# Does Delay Cause Decay? The Effect of Administrative Decision Time on the Labor Force Participation and Earnings of Disability Applicants*

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**Abstract**

We estimate the causal effect of time out of the labor force on subsequent employment of Social Security Disability Insurance (SSDI) applicants and, further, distinguish this delay effect from the direct 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 review. We estimate that on average, the SSDI determination process alone reduces the post-decision employment of SSDI applicants by 4.2 percentage points (19 percent) in the short run, and by 1.6 percentage points (9.5 percent) in the long run. Moreover, 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 benefit receipt effect is 24 to 43 percent larger than previously estimated—and larger still for applicants who received comparatively high earnings prior to disability onset. Combining the delay and benefits receipt channels reveals that the SSDI program reduces subsequent employment of applicants by an average of 6.7 percentage points (30 percent) in the short run and 3 percentage points (18 percent) in the long run—about 2.7 to 3.9 times larger than prior literature suggests.

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# Introduction

A prominent body of research analyzes the causal effect of receipt of Social Security Disability Insurance benefits (SSDI) on labor supply by comparing the post-decision employment rate of applicants awarded benefits to those denied benefits.[1] Implicit in this 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 of first-order importance, it is unlikely to capture the total effect of the SSDI program on the employment and earnings of disability applicants. A second potential channel, and the focus of this paper, is the lengthy disability determination process itself, which may directly reduce applicants' subsequent labor supply by prolonging their time out of the labor force.[2] Due to a combination of strong incentives to limit work activity and long 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-decision 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 delay 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 the post-decision 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

[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 address this channel.

[3] In our administrative sample of SSDI applicants, discussed below, the average time from SSDI application to final determination exceeds one year (13.5 months). Over 40 percent 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 (27.8 months). See Table 1.

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) that handles the initial application and a small number of applicant characteristics used in some offices for initial screening, we do not 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 determination.[4] Initially allowed applicants are a particularly interesting group because they 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 because, 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 variation in processing times, we find that longer processing time significantly reduces 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 the annual post-decision employment rate by 0.39 percentage points (points, for brevity) or 4 percent and lowers post-decision annual earnings by $126 or 8.6 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 year six after the initial decision (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 benefit entitlement date beyond five months *after* disability onset.[6] This observation is significant because an applicant's

[4]Because the examiner processing time instrument is uncorrelated with initial allowance rates, focusing only on initially allowed applicants 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 five-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 SGA. Benefit payments also commence at the end of the Waiting Period. Applicants notified of their award 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]The disability onset date is established 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

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 supply and, under our delay-decay hypothesis, will have no effect on post-allowance labor supply. This is precisely what we find. We detect no significant impact of variation in processing time on the 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 0.46 points, slightly exceeding the effect for the entire 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 applicant health or other unobserved factors affecting labor supply. Following Maestas, Mullen and Strand (2013), we use variation in examiner allowance propensities 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 an additional month of processing time on the full set of applicants—both those initially allowed and initially denied—is 0.31 points or 1.4 percent, similar to the effect of waiting time on the initially allowed sample in the short run, but diminished in magnitude and significance by year six after the initial determination. Given an average total processing time in our sample of 13.5 months, our estimates imply the SSDI determination process reduces the post-decision employment of SSDI applicants by an average of 4.2 points (19 percent) in the short run and 1.6 points (9.5 percent) in the long run. Notably, the long-term effects of processing times on labor supply are larger still for applicants who possessed relatively high earnings in the years prior to applying for SSDI benefits. Although these applicants have greater odds of receiving an allowance, they also appear to maintain greater residual attachment to the labor force. Thus, ironically, the cost of delays appears largest for workers with greater labor force attachment.

The existence of an employment decay effect as a distinct causal channel through which the SSDI determination process affects post-decision labor supply outcomes—separate from the benefit receipt effect, which has been the sole focus of the literature—has two important implications for the total impact of the SSDI program on available and unrealized work capacity. First, as we show formally below, studies that estimate the effect of disability benefit receipt on labor supply but do not account for systematic differences in processing time between allowed and denied applicants will generally produce biased estimates. This bias stems from systematic differences in final processing time among applicants who are initially allowed versus those who are initially denied. Because applicants frequently appeal SSDI denials but never appeal SSDI allowances, applicants who are

the individual stopped working, whichever is later.

randomly assigned to examiners with higher allowance propensities will have higher allowance rates, fewer appeals, and thus *shorter* processing times in total than those randomly assigned to examiners with lower allowance propensities (Maestas, Mullen and Strand, 2013).[7] If, as we establish below, processing time has an independent negative effect on subsequent employment, then conventional two-stage least squares (2SLS) estimates will *underestimate* the causal effect of disability benefit receipt on labor supply because they confound the positive labor supply effect of a denial decision with the negative labor supply effect of additional waiting time. The bias that arises from ignoring the effect of the delay 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 benefits on the labor supply of those on the margin of program entry that do not account for the delay channel imply that the disability award reduces employment by 32 points three years following application and 21 points six years following application. However, accounting for the delay channel implies SSDI benefit receipt reduces employment by 46 points three years later, and 27 points six years later (though the difference between the two estimates in year six is not statistically significant). Noting that benefit receipt effect is experienced only by applicants who are awarded benefits and who would work in the absence of SSDI, these new estimates of the benefit receipt effect that are purged of waiting time bias imply that *benefit receipt alone* reduces the post-decision employment of all SSDI applicants by an average of 2.4 points (10.8 percent) in the short run and 1.4 points (8.3 percent) in the long run.

Second, accounting for both benefit receipt and processing delays provides a more complete—and economically more sizable—estimate of the aggregate labor supply impacts of the Social Security Disability Insurance program. Combining both mechanisms implies the SSDI program reduces post-decision employment among all applicants by 6.7 points (30 percent) in the short run and 3 points (18 percent) in the long run. In other words, the total SSDI program effect on employment is 165 to 300 percent larger than previous estimates have suggested. Importantly, the newly identified delay channel accounts for more than one-half of this total effect; this is because while only some applicants receive SSDI benefits, all applicants must wait for a disability determination. Thus, a key takeaway of this paper is that neither the recent nor established SSDI literature has fully captured the substantial labor supply impacts of the disability system on applicants and beneficiaries.

Our findings contribute to a longstanding and active literature on duration dependence in unemployment (Nekoi and Weber, forthcoming; Price, 2017; Schmieder, von Wachter and Bender, 2016; 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 effect 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

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

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 above SGA.[8] If, as our results imply, the work capacity of beneficiaries continues to decline as they remain out of the labor force, a relaxation of work disincentives among those already receiving SSDI benefits may be insufficient to return long-term beneficiaries to work. Our findings may imply 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 26 million Americans applied for SSDI benefits in the past ten years—with nearly three 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 describes our administrative data and relevant features of the SSDI system. 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 effect of benefit receipt on subsequent employment are confounded with the effect of delays, and shows that purging this confound substantially increases the estimated discouragement effect of benefit receipt on labor supply. In Section 5, we conclude with a new estimate of the aggregate impact of the SSDI program on labor supply that accounts for the combined effects of benefit receipt and processing delays.

## 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 database contains the universe of initial medical determinations (that is, excluding technical denials) made in 2005. We restrict the analytic 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

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

[9] Statistics available at http://www.ssa.gov/OACT/STATS/dibStat.html, accessed 9/22/2014.

[10] The mean number of cases per examiner was 145 in 2005.

into examiner assignment at some DDS offices.[11] Linking the DIODS to SSA's "831" research files (derived from Form SSA-831 which summarizes the result of the initial disability determination for applicants) allows us to observe and exclude cases of alleged terminal illness (TERI), which are flagged for expedited processing, sometimes by examiners who specialize in such cases[12] Once TERI cases have been removed, it is our understanding from interviews with SSA DDS offices that SSDI applications were randomly assigned, conditional on broad impairment type, 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 administrative data include application filing date, date of receipt at the state 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 re-evaluated at the original DDS office in most states[13]; 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 the 831 files, 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 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.

[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] We also exclude cases flagged as part of the Single Decision Maker (SDM) pilot, Special Disability Workload (SDW) and other categories requiring expedited processing. TERI was the most common among those categories in 2005.

[13] 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.

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).[14]

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. From the earnings records, we construct three measures of labor supply: (1) employment (annual earnings above $1,000); (2) earnings above the SGA threshold (in a given year); and (3) annual earnings (in thousands of dollars). All amounts are in 2008 dollars.

Finally, we link to reported death information in the Numerical Identification System (NUMIDENT). SSA receives reports of death from a number of sources, most notably state electronic reporting systems and its own Death Alerts Tracking System (DATS). The DATS system is designed to reduce improper payments to deceased beneficiaries. For example, a returned SSDI benefit check would trigger an alert requiring investigation into the deceased status of the beneficiary. In our sample 55 percent of reported deaths result from alerts, 34 percent from state reports, and the rest from other sources (e.g., field offices). Because deaths are more likely to be observed (earlier) for SSDI beneficiaries than nonbeneficiaries, we include both deceased and living applicants in the main sample. As a result, an observation of zero earnings may reflect either deceased status or nonemployment of a living individual. We make use of death information only for a subsample of initially allowed applicants, as discussed in Section 3. Table 1 presents summary statistics on the sample, overall and separately for initial and final disability determinations.[15] After applying our sample restrictions, we observe SSDI applications for just over one million individuals in 2005. Approximately 36 percent of applicants are initially allowed benefits, although nearly 69 percent 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, and 70 percent of these result in an allowance.[16]

[14] According to the Office of Disability Program Management Information, around 2 percent of claims are denied at the appeals council and federal court levels. For these and any claims in process more than 7 years after the initial determination, we will underestimate true processing time.

