the DDS, and just under four months for an initial determination. The median initial processing time is 3.4 months and 90 percent of applications are processed at this stage in under 6.2 months. Breaking out examiner processing time by decision step—the point at which the examiner provides the formal justification for an allowance or denial—reveals that applicants

[16] In addition, 16 percent of initially denied applicants submit a new application (most while simultaneously pursuing an appeal), yet only 12.5 percent of these new applications are successful.

who are allowed or denied for clear cut reasons receive somewhat faster decisions than applicants who are evaluated using a combination of medical and vocational criteria.[17] Just over a quarter of applications proceed through reconsideration, which adds just over five months on average. Just under a third of applicants participate in a hearing at the ALJ level, which adds more than two years to average cumulative processing time.[18] A very small fraction of applicants receive benefits after appealing a negative ALJ decision, but those who do wait on average an additional 15.4 months. Finally, applicants who submit a new application (either after an initial denial or a denial at the reconsideration or ALJ level) also have a lengthy processing time because the vast majority of them also pursue an appeal.

2 Empirical Strategy

From the time that an SSDI application is filed to the time a final determination is made, the applicant may not earn more than approximately $1,000 per month, since this would exceed the Substantial Gainful Activity (SGA) threshold and result in a denial of benefits.[19] Thus, the vast majority of SSDI applicants would be expected to remain out of the labor force while awaiting a disability determination, regardless of their work capacity. Does this occur in practice? Figure 1 plots the fraction of denied 2005 SSDI applicants who were participating in the labor force during each of the six years before and after their *initial* decision.[20] Applicants are further subdivided into six groups according to the year of their *last* observed SSA decision (2005 – 2011). This variation in last decision date stems in large part from applicants' appeal behavior: applicants who do not appeal their initial denial or whose appeal moves extremely rapidly will have a last decision date of 2005; those who appeal and reach closure by December of the year following their initial denial will have a 2006 date, etc. Figure 1 documents that labor force participation falls for all six applicant groups

[17] Clear cut cases include a disability that meets medical listings or, alternatively, a disability that is judged non-severe or "obviously" temporary, meaning unlikely to last longer than 12 months.

[18] The fraction entering reconsideration is smaller than the fraction receiving an ALJ hearing because in 10 "prototype" states, the reconsideration step was temporarily eliminated, as discussed in footnote 12.

[19] An exception is when work during the 5-month waiting period qualifies as an unsuccessful work attempt. To qualify, the employment spell must be terminated (or earnings reduced to below SGA) as a result of the impairment or the "removal of special conditions related to the impairment that are essential to the further performance of work." Different rules apply to unsuccessful work attempts of different lengths but an unsuccessful work attempt may not last more than 6 months.

[20] The figure focuses on denied applicants to avoid confounding post-decision employment rates with SSDI receipt/work disincentives. Our empirical work analyzes the impact of SSDI decision times on the subsequent employment of *both* allowed and denied applicants.

in the years *prior* to SSDI application, consistent with the onset of disability. Consistent with SSDI program incentives, applicants' employment trajectories vary systematically with their date of final decision. Applicants whose final decision year coincides with their initial denial year of 2005 exhibit a 12 point rebound in employment between 2005 and 2006. Those whose final decision date occurs a year later in 2006 regain only four points of employment between 2005 and 2006—prior to their final decision—and 11 points in the year thereafter. Applicants who obtain a final decision in 2007 gain approximately two to three points per year between 2005 and 2007 and then six points in the year immediately thereafter.[21] While this empirical regularity does not correspond to the causal effect of delays on subsequent employment—the variation in delay seen here stems largely from applicants' own appeal decisions—it clearly reveals that applicants curtail labor force participation while awaiting their SSDI determinations. This motivates our use of examiner processing time as an instrumental variable for applicants' time out of the labor market, potentially leading to a decay effect.

Figure 2 presents a simple schematic to illustrate the potential importance of the human capital decay effect and its relationship to the widely studied benefit receipt effect. The figure shows observed earnings of SSDI applicants as a function of time since the SSDI application for an applicant in two potential states of the world: allowed (green) and denied (red). In this figure, the vertical distance γ represents the causal effect of an SSDI allowance on earnings (or alternatively, the probability of labor force participation). The slopes of the red and green lines, δ, reflect the causal effect of time out of the labor force on earnings (or employment): both allowed and denied applicants lose work capacity at rate δ with elapsed time out of the labor force. Thus, the observed earnings of denied SSDI applicants understate their earnings potential at the time of application, with the gap between initial and final work capacity growing with the length of the application process.

To empirically test for the delay-decay effect of SSDI application on subsequent employment and earnings, we estimate a causal model of labor supply analogous to that in Figure 2:

$$y_i = X_i\beta + \gamma DI_i + \delta T_i - s_i + \varepsilon_i. \tag{1}$$

Here, y_i is the observed labor supply of applicant i measured two to six years following the initial

[21] Also noteworthy, the employment rebound associated with the final claims adjudication date appears to attenuate with each passing year following the initial denial.

determination, respectively, X_i is a vector of observed individual characteristics that influence labor supply (e.g., age, impairment type), DI_i is an indicator for whether the applicant was *ultimately* awarded benefits (i.e., was observed to be a SSDI beneficiary within six years of the initial determination), T_i is the applicant's total processing time measured in months from the application filing date to the last observed decision date, s_i represents unobserved factors that affect labor supply such as impairment severity or lack of labor force attachment, and ε_i is an idiosyncratic error term. As in the figure, the causal parameters of interest are γ and δ, which respectively measure the benefit receipt effect—the reduction in labor supply caused by receipt of disability benefits—and the labor supply decay rate, that is, the reduction in labor supply caused by an additional month of application processing time. Since our outcome variable y_i captures earnings or employment following completion of the SSDI application process, δ reflects the causal effect of *pre*-decision waiting time on *post*-decision employment and earnings rather than the mechanical effect of waiting time on labor force participation during the application process.[22] The combined effect of SSDI on post-application labor supply operating through these two causal channels is $\gamma + \delta T$ for an allowed applicant and δT for a denied applicant.

A key challenge for consistently estimating γ and δ is that unobserved determinants of labor supply contained in s_i may also affect both the ultimate award decision and application processing time. For example, applicants with severe impairments are both more likely to be allowed and more likely to be decided at an earlier decision step (i.e., based on the medical listing criteria) than applicants with less severe impairments. If processing time is shorter for those with more severe impairments, then the ordinary least squares (OLS) estimate of δ will be biased towards zero. Intuitively, applicants with shorter processing times will have relatively low post-decision labor supply due to their unobservably poor health while those with longer processing times will have higher post-decision labor supply due to their relatively good health. Estimates of δ would therefore understate the health-constant impact of additional processing time on subsequent labor supply. Conversely, if processing time is shorter for applicants with stronger labor force attachment because they are more likely to discontinue a claim in favor of returning to the labor force, then the OLS estimate of δ will overstate the true decay effect. These same factors also confound estimation

[22]Two to three years following the initial determination, some rejected applicants remain in the appeals process. This fraction becomes vanishingly small after six years, which is the close of our sample window.

of the benefit receipt effect. The OLS estimate of γ is biased upward to the extent applicants with more severe impairments are both more likely to be allowed benefits and less able to work, and biased downward to the extent applicants with lower labor force attachment are both less likely to be allowed benefits and less likely to participate subsequently.

To overcome these confounds, we leverage the empirical strategy of Maestas, Mullen and Strand (2013, MMS hereafter) to estimate the effect of SSDI benefit receipt on labor supply (γ). MMS show that DDS examiners differ in the implicit thresholds that they employ when judging the severity of a disability. All else equal, applications sent to low-threshold examiners are more likely to be allowed than others whereas those sent to high-threshold examiners are more likely to be denied. MMS observe that because applications are conditionally randomly assigned to examiners, examiner-specific allowance rates can be used to instrument for the ultimate allowance decision for individual applicants, thereby identifying the causal effect of the allowance decision on subsequent labor supply.

Building on MMS, we take advantage of the fact that DDS examiners also vary in the speed at which they process disability applications—some DDS examiners are considerably faster than others. Using the conditional random assignment of cases to DDS examiners, this natural variation in examiner processing speed during the initial determination phase generates exogenous variation in total processing time (which includes time spent in the appellate phases) that is uncorrelated with unobserved applicant characteristics, as we document below. Thus, we can use examiner assignment to isolate exogenous variation in applicant processing times that is independent of impairment severity and labor force attachment.

Specifically, we divide total time T into t_1, representing applicants' time to initial decision, and t_2, representing time in the appeals process or reapplication, where $T = t_1 + t_2$. Note $t_2 = 0$ for initially allowed applicants and those initially denied applicants who decide not to continue pursuing disability benefits after their initial determination. Let

$$t_{1ij} = X_i\beta^0 + \tau_j + \epsilon_i^t, \tag{2}$$

where τ_j represents the examiner-specific component of processing speed. We construct a jackknife instrumental variable, $EXTIME_{j(i)}$, which measures the average processing time of the examiner

j to which applicant i is randomly assigned, excluding applicant i's own processing time:[23]

$$EXTIME_{j(i)} = \frac{1}{N_{j-1}} \sum\nolimits_{k \neq i, k=1}^{N_j} t_{1k},$$

where our construction of $EXTIME_{j(i)}$ parallels the construction of the measure of examiner allowance propensity in MMS 2013, which is equal to the (jackknifed) examiner allowance propensity, $EXALLOW_{j(i)}$, for the examiner to which an applicant is assigned. As documented in MMS, SSDI applications are randomly assigned to DDS examiners conditional on a small set of "assignment variables"—case information that is identified when the application is transmitted from the field office to a particular DDS, and which could potentially be used in the (computerized) assignment of cases to examiners depending on the DDS. All DDS offices use priority processing flags (primarily terminal illnesses in our sample period), which they may use to assign cases to specialty units; furthermore, some DDS offices assign cases based on the affected broad body system (mental, musculoskeletal, etc.) or common condition (e.g., anxiety disorders, back disorders) to new examiners still completing their training. Conditional random assignment of applicants to DDS examiners ensures that after controlling for assignment variables, individual case characteristics are not correlated with examiner processing speed and, apart from a common additive component due to average case mix across all examiners, $EXTIME$ is an unbiased estimator of examiner speed τ_j.

2.1 Verifying the research design

To verify that the data are consistent with random assignment of applicants to case examiners within DDS offices, Table A-1 presents the results of "balance tests" where we regress examiner characteristics $EXALLOW$ (average allowance propensity) and $EXTIME$ (average processing time) on the non-assignment variables, age and prior earnings, with and without assignment variables included as controls (i.e., body system codes, top 20 diagnosis codes, terminal illness flag, month of receipt at DDS, concurrent status and 3-digit zip codes). We examine earnings six to nine years prior to the initial decision to avoid potentially confounding earnings with onset date, which some DDSs use as an assignment variable when case volumes or backlogs are high. As indicated by the F-tests at the bottom of the table, we find that after controlling for assignment variables, individual characteristics

[23] We construct $EXTIME$ using time at the DDS office, excluding the time it takes to arrive at the DDS office from the field office upon filing. Thus t_2 includes this initial component of processing time for all applicants.

no longer predict examiner characteristics.