[15] 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. We infer final allowance status from SSDI benefit receipt; note we observe appeals or reapplication within one year of the last observed decision for 91.4 percent of initially denied applicants.

[16] Of the 64 percent of initially denied applicants who continue their claim, 95 percent pursue an appeal and 70.5 percent of these are successful at the reconsideration or ALJ stage. In addition, 15.5 percent of initially denied applicants who continue their claim submit a new application (most while simultaneously pursuing an appeal), yet only 13 percent of these new applications are successful.

Table 1: Summary Statistics for Analytic Sample of SSDI Applicants Receiving Medical Determinations in 2005

| | All (1) | Initially Allowed (2) | Initially Denied (3) | Finally Allowed (4) | Finally Denied (5) |
|---|---|---|---|---|---|
| % of sample | 100.0% | 35.8% | 64.2% | 68.8% | 31.2% |
| Continue claim \| initial denial | 63.8% | -- | 63.8% | 91.4% | 34.6% |
| Allowance rate \| continued claim | 69.8% | -- | 69.8% | 94.5% | 0.0% |
| Time at DDS (months) | 2.87 | 2.67 | 2.99 | 2.87 | 2.88 |
| | (1.67) | (1.75) | (1.61) | (1.70) | (1.58) |
| Total Processing Time | 13.53 | 3.55 | 19.09 | 14.49 | 11.40[c] |
| | (17.26) | (2.23) | (19.36) | (17.29) | (17.01) |
| Total Processing Time \| Continue Claim after Initial Denial | -- | -- | 27.80 | 28.47 | 25.92[c] |
| | | | (19.38) | (18.09) | (22.49) |
| Examiner processing time (EXTIME), months | 2.87 | 2.85 | 2.89 | 2.88 | 2.87 |
| | (0.80) | (0.80) | (0.80) | (0.81) | (0.78) |
| Examiner allowance rate (EXALLOW) | 0.36 | 0.39 | 0.34 | 0.36 | 0.35 |
| | (0.11) | (0.11) | (0.10) | (0.11) | (0.10) |
| Concurrent claim | 49.2% | 38.3% | 55.3% | 44.2% | 60.3% |
| Musculoskeletal | 36.5% | 24.9% | 42.9% | 34.6% | 40.5% |
| Mental | 20.3% | 23.4% | 18.5% | 20.3% | 20.2% |
| Age | 46.8 | 50.8 | 44.5 | 48.7 | 42.7 |
| | (10.95) | (10.32) | (10.65) | (10.09) | (11.63) |
| Earnings (2008$, thousands) | | | | | |
| 6 years before | 23.937 | 30.090 | 20.508 | 27.216 | 16.712 |
| | (25.012) | (28.279) | (22.265) | (26.064) | (20.765) |
| 3 years later | 3.760 | 1.468 | 5.037 | 1.615 | 8.486 |
| | (11.268) | (8.914) | (12.202) | (8.292) | (14.925) |
| 6 years later | 3.062 | 1.215 | 4.091 | 1.085 | 7.419 |
| | (10.457) | (7.682) | (11.595) | (6.914) | (14.743) |
| Employed (earning more than $1,000) | | | | | |
| 6 years before | 79.2% | 84.7% | 76.1% | 84.0% | 68.7% |
| 3 years later | 22.4% | 9.7% | 29.4% | 11.5% | 46.3% |
| 6 years later | 16.9% | 7.5% | 22.2% | 7.2% | 38.3% |
| Performing SGA (earning more than SGA threshold) | | | | | |
| 6 years before | 57.3% | 68.2% | 51.3% | 64.6% | 41.3% |
| 3 years later | 11.4% | 3.4% | 16.0% | 4.2% | 27.5% |
| 6 years later | 9.0% | 2.7% | 12.5% | 2.5% | 23.3% |
| No. observations | 1,009,382 | 361,169 | 648,213 | 694,301 | 315,081 |

Notes: Standard deviations in parentheses. [c]denotes censored due to the possibility of ongoing (unobserved) higher level appeals.

Approximately one-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. More than one-half of all applicants have either a musculoskeletal (36.5 percent) or mental (20.3 percent) impairment. The average applicant is 46.8 years old at the time of the initial determination and has low pre-onset earnings—$23,937 (in 2008 dollars) six years prior to initial determination. Earnings are substantially lower three and six years after initial determination, and are declining slightly over time.

Average examiner processing time is 2.9 months, and does not differ systematically across applicant groups according to case disposition (columns 2 through 5): those initially allowed, those initially denied, those finally allowed, and those finally denied. At the same time, average processing time at the DDS office *does* differ slightly between initially allowed and denied applicants, with initially allowed applicants receiving quicker initial determinations (2.7 vs. 3.0 months on average).[17] The time between filing date and receipt of the claim at the DDS is 0.7 months on average; thus, the total processing time for initially allowed applicants is 3.6 months. On average total processing time is 13.5 months in our sample. However, there are sizable differences between initially allowed and initially denied applicants: 3.6 months vs. 19.1 months on average. Notably, initially denied applicants who continue their claim through an appeal or reapplication have average total processing times exceeding two years, regardless of the final determination.[18]

Indeed, a central takeaway from Table 1 is that the primary driver of total processing time is whether or not an applicant pursues an appeal. On average, applicants who ultimately receive benefits experience longer processing times (14.5 months) than applicants who do not (11.4 months, as of the end of our followup period).[19] This is because among applicants who are ultimately denied benefits, only about a third participated in the appeals process, as compared with half of those who are ultimately allowed benefits.

## 2 Empirical Strategy

From the time that an SSDI application is filed to the time a final determination is made, an applicant who earns in excess of SGA—approximately $1,000 per month—risks having his or her application denied due to demonstrated work capacity.[20] This incentive structure suggests that many SSDI applicants will reduce labor force participation while awaiting a disability determination, regardless of their work capacity. Does this occur in practice? Figure 1 plots the fraction of denied applicants who were participating in the labor force during each of the six years before and after their *initial*

[17] 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 who are allowed or denied for medical reasons alone receive somewhat faster decisions than applicants who are evaluated using a combination of medical and vocational criteria (see Table A-1, Panel A). Medical reasons include a disability that meets or equals the listing of impairments or, alternatively, a disability that is judged non-severe or "obviously" temporary, meaning unlikely to last longer than 12 months.

[18] Table A-1, Panel B presents descriptive statistics on cumulative processing time by the last observed level of administrative review.

[19] Note this is slightly *underestimated* for the finally denied, since we do not observe denials at higher levels of the appeals process.

[20] An exception is when work during the five-month waiting period qualifies as an unsuccessful work attempt.

decision in 2005.[21] 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 applicant appeals: applicants who do not appeal their initial denial or whose appeal moves exceptionally fast 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 in the years *prior* to SSDI application, coincident with the onset of disability. Consistent with SSDI program incentives, employment trajectories of applicants vary systematically with their final decision dates. Applicants whose final decision year coincides with their initial denial year of 2005 exhibit an 11 point rebound in employment above SGA between 2005 and 2006. Those whose final decision date occurs a year later in 2006 regain only 4.4 points of employment above SGA between 2005 and 2006—prior to their final decision—and then 10 points in the year thereafter. Applicants who obtain a final decision in 2007 gain approximately one to three points per year between 2005 and 2007 and then nearly six points in the year immediately thereafter.[22] This figure documents that applicants curtail labor force participation while awaiting SSDI determinations, and further suggests that longer application waiting times will tend to extend time spent out of the labor force among some SSDI applicants. This motivates our empirical strategy of exploiting exogenous variation in SSDI examiner processing speeds to test whether longer time out of the labor force during SSDI application depresses the post-decision employment and earnings of SSDI applicants.

[21] We focus on ultimately denied applicants to avoid confounding post-decision employment rates with SSDI receipt/work disincentives.

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

Figure 1: Employment at Substantial Gainful Activity (SGA) Before and After Initial Decision, Denied Claimants, by Year of Last Observed Decision


Notes: Dotted lines represent time after last observed decision. Source: DIODS data, initial decisions made in 2005.

## 2.1 Model and assumptions

To estimate the causal effects of SSDI waiting time and SSDI receipt on the labor supply of SSDI applicants, we employ the following heterogeneous treatment effects framework:

$$Y_i = X_i\beta + \gamma_i D_i + \delta_i T_i + \varepsilon_i. \tag{1}$$

Here, $Y_i$ is the observed labor supply of applicant $i$ measured at some point after the initial determination, $X_i$ is a vector of observed individual characteristics that influence labor supply (e.g., age, impairment type), $D_i$ 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, and $\varepsilon_i$ captures unobserved factors affecting labor supply. The causal parameters of interest are $\gamma_i$ and $\delta_i$, 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.[23] The combined effect of SSDI operating through these two causal channels for applicant $i$ is $\gamma_i + \delta_i T_i$ if allowed and $\delta_i T_i$ if denied. Because many applications 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 on outcomes three and six years after the initial decision (2008 and 2011) as our preferred estimates of the short and long run effects of SSDI application processing times and benefit receipt on labor supply.