Although there is wide variation in initial processing times at the applicant level, it does not necessarily follow that there is significant variation in average processing times at the examiner level. To assess this variation, we plot in Figure 3 the distribution of examiner processing time expressed as *deviations* from the average processing time across all examiners within the same DDS office. The DDS-office mean processing time is three months. Adjusting for case-mix differences tightens the distribution of examiner times, reducing the standard deviation from 0.8 months to 0.4 months, but there is still significant variation in average processing times across examiners within the same DDS office (adjusted coefficient of variation of 0.13).[24] Figure 4 plots our measure of examiner speed $EXTIME$ against the measure of examiner allowance propensity $EXALLOW$ from MMS. Interestingly, these two attributes of examiner screening—allowance propensity and processing speed—are essentially uncorrelated with one another (after adjusting for case mix, $\rho = 0.016$).

The variable $EXTIME$ is a valid instrument for final decision time under two key assumptions. The first is a monotonicity assumption: cases processed by "fast" examiners would take longer if processed by "slow" examiners.[25] While this assumption cannot be directly verified, Table A-2 presents a test of its face validity in which we regress time to decision on variants of $EXTIME$ and $EXALLOW$ that are constructed using all cases assigned to the same examiner except those of the same body system type. These estimates confirm that processing speed has a strong examiner-specific component: applicants with body system impairment type A assigned to examiners who make relatively rapid determinations on impairments of type A' also receive relatively fast determinations, and similarly for applicants assigned to relatively slow examiners.

The second key assumption is an exclusion restriction. For $EXTIME$ to be a valid instrument for decision time, it must be orthogonal to other factors affecting labor supply. While conditional random assignment breaks the correlation between T_i and s_i, there remains the possibility of a correlation between the instrument $EXTIME_{j(i)}$ and the indicator for ultimate allowance, DI_i.[26] Even though

[24] We do this adjustment by regressing $EXTIME_{j(i)}$ on DDS office indicators and examiner caseload characteristics (3-digit zip code, body system codes, top 20 diagnosis codes, terminal illness high-priority flag, month of receipt at DDS, age group, average pre-onset earnings and concurrent application status) and plot the residuals from this regression.

[25] The monotonicity assumption is not required if we instead assume that the treatment effect of processing speed is constant in the applicant population. We find the monotonicity assumption more palatable, however, and view our estimates as recovering a local average treatment effect (Imbens and Angrist, 1994).

[26] As noted above, DI_i is also an endogenous regressor correlated with s_i.

examiner speed is uncorrelated with examiner allowance propensity in the initial allowance decision, it could still be the case that the speed of the initial decision could affect the likelihood of a denied applicant continuing his claim through an appeal or reapplication and thus potentially the likelihood that he ultimately receives SSDI benefits (at a later stage). We investigate this possibility in Table A-3 and find that assignment to a slow or fast examiner does not affect likelihood of benefit receipt.

Finally, Table A-4 presents a series of overidentification tests of the causal pathways through which examiners affect applicants' employment rates two to six years after the initial determination.[27] We reject examiner speed as the sole causal pathway but fail to reject ($p>0.05$) the combination of examiner speed and allowance propensity as the sole pathways for all applicants after two years (when many applicants are still in the appeals process). For the subgroups defined by allowance status, we fail to reject examiner speed as the sole causal pathways after two years (and for all years among the initially allowed). Thus, the accept the null hypothesis that there are no additional causal channels through which examiners affect applicants' subsequent labor supply other than application processing time and SSDI receipt.[28]

The above results imply that consistent estimate of δ can be obtained by estimating an instrumental variables model with one endogenous regressor—application processing time—on the full set of applicants ignoring SSDI receipt. At the same time, because $EXTIME$ is uncorrelated with benefit receipt, either initially or ultimately, we can estimate decay effects for different subpopulations, namely the initially allowed, the finally allowed and the finally denied.[29] Our causal framework implies that variation in examiner processing time will only adversely affect the labor supply of applicants who receive a favorable determination *after* the five month waiting period has elapsed; it should not affect labor supply of applicants who receive a favorable determination sooner since these applicants must still complete the five month waiting period before engaging in gainful employment.

[27]Specifically we compute the following test statistic:

$$\frac{RSS_R - RSS_U}{J - M} \times \frac{N - J}{RSS_U} \overset{H_0}{\sim} F(J - M, N - J) \tag{3}$$

where RSS_R is the residual sum of squares from the "restricted" reduced form regression of employment on $EXALLOW$ and/or $EXTIME$ (and covariates) depending on the causal pathway being tested, RSS_U is the residual sum of squares from the "unrestricted" regression of employment on J examiner dummies in lieu of $EXALLOW$ and or $EXTIME$, and M is the number of degrees of freedom in the restricted regression.

[28]This finding makes intuitive sense. Arguably, the only applicant outcomes that examiners can affect are processing time and the initial allowance or denial decision. SSDI benefit amounts are solely determined by prior earnings.

[29]Note that we cannot estimate such models for the subsample of initially denied applicants since examiner time also affects the likelihood of reapplication in the initially denied sample (Table A-3).

We directly test this causal mechanism using the subsample of initially allowed applicants, for whom we observe recorded disability onset date (needed to compute the length of the waiting period) in Section (3).[30]

When we subsequently broaden the sample to include all SSDI applicants—including both the initially allowed and initially denied—to examine the *joint* effects of processing time and SSDI receipt on subsequent labor supply, we require an additional source of variation that affects the likelihood of receiving an SSDI allowance but is uncorrelated with applicants' health or other unobserved factors affecting labor supply. We use variation in examiner allowance propensity as this second source of variation.

Table 3 presents first-stage regression estimates of the effects of $EXTIME$ and $EXALLOW$ on initial processing time, time until final decision and SSDI receipt in columns 1–3, respectively, for the full sample of SSDI applicants. Columns 4–6 present estimates of the effect of $EXTIME$ on final processing time separately for the initially allowed, finally allowed and finally denied, corresponding to the first stage regressions for each of these subgroups. We display the coefficient obtained under three different specifications. The first specification is an OLS regression specification with no controls. The second is a specification that includes the assignment variables (DDS indicators, terminal illness flag, body system codes and top 20 diagnosis codes). The third specification further adds applicant characteristics (age, pre-disability earnings, three-digit zip code). This exercise also doubles as an additional randomization test: if the coefficient on $EXTIME$ is statistically unchanged upon the inclusion of individual characteristics, then our assumption of conditional random assignment is supported.

The first column presents a regression of time from filing to initial decision on $EXTIME$ and $EXALLOW$ for the full sample. Without covariates, the coefficient on $EXTIME$ is 0.953, which is close to its theoretical value of one. The attenuation away from one is due to sampling variation in the construction of $EXTIME$, which is computed over finite examiner caseloads.[31] The coefficient on $EXTIME$ falls to 0.642 when we include the necessary assignment variables and remains unchanged once we add applicant characteristics, indicating that $EXTIME$ is indeed uncorrelated

[30]The DIODS data only provided recorded onset data for initially allowed applicants.

[31]If $EXTIME$ were constructed as a simple mean rather than a jackknife measure, this coefficient would be mechanically one. Attenuation bias due to sampling variation in $EXTIME$ does not bias the causal estimate of the effect of processing time in the second stage since it affects both the first stage and reduced form proportionally.

with applicant characteristics (after conditioning on the assignment variables).[32] Column 2 shows that $EXTIME$ is slightly less predictive of final time than initial time, where final time corresponds to time from filing to the final (observed) decision, including appeals or reapplication. Nevertheless the first stage coefficient of 0.529 is statistically significant, with an Angrist-Pischke multivariate F-statistic of 286, which indicates a strong first stage (Angrist and Pischke, 2009, pp. 217-18).[33] Column 2 also indicates that applicants assigned to examiners with higher allowance rates have substantially lower total processing times—since an initial allowance obviates the need for appeal. This implies that even a small effect of processing time on subsequent employment could have important consequences for estimating the effect of SSDI receipt: assignment to the examiner with the lowest versus highest allowance propensity in a DDS office adds nearly seven months on average to an applicant's time out of the labor market. Finally, column 3 presents the first stage for SSDI receipt (Angrist-Pischke multivariate F-statistic = 158). Consistent with findings from Table A-3, applicants assigned to slower examiners are not any more or less likely to receive SSDI benefits.[34]

3 Do Processing Times Affect Labor Supply of SSDI Beneficiaries?

We first present estimates of the processing time effect for the subsample of initially allowed applicants, then subsequently consider the joint effects of processing time and benefit receipt for all SSDI applicants. Because the examiner processing time instrument is uncorrelated with the ultimate allowance decision for those who are initially allowed (Table A-3), we can test for a delay-decay effect of the application process on SSDI beneficiaries specifically without being concerned about sample

[32] Although $EXTIME$ and $EXALLOW$ are uncorrelated, the coefficient on $EXALLOW$ is statistically significant and positive in the column 1 models because $EXTIME$ and $EXALLOW$ are both constructed on the same finite sample of applicants. This induces a correlation between $EXALLOW$ and the measurement error in $EXTIME$, now part of the error term in Equation (2) (since $EXTIME$ measures "true" average examiner processing time τ with error). This biases the coefficient on $EXALLOW$, which reflects the correlation with the error term rather than its theoretical value of zero. We confirm that the coefficient on $EXALLOW$ is insignificant and small (-0.01) when we exclude $EXTIME$ (and hence any measurement error) from the regression. Consistent with the two theoretical constructs being uncorrelated, excluding $EXALLOW$ from the regression has only a small effect on the estimated coefficient on $EXTIME$ (0.640 vs. 0.642).

[33] The incremental F-statistics for the subsamples are 3,119 for the initially allowed, 107 for the finally allowed and 166 for the finally denied. (Note that these models only have one endogenous regressor, processing time.)

[34] The Table 3 estimate of 0.165 for $EXALLOW$ is slightly smaller than the analogous estimate of 0.204 in MMS (Table 2, column 6). This is due primarily to the inclusion of indicators for the top 20 diagnosis codes to allow for a finer level of homogenous case assignment to trainee examiners to improve balance. We are also now able to directly observe TERI cases, as opposed to having to impute them, although this does not substantially affect the estimated coefficient on $EXALLOW$. Our sample also differs slightly because we exclude examiners with small ($<$30) caseloads in 2005 whereas MMS excluded examiners with small combined caseloads in 2005 and 2006.

selection. Moreover, by comparing the decay effect for the initially allowed with our estimates for the whole sample (presented in Section 3.3), we can determine whether the decay effect appears to be different for the initially allowed and denied. Finally, the fact that examiner processing time is non-binding for the subset of allowed applicants who receive their decision prior to the end of their mandatory 5-month waiting period allows us to implement an informative falsification test of our identification strategy using only initially allowed applicants.

3.1 The effect of processing time for the initially allowed

Table 4 presents presents OLS and 2SLS estimates of the effect of processing time on the employment and earnings of the initially allowed, measured at two through six years following their initial decision in 2005. The OLS estimates in columns 1–3 indicate that each additional month of processing time is associated with a reduction in employment (measured as annual earnings of at least $\$1,000$) of 0.17 points two years later. This association persists for at least six years. These associations should not be taken as causal since, as discussed above, observed claimant-level variation in processing times may reflect both exogenous and endogenous factors, most importantly applicant health. It is plausible that applicants with the most severe health impairments are allowed more quickly by DDS examiners because their impairments meet medical listings. This would bias OLS estimates towards underestimating the effect of processing time on subsequent employment (since those least able to work would receive faster awards).

Instrumental variables estimates of the impact of processing time on labor supply using the examiner instrument $EXTIME$ are consistent with this reasoning. We find that an additional month of processing time causes a 0.44 point reduction in employment (Panel A), a 0.29 point reduction in the probability of engaging in SGA (Panel B) and a \$167 reduction in annual earnings (Panel C) two years later. These effects increase slightly in year three and then fall in year four (2008), when unemployment rates were at their peak during the Great Recession.[35] However, the estimated effects have rebounded to approximately their initial levels by 2011 (the end of our follow-up period). These point estimates are more than twice as large in magnitude than the corresponding OLS estimates. Extrapolating to an average initial processing time of 3.6 months, the 2SLS estimates

[35]Labor force statistics from the BLS website `http://data.bls.gov/pdq/SurveyOutputServlet?request_action=wh&graph_name=LN_cpsbref3`, accessed 9/22/2014.

imply that employment among SSDI beneficiaries who were allowed at the initial level is 1.4 to 1.6 points (approximately 14 percent) lower than it would be if they were able to remain in the labor force during the determination process without jeopardizing the allowance decision. This interpretation assumes that processing time affects post-application labor supply by inducing applicants to withdraw from or remain out of the labor force while awaiting a disability determination. We test this interpretation next.

3.2 Testing the identification strategy using the five month waiting period

To qualify for SSDI, applicants may not perform substantial gainful activity for at least five months before benefits may commence. This rule suggests an identification test for our research design: for applicants who are awarded benefits within five months of disability onset, examiner speed should have no marginal effect on labor force participation after benefit payments begin. Thus, evidence of an examiner time-induced decay effect among applicants awarded benefits within five months would point to a violation of the exclusion restriction assumption.[36]

We perform this test by partitioning total processing time into two components: time during which examiner delays are non-binding constraints on labor supply (i.e., during the mandatory waiting period), and time during which examiner delays are binding constraints (i.e., time after the waiting period).[37] Figure 5 shows three possible cases. In the first case, the applicant files for benefits shortly after disability onset, and the allowance decision comes *before* the applicant's remaining waiting period has elapsed. Since the applicant cannot work before the end of the waiting period (and the start of the Trial Work Period), examiner processing time has no marginal effect on labor supply. Approximately one-quarter of initially allowed applicants in our sample are in this category. In the second case, the applicant files shortly after onset, but the allowance decision comes *after* the applicant's remaining waiting period has elapsed. This describes another one-quarter of initially allowed applicants. For these applicants, every additional month of examiner delay results in an additional month in which labor force non-participation is potentially constrained (and in which

[36]This particular test is only applicable to the initially allowed: denied applicants who appeal their determination will almost universally wait longer than five months for a final allowance. In addition, in SSA's administrative data used for this analysis, only allowed applicants have recorded an established onset date, which is necessary to compute the length of the waiting period.

[37]Note that these constraints are only binding for the subset of applicants who would otherwise wish to participate in gainful employment.

the start of the Trial Work Period is delayed). In the third case, the applicant files for benefits substantially after the onset of disability (perhaps after a period of unemployment), so the waiting period is satisfied at the time of application. For this group, which encompasses approximately one-half of initially allowed applicants, examiner time is fully binding on potential labor supply for applicants who would otherwise work.

To implement this test, we modify Equation (1) as follows

$$Y_i = \delta_0 \min\left[\text{decision\_time}_i, \text{wp}_i\right] + \delta_1 \max\left[\text{decision\_time}_i - \text{wp}_i, 0\right] + s_i + \varepsilon_i, \tag{4}$$

where

$$\text{wp}_i = \min\left[\text{time\_to\_app}_i, 5\right].$$

In Equation (4), decision_time_i, measures total time from disability onset to final decision, time_to_app_i measures time between disability onset and filing, wp_i measures how much of the five month waiting period has elapsed prior to $i's$ application, and as before s_i is unobserved severity or labor force attachment and is likely correlated with both total decision time and the time it takes the applicant to file after disability onset. Since the five-month waiting period begins with the date of disability onset and therefore precedes the filing date, the function wp_i measures how much of applicant $i's$ waiting period has already been satisfied as of the filing date. Our hypothesis is that variation in examiner processing time that occurs during an applicant's five-month waiting period should have no impact on subsequent labor force participation (hence $\delta_0 = 0$) whereas variation in examiner processing time that effectively prolongs the waiting period will adversely affect post-application employment (hence $\delta_1 < 0$).

In partitioning processing time in this manner, we impose a nonlinearity in our endogenous regressor T_i, which complicates instrumental variables estimation. We accordingly implement a control function approach: to account for the endogenous component of decision_time_i, we include in (4) the residuals from our first stage regression of total processing time on $EXTIME_{j(i)}$ (obtained from Table 3, column 4, Panel C). To control for the endogenous component of wp_i (time from onset to application), we include time_to_app_i itself, which we can compute from our data.[38]

Table 5 reports the estimated effect of examiner processing time that occurs before and after the

[38]Mean time from onset to application is 7.94 months, with a standard deviation of 10.66.

waiting period on applicants' subsequent labor supply using the control function specification. Additional processing time *before* the waiting period has fully elapsed causes no incremental reduction in employment two to six years after the initial decision. Thus, the point estimates for δ_0 are an order of magnitude smaller than δ_1 and statistically indistinguishable from zero. In sharp contrast, an additional month of processing that occurs after the applicant has satisfied the waiting period causes a 0.53 point reduction in employment two years later, and this effect falls only slightly by year six. This evidence is strongly consistent with the implications of our identification strategy. We also note that the estimated decay effect for applicants that face binding constraints on labor supply is larger than the effect for all initially allowed applicants (Table 4). This result is expected because the estimated causal effect for all applicants in Table 4 averages the null effect δ_0 for the unconstrained group with the somewhat larger effect δ_1 for the constrained group.

3.3 Estimates of the decay effect using allowed and denied applicants

We now broaden the inquiry to incorporate all SSDI applicants. Table 6 presents our main instrumental variables estimates of Equation (1) for employment and earnings outcomes at years two through six following initial application. Because many applications in the full sample are still in progress two years after the initial decision, and to avoid the period of unusually high national unemployment during 2009-2010, we focus our discussion on effects on outcomes three and six years after the initial decision (2008 and 2011) as our preferred estimates of the short and long run effects, respectively, of SSDI application processing times and benefit receipt on labor supply.

Turning first to the processing time estimates, the three panels of the table document that application delays lead to significant declines in the probability that applicants' annual earnings exceed either $1,000 (Panel A) or annual SGA (Panel B), and significant reductions in average annual earnings (Panel C), in the short run (three years later), though not necessarily in the long run or in the intervening years where unemployment rates were unusually high during the Great Recession. We find that each additional month of processing time reduces employment of SSDI applicants by 0.47 points, reduces the probability of substantial gainful activity by 0.31 points, and lowers annual earnings by $133 three years after the initial decision.

How large are these effects? Noting that processing time averages 14.1 months across all applicants, the Table 6 estimates imply that processing delays reduce employment by 6.7 points, SGA

by 4.3 points and annual earnings by $1,875.[39] Relative to observed employment, these effects are economically significant. Only 24 percent of SSDI applicants earn more than $1,000, and 12 percent earn more than SGA, three years post-application; average annual earnings are only $4,063 overall (including zeroes). Thus, we estimate that an average processing delay of 14.1 months reduces subsequent employment of SSDI applicants by 27.5 percent, the probability of employment above SGA by 35 percent, and annual earnings by 46 percent. These effects attenuate to around half of their previous levels after three years post-initial decision, and the employment effect is not statistically significant (and SGA only marginally significant) in year six (2011, the end of our follow-up period).

Since denied applicants' incentives to participate in the labor force post-denial are not constrained by SSDI program rules, one might have anticipated that the magnitude of the delay-decay channel would be larger for all applicants (including allowed and denied applicants) than for the initially allowed (Table 4). Table 6 finds instead that the effects of processing time on any employment and working above SGA in the full sample of applicants are similar in levels to the effects among initially allowed applicants in the short run, but less persistent than for the initially allowed. The pattern for the effects on total earnings is also distinct: while the delay effect on earnings falls substantially for both groups several years after the initial application, the adverse impact on the initially allowed is larger than for the overall population in both the short and long run.

What might account for these different effect sizes? Initially allowed applicants differ from the overall applicant population along a number of dimensions. First, initially allowed applicants receive their decision in a matter of months, compared to the average waiting time of 14.1 months among all applicants. If the marginal effect of processing time is declining with longer wait times, then the larger estimates among the initially allowed might reflect a steeper slope at shorter processing times. Second, initially allowed applicants differ from the overall applicant population in terms of both observable and (presumably) unobservable characteristics, most notably severity and type of impairment and prior earnings. Finally, as noted above, allowed but not finally denied applicants face SSDI's Substantial Gainful Activity cap, which reduces or eliminate payments for beneficiaries who earn more than approximately $1,000 per month (after completion of the Trial Work Period

[39]Note that although examiner processing speed only directly affects the duration of *initial* disability determinations, it indirectly affects *final* processing times among all applicant groups (since total processing time is cumulative) as shown in Table 3. Thus, the Table 6 models that pool all applicant groups identify a local average treatment effect of additional months of waiting time among applicants with a wide range of spell durations, including those initially allowed, finally allowed, and finally denied.

and Grace Period).

We explore these explanations in Table 7 by estimating effects of processing time separately for finally allowed and finally denied applicants. Recall that this subgroup analysis is valid because examiner speed does not affect SSDI receipt (Table A-3), thus examiner speed is a valid instrument for final processing time in both groups. This subgroup analysis provides two useful sets of contrasts. First, comparing the effects of processing time on initially versus finally allowed applicants allows us to hold constant the role of SSDI work disincentives and focus on differences due to (potentially) nonlinear decay effects and differences in severity or case mix. Average processing time for all finally allowed applicants is 15.3 months, compared to 3.6 months among the initially allowed subpopulation. Initially allowed applicants are likely to include individuals with more severe health impairments than the overall beneficiary population, and they tend to include a more balanced mix of musculoskeletal versus mental disorders (27 percent and 26 percent, respectively, as reported in Table 1) as compared to finally allowed applicants (36.5 percent musculoskeletal, 21 percent mental).[40] Despite the differences in case mix due to impairment type, however, initially and finally allowed applicants tend to have relatively similar pre-onset earnings (Table 1).

The second useful contrast comes from comparing the effects of processing time for finally allowed versus finally denied applicants. This comparison allows us to hold approximately constant average final processing times (15.3 vs. 11.6 months, respectively) and focus on differences in outcomes due to SSDI work disincentives and differences in severity and case mix. Table 1 reveals that finally allowed and finally denied applicants have a relatively similar mixture of mental and musculoskeletal impairments, while of course finally allowed applicants tend to have more severe impairments overall than finally denied applicants. The sharpest contrast between these groups lies in pre-onset earnings, which average $25,520 and $15,582 among finally allowed and finally denied applicants, respectively.[41]

Panel I of Table 7 focuses on finally allowed applicants. The estimated effects of processing

[40] As discussed by MMS 2013, the types of cases allowed differ between those allowed at the DDS office and those allowed on appeal. von Wachter, Song and Manchester (2010) find that applicants allowed on appeal tend to be younger, have lower prior earnings, and have a higher frequency of musculoskeletal and mental disorders than applicants allowed by DDS examiners.