A key challenge for consistently estimating the effects of SSDI receipt and application processing time on labor supply is that unobserved components in $\varepsilon_i$ such as impairment severity or preferences for work 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 receive a decision at an earlier decision step (i.e., based on the medical listing criteria) than applicants with less severe impairments. To overcome these confounds, we build upon the empirical strategy used by Maestas, Mullen and Strand (2013, MMS hereafter) to estimate the effects of SSDI benefit receipt on labor supply. MMS show that the DDS examiners to whom SSDI applicants are conditionally randomly assigned cases differ in the implicit thresholds they use when evaluating the severity of a disability. Taking this approach one step further, we exploit the fact that DDS examiners also vary in the speed at which they process disability applications. 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 application processing time that is uncorrelated with unobserved applicant characteristics, such as impairment severity and labor force attachment.

This variation can be used to identify the causal effects of SSDI receipt and total processing time under plausible assumptions that we spell out here. We denote decisions, appeals, and waiting times as:

$$D_i = D_{1i} + (1 - D_{1i}) A_i D_{2i} \tag{2}$$

$$T_i = T_{1i} + (1 - D_{1i}) A_i T_{2i} \tag{3}$$

where $D_{1i}$ is the initial decision, $A_i$ is an indicator of whether applicant $i$ appeals the initial decision, $D_{2i}$ is the decision on appeal, $T_{1i}$ is initial processing time, and $T_{2i}$ is the incremental processing time from pursuing an appeal. These equations recognize the asymmetry of the appeals process: appeals occur only in the event of denial and not in the event of allowance.

Assume that we have a set of instruments $Z_i = (Z_i', Z_i'')$ where $Z_i' \in \{0, 1\}$ denotes leniency (0 =strict; 1 =lenient) and $Z_i'' \in \{0, 1\}$ denotes speed (0 =fast; 1 =slow) of the initial examiner

[23] Since our outcome variable $Y_i$ captures earnings or employment following completion of the SSDI application process for nearly all applicants, $\delta_i$ 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.

assigned to applicant $i$'s case.[24] Leniency and speed may be correlated with one another (though in practice, they are not). Suppose the initial allowance decision is only causally affected by $Z_i'$ (leniency, not speed—although speed could affect SSDI receipt through other channels), and initial processing time is only causally affected by $Z_i''$ (speed, not leniency—though ultimate processing time could depend upon leniency through other channels). Let $D_{1i}^{z'}$ denote the initial allowance decision for applicant $i$ assigned to an examiner with leniency $Z_i' = z'$, where $D_{1i}^1 \geq D_{1i}^0 \ \forall i$. Similarly, let $T_{1i}^{z''}$ denote the initial allowance decision time for applicant $i$ assigned to an examiner with speed $Z_i'' = z''$, where $T_{1i}^1 \geq T_{1i}^0 \ \forall i$. Let $D_i^{z'z''}$ denote final allowance in the case where $Z_i' = z'$ and $Z_i'' = z''$, and the same for final processing time $T_i^{z'z''}$.

Imbens and Angrist (1994) show that instrumental variables estimators recover local average treatment effects (LATEs) under the following assumptions: independence, exclusion, first stage and monotonicity. The first three assumptions are fairly innocuous in our setting and we present empirical support for them in the next subsection. Independence follows from conditional random assignment of examiners to applicants. Exclusion follows from our causal outcome equation (1) which implies that the only causal channels through which examiner assignment can affect labor supply are SSDI receipt and total processing time. The assumption of a first stage is supported by evidence below that examiner leniency and speed strongly affect the likelihood of SSDI receipt and final processing time.

In contrast, the complexity of our setting—specifically, the fact that denied applicants can appeal their decisions—entails additional monotonicity assumptions beyond those typically invoked. If there were no appeals process—and therefore the initial allowance decision and ultimate SSDI receipt were one and the same, and initial and final processing times were identical accordingly—these monotonicity assumptions would be the standard ones. That is, an applicant allowed by a strict examiner would also be allowed by a lenient examiner, and an applicant denied by a lenient examiner would also be denied by a strict examiner;[25] and similarly, an applicant assigned to a slow examiner would receive a quicker determination if assigned to a fast examiner, and an applicant assigned to a fast examiner would receive a slower determination if assigned to a slow examiner.

Because initial examiner speed and leniency may affect not only initial processing time and allowance decisions but also final (downstream) processing time and allowance decisions, we must invoke the following additional assumptions to guarantee that monotonicity holds downstream of the initial causal effects of examiner speed and leniency on initial waiting time and allowance outcomes:

(A1) $\Pr\left(A_i = 1 | D_{1i} = 0, T_{1i}, Z_i\right) = \Pr\left(A_i = 1 | D_{1i} = 0, T_{1i}\right)$

(A2) $\Pr\left(D_{2i} = 1 | D_{1i} = 0, T_{1i}, Z_i\right) = \Pr\left(D_{2i} = 1 | D_{1i} = 0, T_{1i}\right)$

(A3) $E\left[T_{2i} | D_{1i} = 0, T_{1i}, Z_i\right] = E\left[T_{2i} | D_{1i} = 0, T_{1i})\right]$

(A4) $\partial \Pr\left(A_i = 1 | D_{1i} = 0, T_{1i}\right) / \partial T_{1i} \geq 0$

Assumptions $A1 - A3$ imply that, conditional on initial denial and initial processing time, exam-

[24] For ease of exposition we present our discussion using binary instruments; in the continuous instrument case, 0 and 1 correspond to the minimum and maximum leniency/speed observed among the set of examiners.

[25] A violation of this assumption could occur if examiners differ in how *accurately* they estimate the severity of applicants' disabilities. In this case differences in examiners' implicit thresholds do not fully capture differences in how they evaluate applications.

iner characteristics (speed, leniency) do not otherwise affect: ($A1$) the probability that an applicant appeals; ($A2$) the probability the initial decision is overturned; or ($A3$) the length of additional processing time in the event of appeal. A violation of $A1$ would occur, for example, if applicants *knew* they were assigned a strict or lenient (or fast or slow) examiner and factored this information—in addition to their actual initial allowance decision and waiting time—into their decision to appeal. Similarly, a violation of $A2$ or $A3$ would occur if, for example, ALJs factored the identities or characteristics of initial examiners (average leniency, average processing speed) into their own allowance decisions or speed during the appeal.[26] We show in Appendix A that conditions $A1 - A3$ are sufficient to guarantee that examiner leniency monotonically increases the probability of an allowance and monotonically reduces cumulative processing time. Formally, $D_i^{1z''} \geq D_i^{0z''}$ and $T_i^{1z''} \leq T_i^{0z''}$ $\forall i, \forall z''$.

A final condition needed for identification is that examiner-induced variation in waiting times does not induce a violation of the monotonicity condition for allowances; that is, assignment to a slow examiner should not *decrease* the probability of an allowance. Assumption $A4$ provides a sufficient condition for requirement, stipulating that the probability of appeal is non-decreasing in initial examiner time (an assumption that is supported by the data, as we show below). In combination, assumptions $A1 - A4$ guarantee that $T_i^{z'1} \geq T_i^{z'0}$ and $D_i^{z'1} \geq D_i^{z'0}$ $\forall i, \forall z'$, that is, assignment to a slower examiner weakly increases both total processing time and the probability of an SSDI allowance.

## 2.2 Verifying the research design

To measure examiner processing speed, we construct a jackknife instrumental variable, $EXTIME_{j(i)}$, which measures the average initial processing time of the examiner $j$ to which applicant $i$ is randomly assigned, excluding applicant $i$'s own processing time:[27]

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

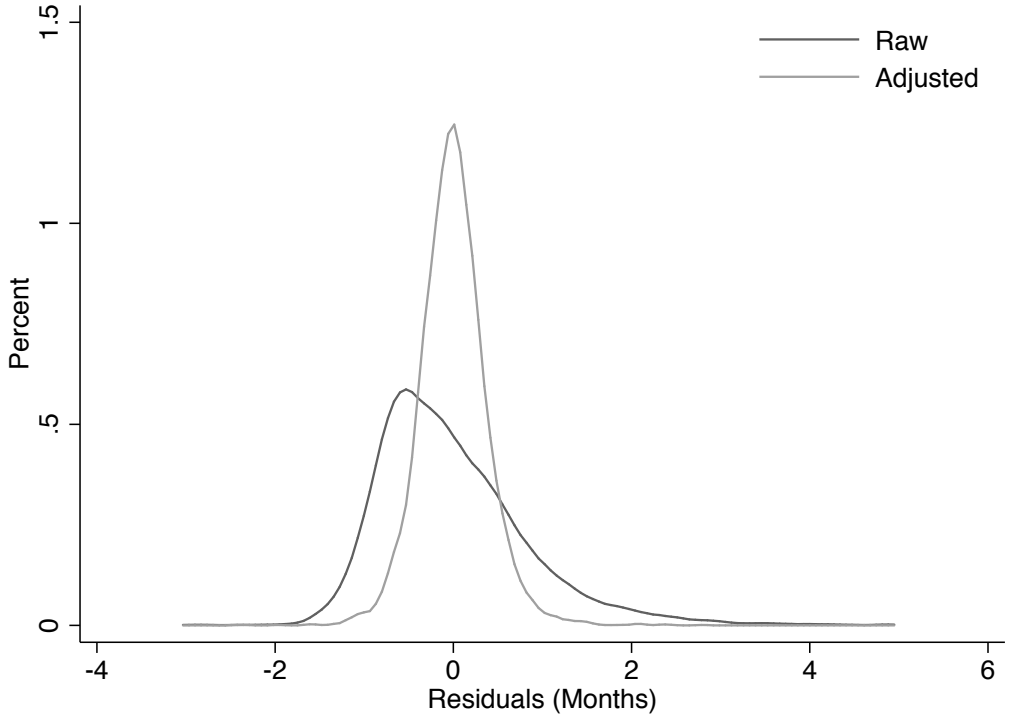
where our construction of $EXTIME_{j(i)}$ parallels the construction of the measure of examiner allowance propensity in MMS, which is equal to the (jackknifed) examiner allowance propensity, $EXALLOW_{j(i)}$, for the examiner to which an applicant is assigned. To assess the variation in examiner processing time, we plot in Figure 2 the distribution of $EXTIME_{j(i)}$ 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 0.9 months to 0.4 months, but there is still significant variation in average processing times across examiners within the same

[26] For example, a judge considering the appeal of an applicant denied by a known strict examiner could be more likely to overturn the initial denial than if the same applicant were denied by a known lenient examiner.