[41] Opposite to initially allowed applicants, finally denied applicants appear most likely to be seeking SSDI for economic rather than medical reasons. Relative to both the initially and finally allowed, finally denied applicants are younger, have weaker earnings histories, and often have difficult to verify impairments such as musculoskeletal disorders.

delays on subsequent employment and earnings for the finally allowed tend to mirror those of the overall applicant population, which is logical since finally allowed applicants comprise two-thirds of our sample.[42] In all cases, we find that finally allowed applicants suffer smaller decay effects per additional month of processing time (though not in net, due to their longer processing times) than do initially allowed applicants (Table 4), though these differences are more pronounced in year six than in year three. For instance, the estimated effect of additional processing time on employment among all allowed applicants is 84 percent as large as the estimated employment effect among the initially allowed in year three, but it is only 54 percent as large as the estimated effect among the initially allowed in year six. The fact that the waiting time effect is similar for finally allowed and initially allowed applicants during the first three years following application suggests that, while nonlinearity in the waiting time effect may play a role over the longer run, it does not fully explain the different estimates between these two groups. This leaves differences in case mix as a likely explanation.

To investigate the role of case mix, Table 8 presents estimates of the effects of processing delays and SSDI allowances on employment for applicants whose primary reported impairment is a mental disorder (Panel A) or a musculoskeletal disorder (Panel B). For these models we pool allowed and denied applicants to conserve power. We find similar decay effects among applicants with mental and musculoskeletal disorders, respectively, in the short run, but only *persistent* (albeit imprecise) decay effects among applicants with mental disorders. This pattern suggests that heterogeneity in the effect of processing time by case mix plays an important role in understanding the differences between initially and finally allowed applicants.

Next we turn our attention to estimates of the decay effect for finally denied applicants (Table 7, Panel II). Because finally denied applicants comprise only one-third of our sample (similar to our sample sizes by body system in Table 8), the estimates for this subpopulation are imprecise. We find that one month of additional processing time reduces employment of the finally denied by 0.28 points in year three after the initial decision but this falls to less than a tenth of a point by year six; the estimated effects on substantial gainful activity are similar in magnitude. In contrast to the extensive margin estimates, the estimated effects on annual earnings (including zeros) are fairly

[42] One notable exception is the estimated effect of processing time on the probability of earning more than the SGA threshold, discussed further below.

persistent: $45 and $53 per additional month of processing time in years three and six, respectively.

Extrapolating to the average processing time of 11.6 months among applicants who are finally denied benefits (Table 1), the Table 7 estimates imply that processing delays reduce employment (i.e., earnings above SGA) by 3.3 points and reduce average annual earnings by $528 three years after the initial decision (typically the year immediately following the final decision for applicants who appealed their initial denial to the ALJ level). Recalling that annual earnings three years post-application average $8,752 among finally denied applicants, with only 48 percent exceeding $1K and only 29 percent exceeding SGA, we estimate that a twelve month processing delay reduces subsequent earnings of denied applicants by six percent, the probability of employment by seven percent, and the probability of substantial work activity by twelve percent over the first three years. Of course, these calculations should be viewed as provisional since the point estimates for earnings in the finally denied sample are statistically insignificant, potentially reflecting smaller sample size, though they are also persistent and stable in magnitude across years.

Why do earnings effects stemming from delays appear to persist into year six for finally denied applicants while estimated effects on any employment and earnings above SGA attenuate? One potential explanation is that a substantial fraction of denied applicants will ultimately return to the labor market if they are not able to obtain benefits. Indeed, Table 1 shows that 48 percent of finally denied applicants have positive earnings three years after application and 29 percent are working above SGA. However, these applicants have substantially lower average earnings after their final denial than before their initial application; post-denial earnings in years three and six are roughly half of pre-application earnings (Table 1). Thus, our tentative interpretation of the Table 7 results for finally denied applicants is that time out of the labor force does not ultimately reduce the probability of *any* earnings, but it may erode earnings capacity nonetheless.

It is also instructive to compare the estimated decay effects for the finally denied with those of the finally allowed (Table 7, Panel I). Whereas the employment and earnings effects are much larger for the finally allowed than the finally denied in both the short and long run, the estimated effects on substantial gainful activity are actually *smaller* for the allowed in the short run and similar in magnitude in the long run. Since SSDI work disincentives likely discourage allowed applicants from earning above SGA—a phenomenon sometimesreferred to as 'parking'—it is possible that if the constraint on earnings were removed, the SGA effect would in fact be larger for allowed applicants

(Weathers and Hemmeter, 2011). Thus, the finding that processing time reduces finally allowed applicants' total annual earnings but does not affect their likelihood of engaging in SGA suggests that SSDI program rules play a significant role in the labor supply outcomes of beneficiaries.

We finally examine heterogeneity in the effects of processing time on employment three and six years post-application according to applicant sex, age, and prior earnings quartile. These results, presented in Figures A-1 and A-2, do not for the most part detect significant differences in the effects of delay on employment across groups. One notable exception is that post-determination employment of applicants in the lowest quartile of pre-application earnings appears to be relatively insensitive to either processing time or benefit receipt (the latter of which is presented in Figures A-3 and A-4). It appears plausible that applicants with extremely low prior earnings possess limited work capacity, so their labor market activity is only minimally affected by their interactions with the SSDI program.

In summary, the analysis in Tables 4 through 8 documents that delays in the disability determination process have unambiguously negative and persistent effects on the post-allowance employment and earnings of applicants who are initially allowed, a group that has relatively high prior labor attachment and receives positive disability determinations relatively rapidly. Among the full population of allowed applicants, which is comprised approximately equally of initially allowed applicants and those allowed on appeal, adverse earnings effects of delay also persist for the full six years of the sample window, but these effects are less sizable than for the initially allowed subsample. For the finally denied group, our estimates suggest still smaller (but non-trivial) adverse earnings effects that also appear to persist to the end of the sample. Available precision does not allow us to confidentially reject the null of no effect for this group, however.

4 The Causal Effect of SSDI Receipt on Labor Supply Revisited

We finally turn to the topic that has been the primary focus of the prior literature on SSDI determinations: the causal effect of SSDI allowances on labor supply. The second row of each panel of Table 6 reports estimates of these causal effects. We find that an SSDI allowance lowers the probability of employment—that is, annual earnings of at least $\$1,000$—by 48 points in year three following application and by 25 points in year six. Of course, $1,000 is a very low benchmark for earnings, and

it is not clear whether earnings near this threshold should be viewed as economically consequential. Panel B, however, shows that the effect of an SSDI allowance on the probability of annual earnings in excess of SGA—approximately $\$12,000$—is approximately 70–75 percent as large as its effect on any earnings: a reduction of 33 percent in year three and 19 percent in year six. As shown in Panel C, earnings reductions stemming from marginal SSDI awards average $\$7,828$ in year three following application, and $\$5,613$ in year six. Relative to the observed annual earnings of those who are finally denied (column 5 of Table 1), these point estimates imply reductions on the order of 70–90 percent of annual earnings.[43]

A critical implication of the results above for existing literature on the labor supply effects of the SSDI program is that studies that estimate the effect of disability allowances on labor supply in the short run but do not account for systematic differences in processing time between allowed and denied applicants will generally produce biased causal estimates. As MMS 2013 note, because applicants assigned to examiners with lower allowance propensities are more likely to appeal their denials, allowance odds will be confounded with processing times in the full sample of applicants.

We can analytically characterize this bias by examining both the first stage regressions for SSDI receipt and final processing reported in Table 3, and the reduced form regressions for labor supply outcomes reported in Table A-5. Suppressing covariates, the two first stage equations are:

$$DI_i = \pi_1^d \cdot EXALLOW_{j(i)} + \pi_2^d \cdot EXTIME_{j(i)} + \varepsilon_i^d \tag{5}$$

and

$$T_i = \pi_1^t \cdot EXALLOW_{j(i)} + \pi_2^t \cdot EXTIME_{j(i)} + \varepsilon_i^t. \tag{6}$$

Substituting these equations into our causal labor supply model (Equation (1)), we obtain the following expression for the reduced form model:

$$y_i = (\gamma\pi_1^d + \delta\pi_1^t) \cdot EXALLOW_{j(i)} + (\gamma\pi_2^d + \delta\pi_2^t) \cdot EXTIME_{j(i)} + \varepsilon_i^y. \tag{7}$$

[43] In Table 8 we present estimates of the SSDI receipt effect for applicants with the two most prevalent types of disorders–musculoskeletal and mental disorders. These results echo those of MMS 2013 (Table 6), who find that SSDI allowances result in the largest labor supply reductions for applicants with reported mental impairments and smaller labor supply reductions among applicants with reported musculoskeletal disorders. Like the decay effect, the SSDI receipt effect is persistent for applicants with mental disorders but not for those with musculoskeletal disorders.

This equation demonstrates why excluding waiting time from a regression of employment on examiner allowance rates will lead to bias estimates. In an IV regression that excludes waiting time, akin to the model that MMS estimate, the *plim* of the IV estimate will simply equal the ratio of the reduced form to first stage coefficients on $EXALLOW$. We refer to this IV estimate as γ^{MMS}, where

$$\gamma^{MMS} = \frac{\gamma\pi_1^d + \delta\pi_1^t}{\pi_1^d}, \tag{8}$$

As is clear from inspection, γ^{MMS} equals the causal parameter of interest (γ in (1)) only if waiting time does not affect employment ($\delta = 0$) or examiner allowance rates do not affect final waiting time ($\pi_1^t = 0$). Neither of these conditions holds in reality (see Tables 3 and 6). Rather, our analysis indicates that $\delta < 0$ (delay causes decay in employment) and $\pi_1^t < 0$ (assignment to an examiner with a higher allowance propensity causes shorter processing time). Accordingly, the reduced form coefficient on $EXALLOW$ will be larger than $\gamma\pi_1^d$, and thus the estimator that excludes waiting time, γ^{MMS}, will be biased *upward* relative to γ.[44] Since $\gamma < 0$, this implies that the MMS estimate will *understate* the magnitude of the true causal effect of SSDI receipt.[45] Intuitively, the shorter final processing time resulting from an applicant's assignment to an examiner with a higher allowance propensity mitigates the decrease in her employment resulting from the applicant's higher odds of receiving an SSDI allowance.[46]

How large is this 'processing time bias?' We benchmark its magnitude in Table 9 by comparing two sets of point estimates for the association between allowances and employment (earnings of at least $\$1,000$) at years three and six following application. The first column of the table presents simple OLS comparisons of allowed and denied applicants, akin to those first reported by Bound (1989). Though Bound argued that such comparisons would place an upper bound on the effect of SSDI allowances on labor supply—since allowed applicants are presumably less healthy than denied applicants—recent literature has questioned this interpretation since rejected applicants may differ not only in health but also in their skills and motivation to participate in the labor force.

[44] We obtain the following expression for the bias in the MMS estimate by rearranging Equation (8): $\gamma^{MMS} - \gamma = \delta \cdot \frac{\pi_1^t}{\pi_1^d}$.

[45] Note that, since $EXALLOW$ and$EXTIME$ are uncorrelated, regressing SSDI receipt on $EXALLOW$ omitting $EXTIME$ still obtains a consistent estimate of the denominator, π_1^d.