[27] We construct $EXTIME$ using processing time at the DDS office, excluding the time it takes an application to be transmitted from the field office to the state DDS office upon filing.

DDS office (adjusted coefficient of variation of 0.13).[28] Figure 3 plots our measure of examiner speed $EXTIME$ against the measure of examiner allowance propensity $EXALLOW$ from MMS. After adjusting for case mix, these two attributes of examiner screening—allowance propensity and processing speed—are essentially uncorrelated ($\rho = 0.016$).

Figure 2: Distribution of Examiner Times (Minus Grand Mean): Raw and Adjusted for Caseload Characteristics




Source: 2005 DIODS data. Examiners with $\geq$ 10 decisions. Caseload characteristics include DDS, geography, body system code, age, pre-onset earnings, concurrent stats, and terminal illness diagnosis.

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 field offices use priority processing flags (primarily terminal illnesses in our sample period), which the DDS agencies may use to assign cases to specialty units; we exclude cases flagged for priority processing from our sample. Furthermore, some DDS offices assign cases based on broad body systems (mental,

[28] We make 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, month of receipt at DDS, age group, average pre-onset earnings and concurrent application status) and plot the residuals from this regression.

musculoskeletal, etc.) or common health conditions (e.g., anxiety disorders, back disorders) to new examiners in training. Conditional random assignment of applicants to DDS examiners ensures that after controlling for assignment variables (including month of application receipt), individual case characteristics are not correlated with examiner processing speed. Hence, $EXTIME$ should provide an estimate of examiner-specific processing speed that is independent of the set of the cases that the examiner is assigned.

To verify that the data are consistent with random assignment of applicants to case examiners within DDS offices, Table A-2 presents the results of balance tests in which we regress the examiner instruments $EXALLOW$ (average allowance propensity) and $EXTIME$ (average processing time) on observable applicant characteristics that are *not* used for case assignment—specifically, age and prior earnings—both with and without assignment variables included as controls (i.e., body system codes, top 20 diagnosis codes, month of receipt at DDS, concurrent status and 3-digit zip codes). We test earnings six to nine years prior to the initial decision to avoid potentially confounding earnings with onset date, which may be used by the DDS 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 no longer predict examiner characteristics. Conditional random assignment (or independence of instruments and potential outcomes) is sufficient for a causal interpretation of the reduced form estimates of the effects of examiner speed and leniency on applicants' labor supply outcomes.

Our instrumental variables setup requires a set of exclusion restrictions discussed above. For $EXTIME$ and $EXALLOW$ to be valid instruments for decision time and SSDI receipt, they must be orthogonal to other factors affecting labor supply (assumptions $A1$ and $A2$). Table A-3 presents a series of overidentification tests of the causal pathways through which examiners affect applicants' employment rates in years three and six following the initial determination.[29] We reject examiner speed as the sole causal pathway (column 2) but do not reject ($p > 0.05$) the combination of examiner speed and allowance propensity as the sole pathways for all applicants (column 3). 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. For initially allowed applicants, we do not reject examiner speed as the sole causal pathway (column 4), a point to which we return below.[30]

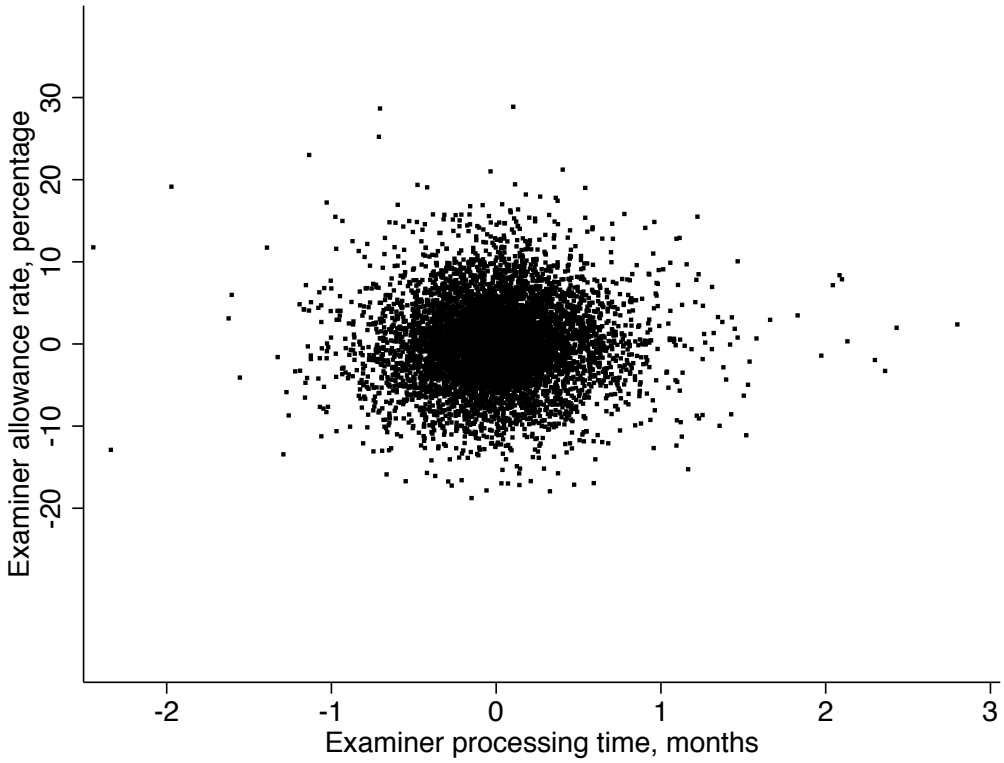
[29] Specifically we compute the following test statistic:

$$\frac{RSS_R - RSS_U}{J - M} \times \frac{N - J}{RSS_U} \overset{H_0}{\sim} F(J - M, N - J) \tag{4}$$

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 (see Davidson and MacKinnon, 2003, section 8.6.)

[30] For completeness, we present overidentification tests for examiner leniency as the sole causal pathway (column 1). Note that we fail to reject the hypothesis that examiner leniency is the sole causal pathway through which examiner assignment affects applicants' subsequent labor supply.

Figure 3: Scatter Plot of Residualized Examiner Allowance Rates vs. Residualized Examiner Waiting Times




Source: 2005 DIODS data. Examiners with $\geq$ 10 decisions. Caseload characteristics include DDS, geography, body system code, age, pre-onset earnings, concurrent stats, and terminal illness diagnosis.

The third key assumption is the presence of a first stage; that is, examiner speed and leniency causally affect the endogenous regressors of interest, application processing time and SSDI receipt. Table 2 presents first-stage regression estimates of the effects of $EXTIME$ and $EXALLOW$ on initial and final time to decision, and SSDI receipt, respectively, in columns 1–3, for the full sample of SSDI applicants. Column 4 presents estimates of the effect of $EXTIME$ on (initial or final) processing time separately for initially allowed applicants. We display the coefficients obtained under three different specifications. The first specification is an OLS regression specification with no controls (Panel A). The second includes the assignment variables (Panel B). The third specification in Panel C further adds applicant characteristics (i.e., age and pre-disability earnings). This specification doubles as an additional randomization check: if the coefficients on $EXTIME$ and $EXALLOW$ are statistically unchanged upon the inclusion of individual characteristics, then the assumption of conditional random assignment is supported.

Table 2: First Stage Regressions of SSDI Receipt and Time to Decision on Examiner's Allowance Propensity Average Processing Time

| | All Applicants | | | Initially Allowed |
|---|---|---|---|---|
| | Initial Time | Final Time | SSDI Receipt | Final Time |
| | (1) | (2) | (3) | (4) |
| | | A. Without Covariates | | |
| EXTIME | 0.956 ** | 1.279 ** | 0.009 ** | 0.902 ** |
| | (0.005) | (0.031) | (0.001) | (0.008) |
| EXALLOW | 0.147 ** | -20.12 ** | 0.326 ** | |
| | (0.034) | (0.243) | (0.008) | |
| $R^2$ | 0.130 | 0.020 | 0.006 | 0.105 |
| | | B. Plus Assignment Variables | | |
| EXTIME | 0.635 ** | 0.484 ** | 0.002 ~ | 0.569 ** |
| | (0.009) | (0.031) | (0.001) | (0.011) |
| EXALLOW | 0.421 ** | -6.219 ** | 0.152 ** | |
| | (0.054) | (0.292) | (0.010) | |
| $R^2$ | 0.276 | 0.089 | 0.099 | 0.292 |
| | | C. Plus Individual Characteristics | | |
| EXTIME | 0.635 ** | 0.492 ** | 0.001 | 0.569 ** |
| | (0.008) | (0.030) | (0.001) | (0.011) |
| EXALLOW | 0.425 ** | -6.087 ** | 0.148 ** | |
| | (0.054) | (0.286) | (0.009) | |
| $R^2$ | 0.278 | 0.129 | 0.155 | 0.294 |
| N | 1,009,382 | 1,009,382 | 1,009,382 | 361,169 |

Notes: See text for definitions of assignment variables and individual characteristics. ** p<0.01, * p<0.05, ~ p<0.1

The first column presents a regression of time from filing until initial decision on $EXTIME$ and $EXALLOW$ for the full sample. Without covariates, the coefficient on $EXTIME$ is 0.956, 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 0.635 when we include the necessary assignment variables and remains unchanged once we add applicant characteristics, indicating that $EXTIME$ is indeed uncorrelated with applicant characteristics, conditional on assignment variables.

Column 2 shows that $EXTIME$ is moderately less predictive of final time than initial time,

[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.

where final time corresponds to time from filing to the final (observed) decision, including appeals or reapplication. Nevertheless the first stage coefficient of 0.492 is statistically significant, with an Angrist-Pischke multivariate F-statistic of 321, which indicates a strong first stage (Angrist and Pischke, 2009, pp. 217-18). 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 six 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 of 164). Consistent with the fact that examiner speed and allowance propensity are uncorrelated with one another, applicants assigned to slower examiners are not any more or less likely to receive SSDI benefits.[32]

One initially puzzling feature of the Table 2 estimates is that although $EXTIME$ and $EXALLOW$ are uncorrelated, the coefficient on $EXALLOW$ is statistically significant and positive in the column 1 models for initial time—suggesting that assignment to a more lenient examiner increases initial waiting time. The genesis of this pattern is a form of finite sample bias discussed in Guryan, Kroft and Notowidigdo (2009). Because $EXTIME$ and $EXALLOW$ are calculated as jackknifed means, the error term in the column 1 model for initial processing time is informative about an applicant's health relative to the other applicants assigned to the same examiner. Specifically, because all else equal, applicants who are sicker are processed more rapidly, an applicant whose observed processing time is unexpectedly high given $EXTIME$ is likely healthier than the average of *other* applicants assigned to the same examiner. This in turn implies that the applicant's processing time residual will be correlated with $EXALLOW$: if an individual applicant is healthier than the average of other applicants' assigned to the same examiner, then that applicant's residual processing time will typically be *positively* correlated with his examiner's leave-out allowance rate, reflecting the worse average health of *other* applicants assigned to the same examiner. This error correlation asymptotically disappears as the number of cases assigned to each examiner grows, causing the jackknifed mean to converge to the population mean. We have also verified in our data that the error correlation is eliminated if we use a non-jackknifed value of $EXALLOW$ or, alternatively, calculate $EXALLOW$ using a split sample. We prefer the approach used in Table 2 because this maximizes power without affecting inference.

Finally, as discussed in Section 2.1, a set of monotonicity assumptions is required for our IV strategy to identify the local average treatment effects of SSDI receipt and total processing time on applicants' post-decision labor supply outcomes. Specifically, we require assumptions $A1-A3$, which

[32]The Table 2 coefficient of 0.148 on $EXALLOW$ is smaller than the analogous coefficient of 0.204 in MMS (Table 2, column 6). This is due primarily to the inclusion here of applicants known to have died after the initial decision. We include these applicants to address the differential reporting of deaths for beneficiaries and non-beneficiaries. Distinct from MMS, we are also now able to directly observe (as opposed to having to impute) and exclude TERI cases, and we added indicators for the top 20 diagnosis codes to account for a finer level of case assignment to trainee examiners. Finally, 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.

state that examiner speed and leniency do not factor into applicants' downstream decisions to appeal (conditional on initial denial) or into subsequent adjudicators' allowance rates or processing times; and assumption $A4$, that initial processing time weakly positively affects the probability of appeal. Although assumptions $A1 - A3$ are fundamentally untestable,[33] we provide empirical support for A4.[34] Table 3 presents reduced form estimates of the effect of examiner speed on the probability of initial denial (column 1) and the probability an applicants appeals conditional on initial denial (column 2). Both estimates are extremely small in magnitude and statistically insignificant. Since examiner speed is a valid instrument for initial processing time, this suggests that, consistent with A4, initial processing time does not (negatively) affect applicants' appeal decisions.

Table 3: Estimated Effect of Examiner Average Processing Time on Initial Determination and Appeal Rate (OLS Models)

| | Initial Denial (1) | Continue Claim After Denial (2) | Receive Benefit (3) |
|---|---|---|---|
| EXTIME | -0.0011 | -0.0004 | -0.0006 |
| | (0.0019) | (0.0011) | (0.0011) |
| Mean dep. variable | 0.642 | 0.638 | 0.688 |
| $R^2$ | 0.289 | 0.076 | 0.154 |
| N | 1,009,382 | 648,213 | 1,009,382 |

Notes: ** p<0.01, * p<0.05, ~ p<0.1

## 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 allowance decision (Table 3), we can test for a delay-decay effect of the application process on SSDI beneficiaries who were initially allowed without introducing sample selection bias. In addition, because initial processing time is identically equal to final processing time for the initially allowed, we do not need

[33] For example, regarding $A2$, empirically we observe that applicants denied by strict examiners are more likely to be allowed on appeal than applicants denied by lenient examiners, but this likely reflects differences in average unobserved severity.

[34] As a face validity test of the assumptions that cases processed by "fast" examiners would take longer if processed by "slow" examiners, we regressed time to decision on variants of EXTIME and EXALLOW that were constructed using all cases assigned to the examiner except those of the same body system type. These estimates (not shown) confirm that processing speed has a strong examiner-specific component.

monotonicity assumptions A1-A4 as we do in our main model with "upstream" and "downstream" treatment variables (initial and final processing time, respectively). Furthermore, as discussed in Section 1, the fact that SSA observes death reports with greater accuracy for SSDI beneficiaries than for non-beneficiaries complicates the use of death information in the full sample. However, since the deaths of initially allowed claimants are observed with the same high level of accuracy, we can restrict the initially allowed sample to applicants who survive through the end of the calendar year to ensure their earnings record represents a full year of potential work. 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 five-month waiting period allows us to implement an informative falsification test of our identification strategy.

### 3.1 The effect of processing time for the initially allowed

Table 4, Panel A, presents OLS estimates of the effect of processing time on the employment and earnings of the initially allowed, measured at three and six years following their initial decision in 2005, respectively. The OLS estimates in columns 1 through 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 0.20 points (2.1 percent), a reduction in employment above SGA of 0.14 points (4.4 percent), and a reduction in annual earnings of 61 (4.2 percent) three years later. This association persists through at least six years after the decision (columns 4–6). These associations should not be taken as causal since, as discussed above, it is plausible that applicants with the most severe health impairments are allowed more quickly by DDS examiners because their impairments meet the 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).

Table 4: OLS, Reduced Form and Two-Stage Least Squares Estimates of Effect of Examiner Assignment on Labor Supply Outcomes of Initially Allowed Applicants

| | Three Years Later (2008) | | | Six Years Later (2011) | | |
|---|---|---|---|---|---|---|
| | 100 × [Earn ≥ $1K] (1) | 100 × [Earn ≥ SGA] (2) | $ Earnings (1,000s) (3) | 100 × [Earn ≥ $1K] (4) | 100 × [Earn ≥ SGA] (5) | $ Earnings (1,000s) (6) |
| | | | A. OLS | | | |
| Final time | -0.202 ** | -0.139 ** | -0.061 ** | -0.179 ** | -0.114 ** | -0.052 ** |
| | (0.029) | (0.018) | (0.007) | (0.029) | (0.018) | (0.008) |
| | | | B. Reduced Form | | | |
| EXTIME | -0.233 * | -0.113 ~ | -0.075 * | -0.198 * | -0.118 ~ | -0.054 |
| | (0.103) | (0.069) | (0.033) | (0.100) | (0.068) | (0.033) |
| | | | C. 2SLS | | | |
| Final time | -0.391 * | -0.190 ~ | -0.126 * | -0.332 * | -0.199 ~ | -0.091 |
| | (0.172) | (0.115) | (0.054) | (0.168) | (0.114) | (0.056) |
| Mean dep. variable | 9.68 | 3.36 | 1.47 | 7.49 | 2.74 | 1.22 |

Notes: $N = 302,762$ in 2008 and $N = 277,024$ in 2011. Beneficiaries who die before the end of the calendar year are excluded. ** p<0.01, * p<0.05, ~ p<0.1

Panel B of Table 4 presents reduced form estimates of the effect of examiner processing speed on the employment and earnings of initially allowed applicants. We find that assignment to an examiner whose average application processing time is one month slower predicts a 0.23 point decrease in an initially allowed applicant's likelihood of employment three years after the decision, a 0.11 point decrease in employment above SGA, and a 75 decrease in annual earnings. These effects persist at six years for both any employment and for employment above SGA, but are not significant for annual earnings in year six. Recall that conditional random assignment of applicants to examiners is sufficient for a causal interpretation of the reduced form regressions. Thus, among initially allowed applicants, assignment to a slower examiner leads to lower post-decision employment and earnings. Since all initially allowed applicants receive SSDI benefits, plausibly the only pathway through which examiner speed could affect employment outcomes is through its impact on applicants' time to decision.