[46] Note that, since $\pi_2^d = 0$ and $EXALLOW$ and$EXTIME$ are uncorrelated, omitting $EXALLOW$ and taking the ratio of estimated coefficients on $EXTIME$ from Equations (6) and (7) will result in a consistent estimate of the causal effect of processing time on labor supply.

The second column of Table 9 implements the instrumental variables strategy used in recent literature where allowances are instrumented with examiner allowance propensity as in MMS 2013, which in turn is closely akin to the strategy of instrumenting allowances using Administrative Law Judge allowance propensity (French and Song, 2014). Following our reasoning above, we would expect these instrumental variables estimates to *underestimate* the causal effect of allowances on labor supply because they do not account for the fact that applicants assigned to examiners or ALJs with lower allowance propensities have both lower allowance odds and *longer* processing times. The third column of Table 9 presents our preferred estimates (akin to Table 6) where both processing time and allowance odds are instrumented by examiner speed and allowance propensity. Finally, the fourth column of Table 9 presents the difference between our preferred estimate and the 2SLS estimate excluding processing time. To account for the correlation between the two estimators, we bootstrap the distribution of the difference by sampling observations clustered by examiner with replacement $S = 300$ times; we report the 95 percent confidence interval obtained by taking the 2.5^{th} and 97.5^{th} percentiles of this distribution. Note that the estimates in columns 2 and 3 are both local average treatment effects (LATEs) that apply to the same 16.5 percent of applicants on the margin of SSDI receipt based on initial examiner assignment.

The results in Table 9 indicate that processing time bias is of first order importance, particularly in the short run (three years later, in 2008), though less so over the longer run (six years later, in 2011), when the effect of processing time on employment falls to half of its previous magnitude and becomes statistically indistinguishable from zero. A comparison of the column 1 and column 2 estimates would naively suggest that OLS comparisons of allowed and denied applicants overstate the causal effects of allowance on labor supply, consistent with the influential argument of Bound (1989). Our reasoning implies instead that the column 2 estimates—which instrument for allowances using examiner allowance propensity but do not account for the indirect effect of allowance propensity on waiting times—are likely to underestimate the direct effect of allowances on work. The column 3 estimates, which instrument for both variables, corroborate this contention. In year three following application, the column 3 estimate of the causal effect of allowance on labor force participation, holding processing time constant, is substantially larger than the either the conventional 2SLS estimate or the canonical OLS estimate. In year six, our preferred estimate is lower than the OLS estimate but not significantly so. Taken together, our results suggest that OLS estimates of the

effect of SSDI receipt on labor supply outcomes cannot be relied upon to produce an upper bound on the magnitude of the true causal effect.

5 Discussion and Conclusion

A well-known body of research explores how the award of SSDI benefits affects the labor supply and earnings of beneficiaries. In this paper we explore a complementary—and we believe equally consequential—question: how do long application processing times, during which applicants must not earn more than $1,000 per month, affect the subsequent employment of denied applicants and SSDI beneficiaries? Our approach exploits exogenous variation in average processing time by disability examiners as an instrument for applicant waiting time. Using a unique administrative workload database, we evaluate how the substantial time spent out of the labor market during the application and appeals process—more than one year on average, across all applicants—affects subsequent employment opportunities and earnings of both allowed and denied applicants.

We find that longer processing times significantly reduce the employment and earnings of SSDI applicants in the years after their initial decision. Our main estimates indicate that a one standard deviation (2.1 months) increase in initial processing time reduces annual employment rates by about 1 point (4.1%) in the three years following the initial determination, falling to 0.43 points (2.2%) by six years after the initial determination. Extrapolating to total applicant processing times, we estimate that the SSDI determination process directly reduces the long-run post-application employment of denied applicants by approximately 2.4 points (5.8%) and allowed applicants by approximately 3.1 points (36.5%).

On net, our results imply that neither the recent nor established SSDI literature has fully captured the labor supply impacts of the disability system on applicants and beneficiaries. Though prior literature has posited that the decay channel may be economically important (Parsons, 1991), no prior paper has provided direct estimates of this causal pathway. Moreover, due to the confounding of allowance odds and processing times, the existing literature has underestimated the labor supply effects of SSDI awards on beneficiaries. Accounting for both mechanisms provides a more complete—and economically more sizable—picture of the aggregate labor supply impacts of the Social Security Disability Insurance program. For instance, using the instrumental variables

methodology of Maestas, Mullen and Strand (2013), the estimated effect of SSDI receipt on employment *ignoring processing time* implies that the SSDI program reduces employment by 9 points in the short run and 5.5 points in the long run, among the subset of applicants on the margin of SSDI receipt.[47] However, in this paper we estimate that this effect is closer to 22 points in the short run and 11 points in the long run accounting for processing time.[48] That is, combining the labor supply decay effect, estimated for the first time in this paper, with new estimates of the benefit receipt effect that are purged of waiting time bias implies that the SSDI program effect on employment is 105 to 150 percent larger than previous estimates have suggested for applicants on the margin of SSDI receipt. A key implication of our findings is that the design of disability insurance programs should account for not only the work disincentives that arise from benefit receipt but also those that arise from the disability determination process itself.

6 References

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[47] The estimated effect of the SSDI program for applicants on the margin of SSDI receipt ignoring processing time is $p \cdot \gamma^{MMS}$, where $p = 0.331$ is the initial allowance rate from Table 1 and γ^{MMS} is the updated estimate at either three years post-decision (short run) or six years post-decision (long run) from Table 9. .

[48] Our estimate of the effect of the SSDI program is $p \cdot (\gamma + \delta T^A) + (1 - p) \cdot (\delta T^D)$ where estimates of γ and δ are taken from Table 6 and T^A and T^D are average total processing times for initially allowed and initially denied applicants (3.6 and 19.3 months), respectively, reported in Table 1.

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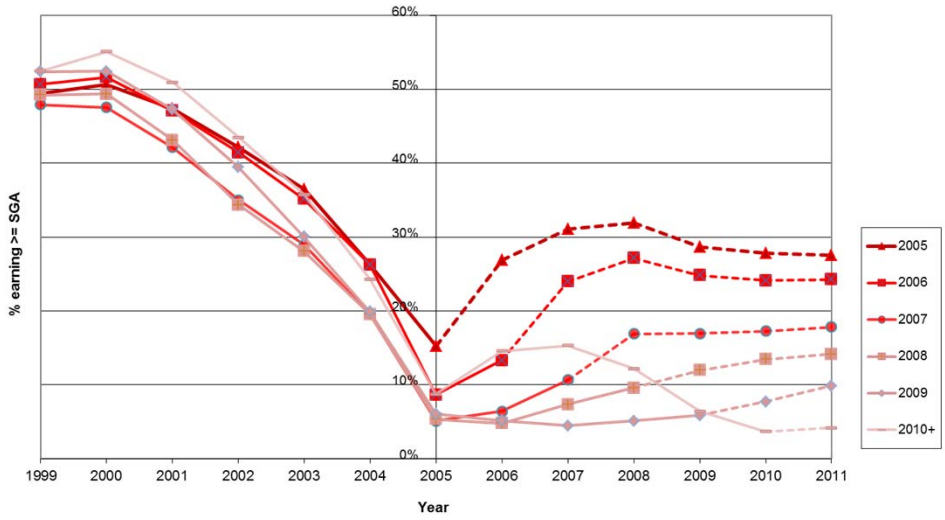
Figure 1. Employment at or above Substantial Gainful Activity (SGA) Before and After Initial Decision, Denied Applicants, by Year of Last Observed Decision



Note: dotted lines represent time after last observed decision.
Source: DIODS data for initial decisions made in 2005.

Figure 2. Conceptual Sketch of the Effects of SSDI Processing Time and Benefit Receipt on Labor Supply

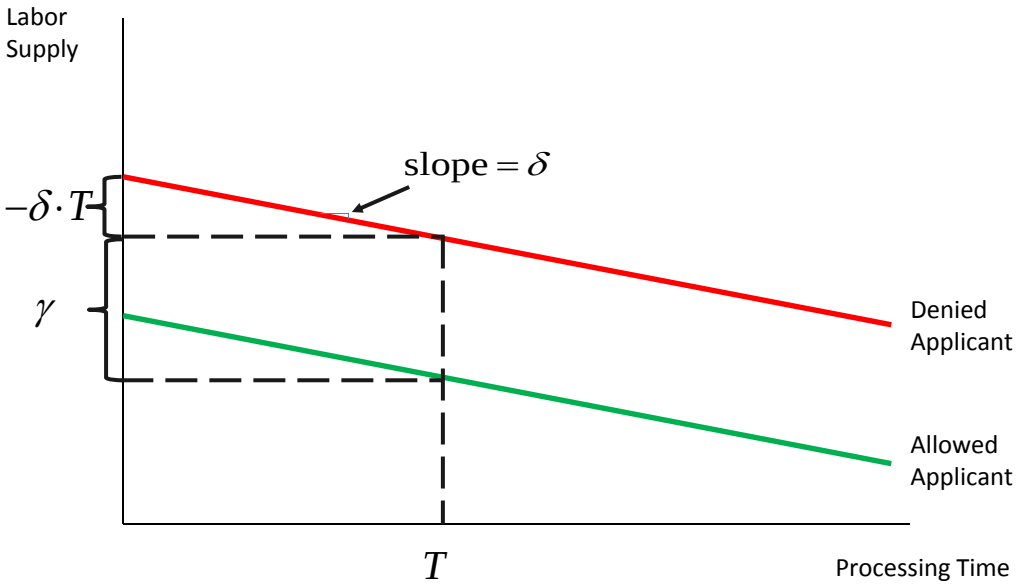


Figure 3. Distribution of Examiner Mean Processing Times

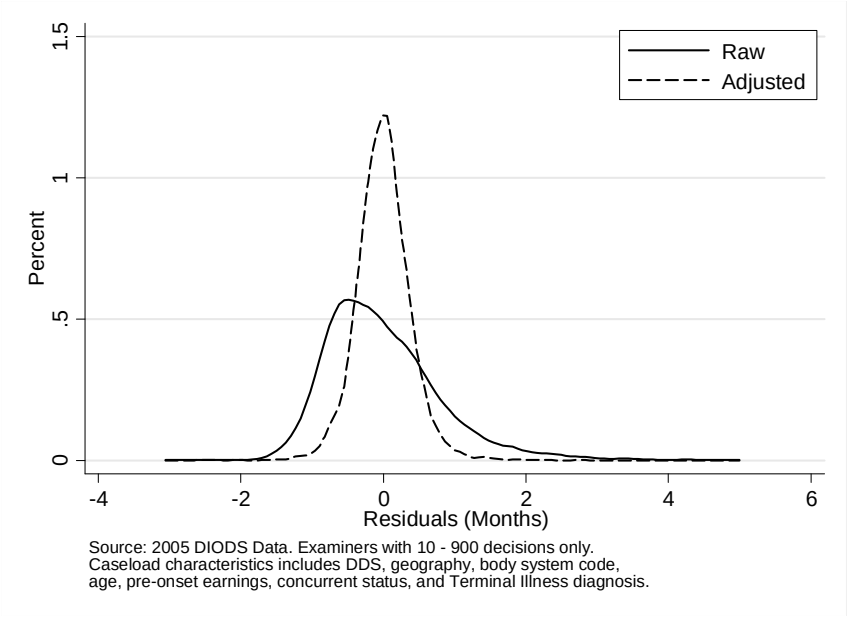


Figure 4. Scatter Plot of Residualized Examiner Allowance Rate and Residualized Examiner Waiting Time