Panel C of Table 4 presents the instrumental variables estimates of the impact of processing time on labor supply using the examiner instrument $EXTIME$. We find that an additional month of processing time causes a 0.39 point (4 percent) reduction in employment (column 1), a 0.19 point (5.9 percent) reduction in the probability of engaging in SGA (column 2) and a $126 (8.6 percent) reduction in annual earnings (column 3) three years later. As with the reduced form estimates, these effects persist for any employment and employment above SGA into year six, but become

imprecise for annual earnings (columns 4 through 6). Consistent with the likely bias of the OLS models, the 2SLS estimates are approximately twice as large in magnitude as the corresponding OLS estimates. Extrapolating to an average initial processing time of 3.6 months, the 2SLS estimates imply that employment among SSDI beneficiaries who were allowed at the initial level is 1.4 points (14.5 percent) lower three years after the decision, and 1.2 points (15.9 percent) lower six years after the decision, than would have been the case had they had been able to remain in the labor force during the determination process without jeopardizing the allowance decision. This interpretation relies on our exclusion restriction that processing delays affect post-decision labor supply exclusively by inducing applicants to withdraw from or remain out of the labor force while awaiting a disability determination. We test this interpretation next by asking whether, as implied by our exclusion restriction, processing delays that do *not* increase time out of the labor force leave post-decision labor supply unaffected

### 3.2 Testing the identification strategy using the five-month waiting period

Once a DDS examiner determines an applicant to be medically eligible for SSDI benefits, SSA must verify that the applicant has not performed substantial gainful activity since the established date of disability onset. If this is verified, entitlement to benefit payments begins five months after the onset date, a requirement known as the five-month waiting period. If, however, the applicant did do substantial work at any point after the onset date, the claim can be denied on grounds that the disability was temporary. Once entitlement to benefit payments has begun, however, work above the substantial gainful activity level is permitted under Trial Work Period protections. Thus, while work activity prior to entitlement to benefits can jeopardize a claim, work activity after entitlement is protected and even encouraged. This rule suggests an identification test for our research design: for applicants who are awarded benefits quickly—in fewer than five months from their disability onset date, i.e., before their waiting period has elapsed—examiner speed should have no marginal effect on employment after completion of the remaining waiting period; conversely, for applicants whose waiting time for a decision commences or extends beyond the five-month waiting period, longer waiting times should reduce subsequent employment through the decay effect.

To test whether a delay-decay effect *is* present among applicants awarded benefits after five months but is *not* present among applications awarded benefits within five months, we partition total processing time into two components: time during which examiner delays are non-binding constraints on labor supply (i.e., during the waiting period), and time during which examiner delays are binding constraints (i.e., time after the waiting period but before benefits have been awarded).[35] Figure 4 depicts three possible cases. In the first, 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 is otherwise ineligible to 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

[35]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, only allowed applicants are given an established onset date, which is necessary to compute the length of the waiting period.

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 waiting period has elapsed. This describes another one-quarter of initially allowed applicants. For these applicants, every additional month of examiner processing time results in an additional month in which labor force non-participation is potentially constrained (and in which 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 retroactively 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 the set of applicants who would otherwise work.

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

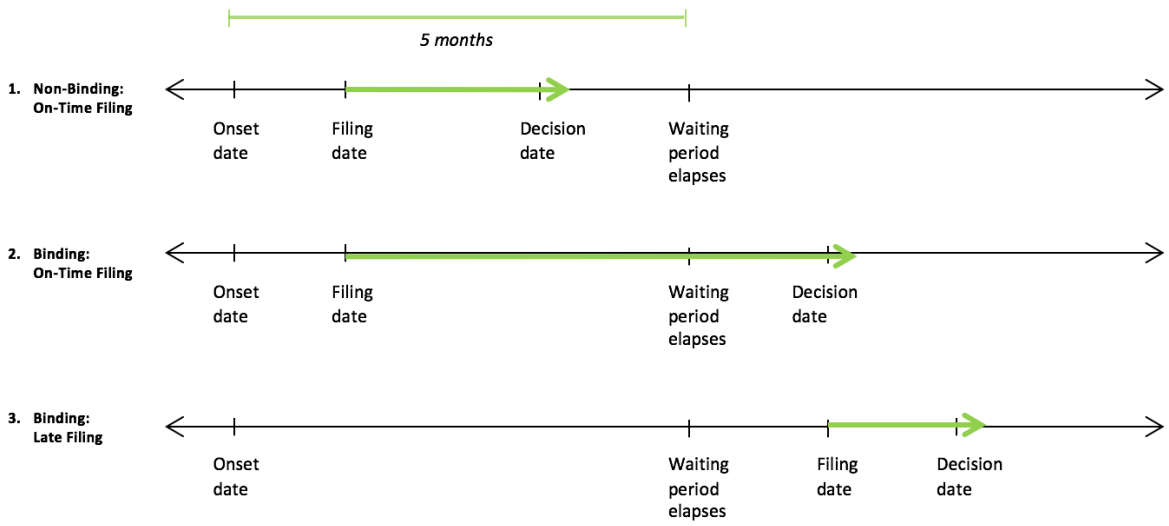
$$Y_i = \delta_0 \min\left[\text{decision\_time}_i, \text{wp}_i\right] + \delta_1 \max\left[\text{decision\_time}_i - \text{wp}_i, 0\right] + s_i + \varepsilon_i, \tag{5}$$

where

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

In equation (5), $\text{decision\_time}_i$, measures total time from disability application to decision, $\text{time\_to\_app}_i$ measures time between disability onset and filing, and $\text{wp}_i$ measures how much of the five-month waiting period has elapsed prior to $i's$ filing date.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 in most cases precedes the filing date, the function $\text{wp}_i$ 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 within 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 extends beyond the waiting period may adversely affect post-decision employment (hence $\delta_1 < 0$).

Figure 4: Examples of Binding and Non-Binding Processing Time




Notes: This figure shows the hypothetical interaction between processing time and filing date relative to onset of disability in determining whether processing time constrains applicants' labor force participation (if desired) beyond the five month waiting period from onset to benefits eligibility. In the first sequence, the claimant files for SSDI application shortly after onset and receives a determination within five months of onset. Here, because the five month waiting period expires subsequent to the DDS determination, waiting time does not constrain labor force participation. In the second sequence, the applicant files shortly after disability onset but does not receive a determination until after five months have elapsed; here, wait time is binding. In the final sequence, the applicant files for SSDI more than five months following disability onset, so processing time is necessarily binding.

In partitioning processing time as done in equation (5), we impose a nonlinearity in our endogenous regressor $T_i$, which complicates instrumental variables estimation. We accordingly implement a control function approach (Heckman and Robb, 1985). To account for the endogenous component of decision_time$_i$, we include in (5) the residuals from our first stage regression of total processing time on $EXTIME_{j(i)}$ (obtained from Table 2, column 4, Panel C).[36] 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.[37] Conditional on these two control variables (i.e., the first stage residual and time to application), processing time before and after the elapsed waiting period is uncorrelated with the error term, and the control function estimator produces unbiased estimates of the (nonlinear) effect of processing time on post-determination employment of initially allowed applicants.

Table 5 reports the estimated effect of examiner processing time that occurs before and after the waiting period on applicants' subsequent labor supply—here, measured as the probability of

[36] Dhrymes (1970) showed that including the first stage residual as a control variable in the second stage regression is equivalent to implementing two-stage least squares.

[37] Mean time from onset to application filing is 7.83 months, with a standard deviation of 10.55.

earning in excess of $\$1K$—using the control function specification. Consistent with the implications of our identification strategy, additional processing time *before* the waiting period has fully elapsed causes no incremental reduction in employment three or six years after the initial decision. In sharp contrast, an additional month of processing that occurs after the applicant has satisfied the waiting period causes a 0.46 point reduction in the probability of employment three years later, and this effect remains significant and nearly as large ($\hat{\beta} = -0.37$) in year six. 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 initially allowed applicants in Table 4 averages the null effect $\delta_0$ for the unconstrained group with the somewhat larger effect $\delta_1$ for the constrained group.

Table 5: Effect of Time to Decision on Employment Before vs. After Waiting Period (WP) Has Elapsed for Initially Allowed Applicants, Control Function Estimates
Dependent Variable: $100 \times$ [Earn $\geq \$1K$]

| | 3 Years Later (2008) (1) | 6 Years Later (2011) (2) |
|---|---|---|
| Time Before WP | -0.069 | -0.148 |
| | (0.181) | (0.179) |
| Time After WP | -0.461 ** | -0.372 * |
| | (0.172) | (0.175) |
| Elapsed time onset to filing | -0.098 ** | -0.078 ** |
| | (0.001) | (0.006) |
| Residual from first stage | 0.170 | 0.140 |
| | (0.172) | (0.177) |
| Mean dep. variable | 9.68 | 7.49 |
| $R^2$ | 0.057 | 0.054 |
| N | 302,762 | 277,024 |

Notes: See text for details of estimation. Standard errors calculated by bootstrap clustered on examiner (S=200). ** p<0.01, * p<0.05, ~ p<0.1

### 3.3 The effect of processing time on the full population of applicants

We now broaden the inquiry to incorporate the full population of SSDI applicants by including those initially denied. Recall from Section 1 that SSA is more likely to observe a death report for an SSDI beneficiary than for a non-beneficiary, complicating the use of the death data in the

full sample. To mitigate potential bias arising from this differential reporting, we estimate the effects of examiner assignment on the labor supply outcomes of the full population of applicants, including those known not to survive through the follow-up period. In this expanded population, an observation of zero earnings may reflect either non-employment status or deceased status. The inclusion of potentially deceased SSDI applicants should not bias our point estimates—applicant mortality should be independent of examiner assignment—but it does change their interpretation. Because the treatment effect of processing delay on subsequent employment of deceased applicants is necessarily zero, including these applicants in the sample will both dampen the estimated causal effect of processing delays and will reduce statistical power.[38]

Panel A of Table 6 presents reduced form estimates of the effects of examiner speed and leniency on the employment and earnings of all SSDI applicants during years three and six following the initial decision. Consistent with the reduced form regressions estimated on initially allowed applicants only, we find that assignment to an examiner whose average application processing time is one month slower predicts a 0.20 point (0.9 percent) decrease in the likelihood of employment three years after the initial decision, a 0.12 point (1 percent) decrease in employment above SGA, and a $38 (1 percent) decrease in annual earnings. Unlike the findings for initially allowed applicants, the estimated effects of examiner processing speed largely fade out by year six after the initial decision. Consistent with Maestas, Mullen and Strand (2013) and French and Song (2014), we find that examiner leniency has strong and persistent effects on applicants' post-decision labor supply. Assignment to the most lenient examiner—as compared to the strictest examiner—causes a 4.9 point (22 percent) reduction in employment three years after the initial decision, as well as a 3.5 point (30 percent) reduction in employment above SGA and $816 (22 percent) reduction in annual earnings.

Conditional random assignment of applicants to examiners is sufficient, as above, for a causal interpretation of the reduced form regressions of the effect of examiner assignment on applicants' post-decision labor supply outcomes. However, since examiner leniency affects both SSDI receipt *and* total processing time (due to the appeals process; see Table 2), the reduced form estimates cannot simply be scaled by the first stage estimates to obtain the 2SLS estimates of the causal effects of application processing time and SSDI receipt on labor supply outcomes of all applicants. (We discuss the relationship between the reduced form and 2SLS estimates of SSDI receipt in further detail in Section 4.)

[38]The dampening of the point estimates stems from the difference in the average treatment effect for the full population (living and deceased applicants) and the subpopulation of living applicants.

Table 6: Reduced Form and Two-Stage Least Squares Estimates of Effect of Examiner Assignment on Labor Supply Outcomes of All Applicants

| | Three Years Later (2008) | | | Six Years Later (2011) | | |
|---|---|---|---|---|---|---|
| | 100 × [Earn ≥ $1K] | 100 × [Earn ≥ SGA] | $ Earnings (1,000s) | 100 × [Earn ≥ $1K] | 100 × [Earn ≥ SGA] | $ Earnings (1,000s) |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | | | A. Reduced Form | | | |
| EXTIME | -0.202 ** | -0.116 ~ | -0.038 ~ | -0.086 | -0.083 ~ | -0.031 ~ |
| | (0.074) | (0.060) | (0.021) | (0.065) | (0.050) | (0.019) |
| EXALLOW | -4.86 ** | -3.46 ** | -0.82 ** | -3.23 ** | -2.23 ** | -0.58 ** |
| | (0.64) | (0.49) | (0.18) | (0.55) | (0.42) | (0.17) |
| | | | B. 2SLS | | | |
| Final time | -0.314 * | -0.171 | -0.061 | -0.118 | -0.126 | -0.051 |
| | (0.132) | (0.105) | (0.037) | (0.113) | (0.088) | (0.033) |
| SSDI receipt | -45.60 ** | -30.30 ** | -8.00 ** | -26.50 ** | -20.20 ** | -5.95 ** |
| | (6.92) | (5.55) | (1.90) | (5.94) | (4.67) | (1.71) |
| Mean dep. variable | 22.37 | 11.45 | 3.76 | 16.95 | 8.99 | 3.06 |

Notes: Sample includes non-survivors. $N = 1,009,382$ in both years. ** p<0.01, * p<0.05, ~ p<0.1

We present our main instrumental variables estimates of equation (1) for employment and earnings outcomes at three and six years following the initial decision in Panel B of Table 6. We estimate that each additional month of processing time reduces the probability of earnings exceeding $1,000 among SSDI applicants by 0.31 points in the third year following the initial determination (column 1, Panel B). How large is this effect? Noting that processing time averages 13.5 months across all applicants, this estimate implies that processing delays reduce employment by 4.2 points on average. Relative to observed employment, this effect is economically significant. Because only 22 percent of SSDI applicants earn $1,000 or more, an average processing delay of 13.5 months reduces subsequent employment of SSDI applicants by an estimated 19 percent. By year six, however, this employment effect attenuates to around one-third of its previous level and is not statistically significant.

Comparing the estimates for the full sample of applicants in Table 6 with those for initially allowed applicants in Table 4 yields two surprising results: first, the short-run effect of processing time on employment and working above SGA in the *full* sample of applicants (initially allowed and initially denied) is comparable to the effect for the *subsample* of initially allowed applicants; and second, while the employment effect of initial delay persists through year six for the initially allowed subsample, it fades out in the full sample. Since denied applicants' incentives to participate in the labor force are not constrained by SSDI program rules (after denial), one might expect the magnitude and persistence of the delay-decay channel to be larger for the full applicant population—incorporating denied applicants—than for the initially allowed subpopulation. What explains

this unexpected pattern?

We hypothesize that the source is systematic differences in labor force attachment between applicants who are initially allowed and the full sample of applicants, many of whom are allowed or denied after long appeals. Specifically, comparing applicants who are initially allowed to those initially denied in Table 1, the former group (initially allowed) has a substantially higher rate of positive earnings (85% versus 75%), rate of SGA attainment (68% versus 51%), and average annual earnings ($\$30.1K$ versus $\$20.5K$) in year six prior to SSDI application. By contrast, those initially denied—and even more so those finally denied—have weaker earnings histories, are more likely to be claiming SSDI and SSI simultaneously (indicating poverty), and have far higher prevalence of musculoskeletal impairments (which are generally associated with cases that are difficult to verify medically). Given that initially denied applicants typically have relatively weak pre-application labor force attachment, these observations suggest that the potential for processing delays to impact their subsequent employment may be limited.

We explore this hypothesis by estimating the main instrumental variables models for post-determination earnings separately for applicants whose pre-onset earnings are below versus above the median of those in their application cohort. To measure pre-onset earnings, we use earnings in year six prior to application because, as shown in Maestas, Mullen and Strand (2013), employment rates of eventual SSDI applicants decline steeply in the five years prior to application (see Figure 2 of MMS).[39] Descriptive statistics for these subpopulations (reported in Appendix Table A-5) reveal that those with high pre-onset earnings are more likely to be initially allowed (44% versus 28%), more likely to continue a claim conditional on an initial denial (70% versus 59%), and more likely to receive an allowance conditional on continuing a claim (77% versus 63%), than are applicants with low pre-onset earnings. This is consistent with high pre-onset earners having disabilities with greater average severity. But, conditional on final *denial*, those with high pre-onset earnings have far higher earnings, employment rates, and rates of SGA attainment six years later than those with low pre-onset earnings. This suggests that SSDI applicants with relatively high pre-onset earnings may have greater residual labor force attachment and earnings capacity.[40]

[39] In a separate paper, Maestas, Mullen and Strand (2015) show that the time from self-reported onset of disability to SSDI application filing is typically less than a year.

[40] These conditional comparisons are, of course, merely suggestive because the characteristics of allowed and denied applicants differ both within and across prior-earnings groups. Our instrumental variables estimates help to resolve this selection problem for the population of compliers to the instruments.