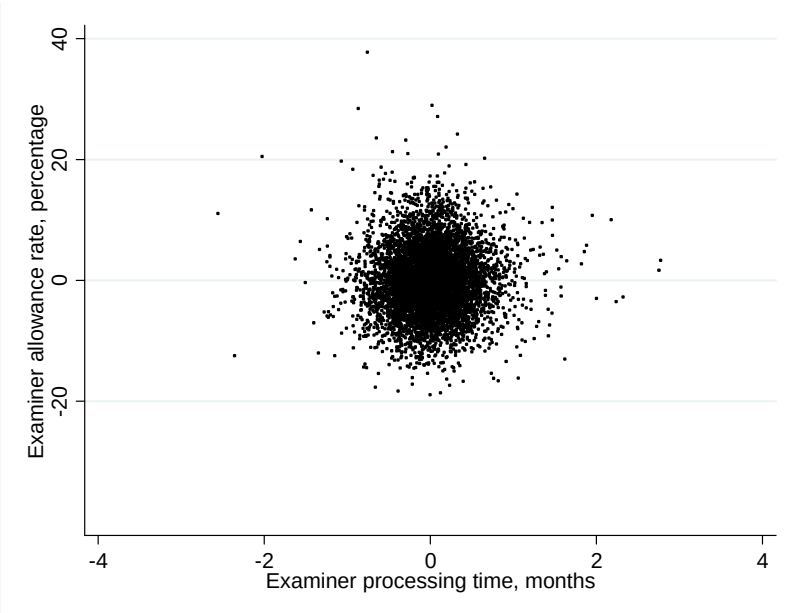


Figure 5. Examples of Non-binding and Binding Processing Time

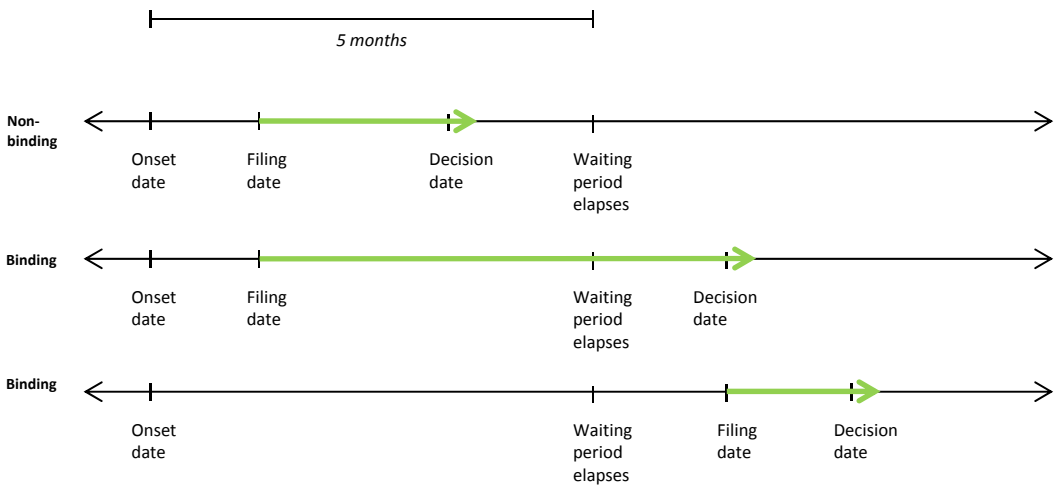


Table 1. Summary Statistics

	(1) All	(2) Initially Allowed	(3) Initially Denied	(4) Finally Allowed	(5) Finally Denied
% of sample	100.0%	33.1%	66.9%	67.7%	32.3%
Continue claim | initial denial	64.1%	--	64.1%	91.3%	34.9%
Allowance rate | continued claim	69.7%	--	69.7%	94.4%	0.0%
Appeal | initial denial	61.1%	--	61.1%	88.7%	31.6%
Allowance rate | appeal	70.3%	--	70.3%	93.8%	0.0%
Reapplication | initial denial	15.7%	--	15.7%	20.2%	10.9%
Allowance rate | reapplication	12.5%	--	12.5%	18.0%	0.0%
Time at DDS (months)	2.91	2.77	2.98	2.93	2.88
	(1.65)	(1.74)	(1.60)	(1.69)	(1.57)
Total Processing Time	14.12	3.64	19.31	15.35	11.55[c]
	(17.64)	(2.22)	(19.53)	(17.70)	(17.23)
Total Processing Time | Continue Claim after Initial Denial	--	--	28.05 (19.51)	28.72 (18.19)	26.16[c] (22.69)
Examiner processing time (EXTIME), months	2.91 (0.79)	2.89 (0.79)	2.92 (0.78)	2.92 (0.80)	2.90 (0.76)
Examiner allowance rate (EXALLOW)	0.33 (0.10)	0.36 (0.11)	0.32 (0.10)	0.34 (0.11)	0.32 (0.10)
Concurrent claim	49.9%	39.1%	55.2%	44.9%	60.3%
Terminal illness	0.6%	1.2%	0.3%	0.7%	0.3%
Musculoskeletal	38.0%	27.0%	43.4%	36.5%	41.0%
Mental	20.7%	25.7%	18.2%	21.0%	20.0%
Age	46.5	50.5	44.5	48.4	42.6
	(11.0)	(10.5)	(10.7)	(10.1)	(11.6)
Earnings (2008$, thousands)					
3-5 years prior	22.308	28.320	19.333	25.520	15.582
	(22.937)	(26.072)	(20.575)	(23.937)	(19.005)
3 years later	4.063	1.768	5.174	1.792	8.752
	(11.711)	(10.061)	(12.277)	(8.877)	(14.998)
6 years later	3.495	1.604	4.363	1.289	7.870
	(11.080)	(8.799)	(11.882)	(7.512)	(15.017)
Employed (earning more than $1,000)					
3 years later	24.2%	11.5%	30.3%	12.7%	47.9%
6 years later	19.3%	9.7%	23.7%	8.5%	40.8%
Performing SGA (earning more than SGA threshold)					
3 years later	12.4%	4.0%	16.4%	4.6%	28.5%
6 years later	10.3%	3.6%	13.4%	3.0%	24.8%
No. observations	1,039,221	344,069	695,152	703,358	335,863

Notes: Standard deviations in parentheses. [c] Denotes censored due to unobserved higher level

Table 2. SSDI Processing Times in Months:
Cumulative Time from Filing to Observed Decision, by Administrative Level

	(1) % Cases	(2) Mean	(3) Std. Dev.	(4) 50th Perc.	(5) 90th Perc.
Initial	100.0	3.8	2.1	3.4	6.2
Time at DDS office	100.0	2.9	1.7	2.6	5.1
Duration < 12 months or non-severe? (denied)	17.1	2.6	1.5	2.3	4.6
Meets listings? (allowed)	13.9	2.5	1.7	2.1	4.7
Capacity for past work? (denied)	24.5	3.1	1.6	2.8	5.2
Capacity for any work? (allowed or denied)	44.5	3.1	1.7	2.8	5.3
Reconsideration	27.5	8.9	3.9	8.0	13.8
ALJ	31.9	33.7	18.9	28.8	63.9
Higher Appeals*	0.3	49.1	17.4	51.4	70.2
Reapplication	10.5	21.8	12.2	17.5	40.4
Final Decision	3.4	14.1	17.6	5.5	37.1

Note: * indicates we only observe time to decision at these stages if the final decision is allowance.

Table 3. First Stage Regressions of SSDI Receipt and Time to Decision on Examiner's Allowance Propensity (EXALLOW) and Examiner's Average Processing Time (EXTIME)

	All Applicants			Initially Allowed	Finally Allowed	Finally Denied
	(1)	(2)	(3)	(4)	(5)	(6)
	Initial Time	Final Time	SSDI Receipt	Final Time	Final Time	Final Time
			A. Without Covariates			
EXTIME	0.953***	1.272***	0.00896***	0.912***	1.662***	1.065***
	(0.0051)	(0.0305)	(0.0010)	(0.0078)	(0.0764)	(0.0435)
EXALLOW	0.162***	-20.68***	0.309***			
	(0.0322)	(0.2230)	(0.0068)			
R^2	0.126	0.019	0.005	0.106	0.006	0.002
			B. Plus Assignment Variables			
EXTIME	0.642***	0.520***	0.000417	0.593***	0.520***	0.673***
	(0.0084)	(0.0303)	(0.0009)	(0.0107)	(0.0545)	(0.0533)
EXALLOW	0.294***	-7.160***	0.169***			
	(0.0454)	(0.2730)	(0.0085)			
R^2	0.263	0.073	0.084	0.276	0.132	0.029
			C. Plus Individual Characteristics			
EXTIME	0.642***	0.529***	-0.000232	0.592***	0.536***	0.677***
	(0.0084)	(0.0298)	(0.0008)	(0.0106)	(0.0519)	(0.0525)
EXALLOW	0.301***	-6.984***	0.165***			
	(0.0454)	(0.2620)	(0.0079)			
R^2	0.265	0.118	0.147	0.279	0.206	0.049
n	1,039,221	1,039,221	1,039,221	344,069	703,358	335,863

Note: Assignment variables include: DDS indicators, body system codes, top 20 diagnosis codes, terminal illness flag, month of receipt at DDS, concurrent status and 3-digit zip codes. Individual characteristics include: five-year age group dummies and average prior earnings 3-5 years before application.

Table 4. OLS and 2SLS Estimates: Effect of Final Time to Decision on Labor Supply Outcomes among Initially Allowed Applicants Only

	OLS Estimates			2SLS Estimates				
	(1) 2 Years Later (2007)	(2) 4 Years Later (2009)	(3) 6 Years Later (2011)	(4) 2 Years Later (2007)	(5) 3 Years Later (2008)	(6) 4 Years Later (2009)	(7) 5 Years Later (2010)	(8) 6 Years Later (2011)
	A. Dependent Variable: Earn >= $1,000/Year							
Final Time	-0.00174***	-0.00137***	-0.00175***	-0.00442**	-0.00523***	-0.00270*	-0.00340**	-0.00381**
	(0.000276)	(0.000275)	(0.000277)	(0.001760)	(0.001720)	(0.001620)	(0.001620)	(0.001680)
R^2	0.054	0.052	0.055	0.053	0.056	0.052	0.051	0.055
	B. Dependent Variable: Earn >= SGA							
Final Time	-0.00138***	-0.000964***	-0.00111***	-0.00291***	-0.00269**	-0.00270**	-0.00178*	-0.00257**
	(0.000162)	(0.000165)	(0.000172)	(0.001120)	(0.001120)	(0.001050)	(0.001040)	(0.001180)
R^2	0.039	0.04	0.044	0.039	0.04	0.039	0.04	0.043
	C. Dependent Variable: Annual Earnings (in Thousands)							
Final Time	-0.0473***	-0.0416***	-0.0446***	-0.167**	-0.237***	-0.0667	-0.121**	-0.131**
	(0.0080)	(0.0076)	(0.0074)	(0.0733)	(0.0900)	(0.0800)	(0.0573)	(0.0563)
R^2	0.035	0.032	0.051	0.035	0.042	0.032	0.046	0.05
n	344,069	321,835	302,683	344,069	332,304	321,835	312,134	302,683

Table 5. Effect of Time to Decision on Employment Before vs. After Waiting Period (WP) Has Elapsed, Control Function Estimates

	(1) 2 Years Later (2007)	(2) 3 Years Later (2008)	(3) 4 Years Later (2009)	(4) 5 Years Later (2010)	(5) 6 Years Later (2011)
Time Before WP	-0.000453	-0.00164	0.000492	-0.000605	-0.00167
	(0.002090)	(0.001950)	(0.001930)	(0.001810)	(2.900000)
Time After WP	-0.00526***	-0.00610***	-0.00323*	-0.00456**	-0.00434**
	(0.002040)	(0.001900)	(0.001890)	(0.001740)	(0.001880)
Elapsed time onset to filing	-0.000776***	-0.000852***	-0.000744***	-0.000636***	-0.000677***
	(0.000054)	(0.00001)	(0.000050)	(0.000052)	(0.00005)
Residual from first stage	0.00253	0.00328*	0.00101	0.00229	0.00199
	(0.002080)	(0.00195)	(0.001890)	(0.001770)	(0.00193)
R^2	0.055	0.059	0.053	0.052	0.056
n	352,495	332,304	329,630	319,665	302,683

Notes: See text for details of estimation. Standard errors calculated by bootstrap clustered on examiner (S=200).

Table 6. Joint Estimation of Effect of SSDI Receipt and Time to Decision on Employment and Earnings, 2SLS Estimates

	(1) 2 Years Later (2007)	(2) 3 Years Later (2008)	(3) 4 Years Later (2009)	(4) 5 Years Later (2010)	(5) 6 Years Later (2011)
	A. Dependent Variable: Earn >= $1,000/Year				
Final time	-0.00381***	-0.00472***	-0.00237*	-0.00154	-0.00203
	(0.00150)	(0.00149)	(0.00139)	(0.00133)	(0.00131)
SSDI receipt	-0.486***	-0.478***	-0.298***	-0.256***	-0.254***
	(0.07540)	(0.07490)	(0.07030)	(0.06750)	(0.06620)
R^2	0.124	0.141	0.194	0.198	0.205
	B. Dependent Variable: Earn >= SGA				
Final time	-0.00342***	-0.00306***	-0.00165	-0.0011	-0.00173*
	(0.00114)	(0.00118)	(0.00107)	(0.00102)	(0.00103)
SSDI	-0.388***	-0.330***	-0.212***	-0.179***	-0.192***
	(0.05870)	(0.05910)	(0.05410)	(0.05210)	(0.05200)
R^2	0.058	0.127	0.156	0.159	0.164
	C. Dependent Variable: Annual Earnings (in Thousands)				
Final time	-0.164***	-0.133***	-0.0667	-0.0673*	-0.0847**
	(0.0481)	(0.0488)	(0.0467)	(0.0394)	(0.0391)
SSDI	-12.06***	-7.828***	-5.382**	-4.667**	-5.613***
	(2.3220)	(2.1580)	(2.1660)	(1.9000)	(1.9080)
R^2	0.039	0.124	0.128	0.142	0.146
n	1,039,221	1,018,984	999,779	981,000	962,045

Table 7. 2SLS Estimates: Effect of Final Time to Decision on Labor Supply Outcomes, Finally Allowed and Finally Denied Applicants

	(1) 2 Years Later (2007)	(2) 3 Years Later (2008)	(3) 4 Years Later (2009)	(4) 5 Years Later (2010)	(5) 6 Years Later (2011)
			Panel I. Finally Allowed Applicants		
			A. Dependent Variable: Earn >= $1,000/Year		
Final Time	-0.00339**	-0.00441***	-0.00204	-0.00188	-0.00205
	(0.00147)	(0.00142)	(0.00130)	(0.00126)	(0.00126)
R^2			0.016	0.024	0.031
			B. Dependent Variable: Earn >= SGA		
Final Time	-0.00217**	-0.00192**	-0.00150*	-0.000592	-0.00129
	(0.00090)	(0.00092)	(0.00082)	(0.00077)	(0.00082)
R^2			0.004	0.026	0.023
			C. Dependent Variable: Annual Earnings (in Thousands)		
Final Time	-0.153***	-0.150***	-0.0492	-0.0648*	-0.0717*
	(0.05460)	(0.05290)	(0.04980)	(0.03780)	(0.03700)
R^2			0.02	0.021	0.023
n	703,358	686,475	670,574	655,101	639,578
			Panel II. Finally Denied Applicants		
			A. Dependent Variable: Earn >= $1,000/Year		
Final Time	-0.00228	-0.00281	-0.00146	0.000121	-0.000809
	(0.00225)	(0.00225)	(0.00220)	(0.00216)	(0.00211)
R^2	0.139	0.147	0.131	0.118	0.132
			B. Dependent Variable: Earn >= SGA		
Final Time	-0.00326*	-0.00289	-0.000511	-0.000703	-0.00113
	(0.00198)	(0.00204)	(0.00194)	(0.00192)	(0.00191)
R^2	0.132	0.136	0.113	0.115	0.12
			C. Dependent Variable: Annual Earnings (in Thousands)		
Final Time	-0.101	-0.0455	-0.0469	-0.0244	-0.0527
	(0.06300)	(0.06700)	(0.06420)	(0.06390)	(0.06490)
R^2	0.217	0.21	0.195	0.183	0.182
n	335,863	332,509	329,205	325,899	322,467

Table 8. Joint Estimation of Effect of SSDI Receipt and Time to Decision on Probability of Earnings Exceeding $1,000/yr, Claimants with Mental or Musculoskeletal Disorder as Primary Impairment

	(1) 2 Years Later (2007)	(2) 3 Years Later (2008)	(3) 4 Years Later (2009)	(4) 5 Years Later (2010)	(5) 6 Years Later (2011)
			A. Primary Impairment Mental Disorder		
Final time	-0.00375	-0.00302	0.0015	-0.00388	-0.00403
	(0.00358)	(0.00346)	(0.00325)	(0.00313)	(0.00315)
SSDI receipt	-0.494***	-0.457***	-0.217	-0.455***	-0.398***
	(0.15100)	(0.14600)	(0.14000)	(0.13700)	(0.13500)
R^2	0.111	0.148	0.152	0.126	0.15
n	215,110	212,887	210,582	208,066	205,513
			B. Primary Impairment Musculoskeletal Disorder		
Final time	-0.00307*	-0.00333*	-0.00241	-0.00067	-0.00173
	(0.00184)	(0.00186)	(0.00179)	(0.00178)	(0.00171)
SSDI receipt	-0.324***	-0.345***	-0.206**	-0.0847	-0.126
	(0.09580)	(0.09600)	(0.09390)	(0.09330)	(0.09110)
R^2	0.192	0.216	0.207	0.154	0.193
n	394,513	390,770	386,852	382,695	378,187

Table 9. The Effect of SSDI Award on Probability of Positive Annual Earnings (>$1K) in Years Following Application, Impact of Accounting for Processing Time

	OLS	2SLS: Excluding Processing Time	2SLS: Including Processing Time	Difference in 2SLS Estimates	N
	(1)	(2)	(3)	(4)	
3 Years Later (2008)	-0.328***	-0.273***	-0.478***	-0.205***	1,018,984
	(0.001)	(0.038)	(0.075)	(0.064)†	
				[-0.329,-0.087]	
6 Years Later (2011)	-0.306***	-0.166***	-0.254***	-0.088	962,045
	(0.001)	(0.037)	(0.066)	(0.062)†	
				[-0.205,0.042]	

† Standard errors calculated by bootstrap (S=300 simulations).

Note: Bootstrapped 95 percent confidence intervals in brackets.

Figure A-1. Heterogeneity in Effect of Processing Time on Employment Three Years After Initial Decision, All Applicants

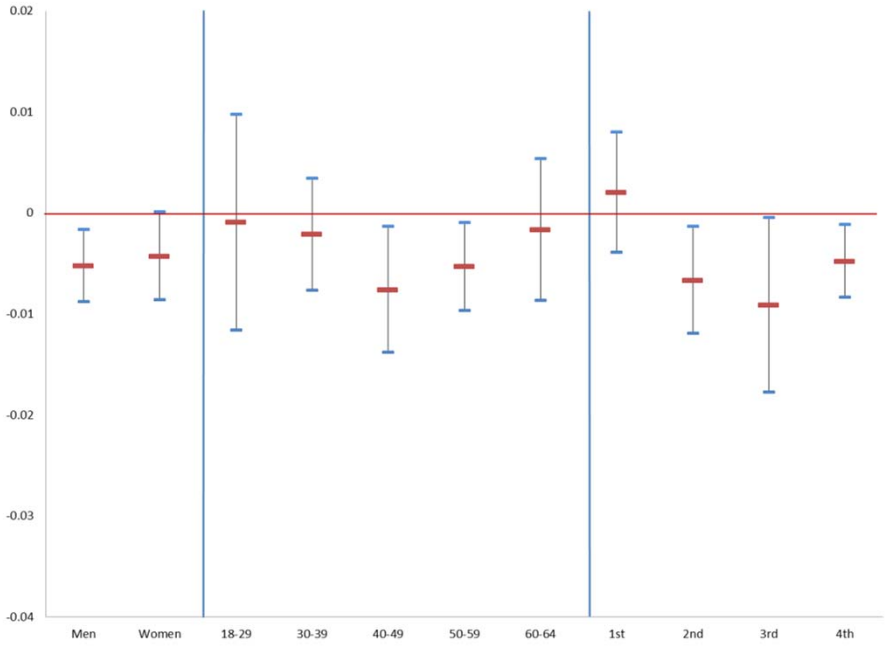


Figure A-2. Heterogeneity in Effect of Processing Time on Employment Six Years After Initial Decision, All Applicants

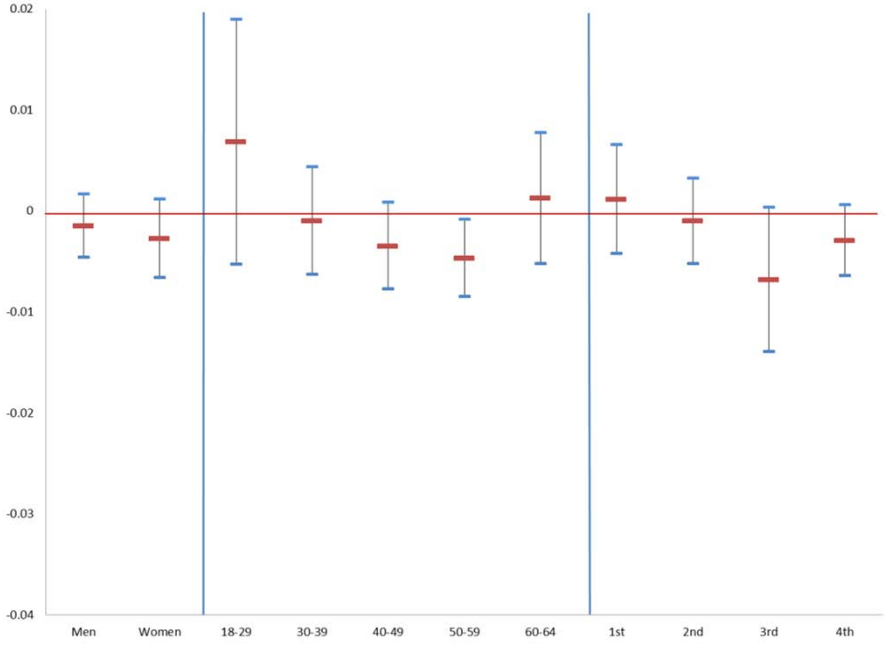


Figure A-3. Heterogeneity in Effect of SSDI Receipt on Employment Three Years After Initial Decision, All Applicants

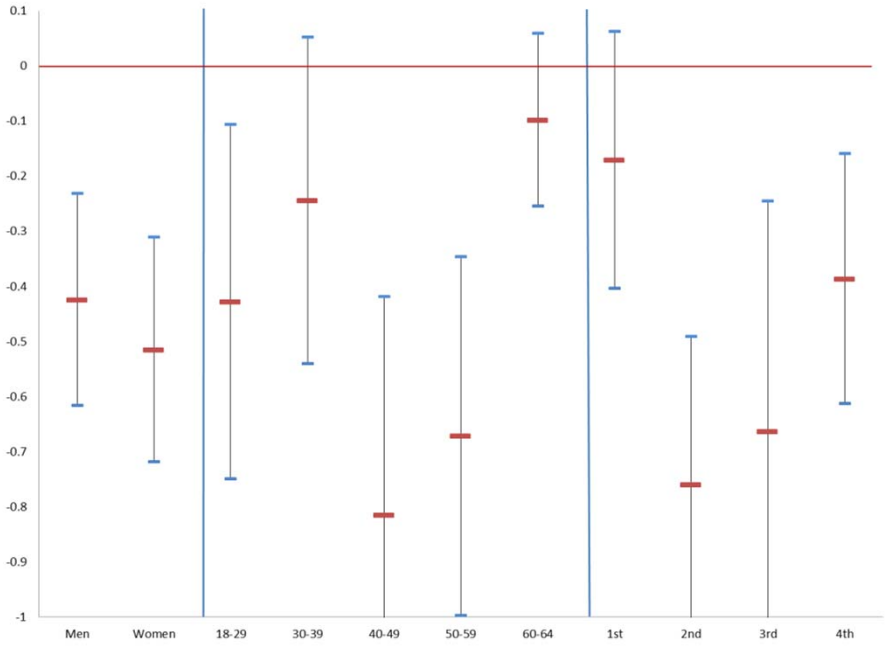


Figure A-4. Heterogeneity in Effect of SSDI Receipt on Employment Six Years After Initial Decision, All Applicants

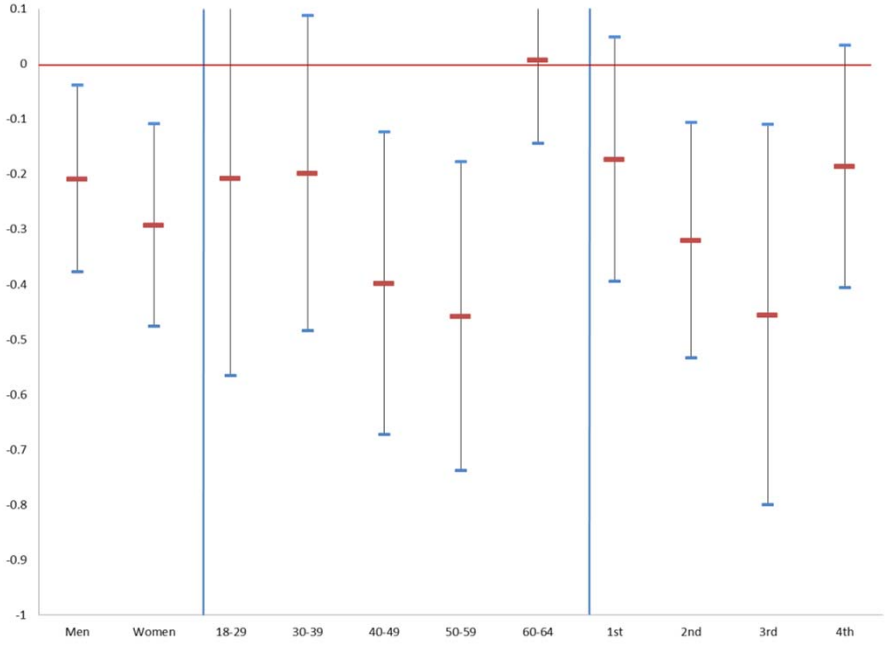


Table A-1. Balance Tests

	Without Assignment Variables		With Assignment Variables	
	(1) Examiner Allowance Rate (EXALLOW)	(2) Examiner Allowance Time (EXTIME)	(3) Examiner Allowance Rate (EXALLOW)	(4) Examiner Allowance Time (EXTIME)
Age				
18-24	-0.000237	0.005380	-0.000067	-0.004190
	(0.000436)	(0.003780)	(0.000438)	(0.003660)
25-29	-0.000772*	0.00688**	-0.000323	-0.003660
	(0.000446)	(0.003310)	(0.000383)	(0.003120)
30-34	-0.000463	0.0106***	0.000140	-0.002770
	(0.000480)	(0.003580)	(0.000371)	(0.003240)
35-39	-0.000976**	0.009840***	-0.000379	-0.003830
	(0.000422)	(0.003090)	(0.000340)	(0.002770)
40-44	-0.001210***	0.012100***	-0.000533*	-0.002000
	(0.000427)	(0.003080)	(0.000314)	(0.002670)
45-49	-0.001300***	0.012600***	-0.000640**	0.000905
	(0.000388)	(0.002910)	(0.000308)	(0.002550)
50-54	-0.000985***	0.014700***	-0.000425	0.003040
	(0.000344)	(0.002700)	(0.000283)	(0.002380)
55-59	-0.000669**	0.009320***	-0.000308	0.002580
	(0.000288)	(0.002340)	(0.000255)	(0.002160)
Prior Earnings				
t-6	0.000020***	-0.000237***	0.000003	-0.000064
	(0.000007)	(0.000057)	(0.000006)	(0.000052)
t-7	0.0000150*	0.000089	0.000012	0.000087
	(0.000008)	(0.000069)	(0.000008)	(0.000067)
t-8	-0.000009	-0.000020	-0.000011	-0.000041
	(0.000010)	(0.000075)	(0.000009)	(0.000072)
t-9	0.000009	0.000035	0.000005	0.000005
	(0.000007)	(0.000057)	(0.000007)	(0.000055)
R^2	0.602	0.481	0.61	0.515
P value F test Age	0.006	0.000	0.214	0.092
P value F test Prior Earning	0.000	0.001	0.058	0.726
P value F test Both	0.000	0.000	0.105	0.216
No. observations	1,039,221			

Note: All regressions include DDS dummies. Assignment variables include: body system codes, top 20 diagnosis codes, terminal illness flag, month of receipt at DDS, concurrent status and 3-digit zip codes.
*** p<0.01, ** p<0.05, * p<0.1

Table A-2. Monotonicity Tests: First Stage Regressions of Time to Decision an
Leave-Body-System-Out Measures of EXTIME and EXALLOW for Select B

	Initial Time			Final Time		
	(1)	(2)	(3)	(4)	(5)	(6)
	All Applicants	Mental Disorders	Muscul. Disorders	All Applicants	Mental Disorders	Muscul. Disorders
EXTIME	0.598***	0.616***	0.626***	0.519***	0.442***	0.480***
	(0.00836)	(0.0102)	(0.01230)	(0.0331)	(0.0507)	(0.0708)
EXALLOW	0.336***	0.621***	0.492***	-2.165***	-3.062***	-4.086***
	(0.04060)	(0.0578)	(0.08120)	(0.3480)	(0.4080)	(0.5950)
R^2	0.262	0.258	0.236	0.117	0.129	0.076
n	1,039,221	394,513	215,110	1,039,221	394,513	215,110

Table A-3. Effect of Examiner Average Processing Time (EXTIME) on Initial Determination, Appeal Rate and Benefit Receipt

	(1)	(2)	(3)	(4)	(5)
		Conditional on Initial Denial			
	Initial Denial	Continue Claim	Appeal	Reapply	Receive Benefit
EXTIME	0.000235	-0.000629	-0.000981	-0.00224***	-0.0036
	(0.00167)	(0.00108)	19.34410	(0.00079)	(0.00103)
R^2	0.248	0.075	0.081	0.028	0.147
Mean Dep. Variable	0.669	0.641	0.661	0.157	0.677
n	1,039,221	695,152	695,152	695,152	1,039,221

Table A-4. P-values from Overidentification Tests of Causal Pathways

	All Applicants			Initially Allowed	Finally Allowed	Finally Denied
	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable:	EXALLOW	EXTIME	EXALLOW &			
Earn >= $1,000/Year	only	only	EXTIME	EXTIME	EXTIME	EXTIME
2 Years Later (2007)	0.0120	0.0000	0.0155	0.4983	0.0105	0.0817
3 Years Later (2008)	0.0526	0.0004	0.0691	0.3765	0.0883	0.0865
4 Years Later (2009)	0.0513	0.0027	0.0558	0.6956	0.2895	0.2365
5 Years Later (2010)	0.6047	0.2116	0.6119	0.7781	0.4735	0.8903
6 Years Later (2011)	0.2370	0.0606	0.2474	0.2298	0.4166	0.8467

Table A-5. Reduced Form Effect of Examiner's Allowance Propensity (EXALLOW) and Average Processing Time (EXTIME) on Employment and Earnings

	(1) 2 Years Later (2007)	(2) 3 Years Later (2008)	(3) 4 Years Later (2009)	(4) 5 Years Later (2010)	(5) 6 Years Later (2011)
			A. Dependent Variable: Earn >= $1,000/Year		
EXALLOW	-0.0534***	-0.0465***	-0.0328***	-0.0320***	-0.0281***
	(0.00649)	(0.00644)	(0.00663)	(0.00629)	(0.00630)
EXTIME	-0.00191**	-0.00232***	-0.00115	-0.000748	-0.00102
	(0.00078)	(0.00078)	(0.00077)	(0.00074)	(0.00073)
R^2	0.091	0.091	0.08	0.079	0.084
			B. Dependent Variable: Earn >= SGA		
EXALLOW	-0.0401***	-0.0335***	-0.0235***	-0.0222***	-0.0200***
	(0.00497)	(0.00525)	(0.00494)	(0.00479)	(0.00504)
EXTIME	-0.00172***	-0.00150**	-0.000799	-0.000535	-0.000876
	(0.00059)	(0.00063)	(0.00059)	(0.00057)	(0.00057)
R^2	0.053	0.057	0.053	0.054	0.059
			C. Dependent Variable: Annual Earnings		
EXALLOW	-0.841***	-0.37	-0.424**	-0.304	-0.342*
	(0.2140)	(0.3400)	(0.1980)	(0.1980)	(0.2050)
EXTIME	-0.0840***	-0.0676***	-0.0335	-0.0346	-0.0441**
	(0.0252)	(0.0259)	(0.0251)	(0.0216)	(0.0218)
R^2					
n	1,039,221	1,018,984	999,779	981,000	962,045

*** p<0.01, ** p<0.05, * p<0.1