Table 7: Two-Stage Least Squares Estimates of Effect of Processing Time and SSDI Award on Positive Annual Earnings (>$1K) in Years Following Application, by Below-Median and Above-Median Pre-Onset Earnings
Dependent Variable: $100 \times [\text{Earn} \geq \$1K]$

| | Three Years Later (2008) | | Six Years Later (2011) | |
|---|---|---|---|---|
| | Below-Median Earnings (1) | Above-Median Earnings (2) | Below-Median Earnings (5) | Above-Median Earnings (6) |
| | | A. Initially Allowed Applicants | | |
| Final time | -0.472 | -0.337 | -0.394 | -0.212 |
| | (0.289) | (0.216) | (0.255) | (0.193) |
| Mean Dep. Variable | 12.64 | 10.61 | 9.86 | 8.33 |
| | | B. All Applicants | | |
| Final time | -0.191 | -0.449 ** | 0.120 | -0.378 * |
| | (0.198) | (0.165) | (0.173) | (0.150) |
| SSDI receipt | -41.77 ** | -50.60 ** | -21.34 * | -34.98 ** |
| | (9.73) | (9.09) | (8.45) | (7.99) |
| Mean Dep. Variable | 24.62 | 20.13 | 18.43 | 15.46 |

Notes: Panel A uses surviving initially allowed applicants as in Table 4 and is split on median annual earnings in year six prior to initial allowance (1999) for the full sample of 1,009,382 applicants (including those initially denied) yielding subsamples of initially allowed applicants of size 139,681 (below-median) and 221,488 (above-median). The panel B sample includes survivors and non-survivors and is split on median annual earnings in year six prior to the initial examiner decision (1999), yielding two subsamples of high and low earners each of size N=504,691. ** p<0.01, * p<0.05, ~ p<0.1

Consistent with these observations, the estimates in the upper panel of Table 7 find striking heterogeneity in the causal effect of processing delays on the medium and long-term labor supply of applicants with high versus low pre-onset earnings. Among those with low pre-onset earnings, the estimated effect of processing delays on the probability of realizing positive annual earnings (exceeding $\$1K$) in years three and six following the initial determination is small, statistically insignificant, and inconsistently signed; delay does not appear to cause decay among this group. Among applicants with high pre-onset earnings, by contrast, processing delays exert a negative and statistically significant effect on labor supply in both years three and six following the initial determination. For applicants with above-median pre-onset earnings, each month of processing time

reduces the probability of positive earnings by −0.45 percentage points in year three and by −0.38 percentage points in year six (columns 2 and 4).[41] Complementing this finding, we estimate that the negative effect of an SSDI allowance (instrumented as above by examiner leniency) on subsequent labor force participation is 20 percent larger at year three on high pre-onset-earners than on low pre-onset-earners (-51% versus −42%), and 60 percent larger in year six (−35% versus −21%). This pattern of results indicates that underlying heterogeneity in labor force attachment shapes how processing delays and allowance decisions ultimately affect post-determination employment. For applicants with low pre-onset earnings, processing delays do not appear to significantly reduce subsequent labor supply, while allowances do in fact reduce labor supply, but by less than for the average applicant. Among those with high pre-onset earnings, delays significantly reduce labor supply—even six years after the initial determination—and allowances cause steep reductions in employment over both the medium and long run.

For completeness, we repeat this exercise for initially allowed applicants (as in Table 4, splitting applicants at the median of pre-onset earnings.[42] While Table 4 documents that processing delays reduce subsequent labor force participation among initially allowed applicants in both years three and six after the initial determination, these estimates lose precision when the initially allowed subsample is further split on pre-onset earnings (seeTable 7, Panel B). That is, while processing delays significantly reduce subsequent employment for initially allowed applicants and for the full sample of high pre-onset-earners, our estimates do not suggest that delays are differentially impactful according to pre-onset earnings among those initially allowed.[43]

# 4 The Causal Effect of SSDI Receipt on Labor Supply Revisited

We turn in this final section to the topic that has been the primary focus of prior literature on the economic effects of the SSDI program: the causal effect of SSDI receipt on labor supply. The second row of Panel B of Table 6 reports estimates of these causal effects. We find that an SSDI award

[41] Both coefficients exceed the corresponding estimates of the impact of waiting time on post-determination labor supply among initially allowed applicants (Table 4), although available precision would not rule out that the effect sizes are comparable.

[42] Note that this split is based on median earnings for the full sample of 1,009,382 applicants used in Panel A. Reflecting the higher allowance rates among applicants with higher pre-onset earnings, there are more above-median than below-median pre-onset-earners in the initially allowed sample.

[43] Another difference between the initially allowed sample and the full sample of applicants (Table 7, panel A versus panel B, as well as Table 4 versus Table 6) is that the initially allowed sample excludes applicants who did not survive through the end of a given follow-up year whereas the full sample of applicants does not condition on survivorship so as to avoid selection bias (because deaths are more consistently reported for beneficiaries than non-beneficiaries). The inclusion of deceased applicants in the full sample is likely to attenuate the estimated treatment effect of delay since earlier processing delays cannot affect the current employment of now-deceased applicants. To illustrate the potential impact of this sample restriction, Table A-4 presents OLS, reduced form, and 2SLS estimates of the impact of processing delays for the initially allowed while including non-survivors, comparable to the selection criteria for the full sample. Mortality is high among initially allowed applicants: 16 percent were deceased within three years of the initial decision and 23 percent were deceased within six years. Thus, it is not surprising that the labor supply estimates for the initially allowed including non-survivors in Table A-4 are significantly attenuated as compared to the estimates for initially allowed survivors in Table 6. This pattern suggests that the causal effect of delay on employment for the full sample is somewhat attenuated by inclusion of non-survivors, though differential reporting of deaths for beneficiaries and non-beneficiaries makes it difficult to show conclusively that this is the case.

lowers the probability of employment—that is, annual earnings of at least $\$1,000$—by 46 points in year three following application and by 27 points in year six. We find the effect of an SSDI allowance on the probability of annual earnings in excess of SGA—approximately $\$12,000$—is approximately 66–76 percent as large as its effect on any earnings: a reduction in employment above SGA of 30 percent in year three and 20 percent in year six. Earnings reductions stemming from marginal SSDI awards average $\$7,998$ in year three following application, and $\$5,951$ 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 94 percent of annual earnings in year three and 80 percent of annual earnings in year six following the initial determination.

As originally noted by MMS, because applicants assigned to examiners with lower allowance propensities are more likely to appeal their denials, allowance odds will be confounded with processing times. As we have shown above, processing time causally affects labor supply. These observations hold a critical implication for prior literature: because the longer processing times of denied relative to allowed applicants lead to differential reductions in post-decision employment and earnings, analyses that estimate the effect of disability allowances on labor supply without accounting for systematic differences in processing time between allowed and denied applicants will generally produce biased estimates.

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 6. Suppressing covariates, the two first stage equations are:

$$DI_i = \pi_1^d \cdot EXALLOW_{j(i)} + \pi_2^d \cdot EXTIME_{j(i)} + \varepsilon_i^d \tag{6}$$

and

$$T_i = \pi_1^t \cdot EXALLOW_{j(i)} + \pi_2^t \cdot EXTIME_{j(i)} + \varepsilon_i^t. \tag{7}$$

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

$$Y_i = (\gamma\pi_1^d + \delta\pi_1^t) \cdot EXALLOW_{j(i)} + (\gamma\pi_2^d + \delta\pi_2^t) \cdot EXTIME_{j(i)} + \varepsilon_i^y, \tag{8}$$

where $\gamma$ and $\delta$ are the causal effects of allowance and waiting time on post-decision employment. This equation demonstrates how examiner allowance propensity can affect the post-decision labor supply of applicants through two channels—the examiner's effect on (1) the probability of award and (2) the applicant's waiting time to the final award decision. In an IV regression that excludes waiting time, akin to the model that MMS estimate, the *plim* of the IV estimate will equal the ratio of the reduced form to first stage coefficients on $EXALLOW$. We refer to this IV estimate as $\gamma^{MMS}$, where

$$\gamma^{MMS} = \frac{\gamma\pi_1^d + \delta\pi_1^t}{\pi_1^d}, \tag{9}$$

This equation indicates why $\gamma^{MMS}$ is likely to provide a biased estimate of the causal affect of SSDI receipt on subsequent labor supply ($\gamma$ in equation (1)): $\gamma^{MMS}$ will equal the causal parameter of interest only if waiting time does not affect employment ($\delta = 0$) or if examiner allowance rates do not affect final waiting time ($\pi_1^t = 0$). We have shown that neither of these conditions holds in the the first three years following application, nor do they hold over the six year interval for applicants with above-median pre-application earnings (see Tables 2, 6, and 7). More precisely, we estimate 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), meaning that $\gamma^{MMS}$ will not consistently estimate $\gamma$ in equation (1), which is our target of inquiry. These sources of bias imply that the reduced form coefficient on $EXALLOW$ in equation (8) will be larger than $\gamma\pi_1^d$ , and thus the estimator that excludes waiting time, $\gamma^{MMS}$, will be biased upward relative to $\gamma$. Since $\gamma < 0$, this implies that the MMS estimate will *understate* the magnitude of the causal effect of SSDI receipt. 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.[44]

To assess the magnitude of this 'processing time bias,' the regressions reported in Table 8 compare three sets of point estimates for the effect of SSDI benefit receipt on employment (earnings of at least $\$1,000$) at years three and six following application. Row A of the table presents simple OLS estimates akin to those first reported by Bound (1989), contrasting differences between allowed and denied applicants in the probability of attaining positive earnings in years three and six following application. 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—MMS qualified this interpretation, noting that denied applicants may differ not only in health but also in their skills and underlying labor force attachment.

[44]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 (7) and (8) will result in a consistent estimate of the causal effect of processing time on labor supply. Similarly, since $EXALLOW$ and $EXTIME$ are uncorrelated, regressing SSDI receipt on $EXALLOW$ omitting $EXTIME$ still obtains a consistent estimate of the denominator, $\pi_1^d$.

Table 8: The Effect of SSDI Award on the Probability of Positive Annual Earnings (>$1K) in Years Following Application: Impact of Accounting for Processing Time
Dependent Variable: $100 \times [\text{Earn} \geq \$1K]$

| | All Applicants (1) | Below-Median Earnings (2) | Above-Median Earnings (3) |
|---|---|---|---|
| | I. Three Years Later (2008) | | |
| A. OLS | -31.3 ** | -26.5 ** | -40.8 ** |
| | (0.11) | (0.14) | (0.17) |
| B. 2SLS: Excluding Processing Time | -31.8 ** | -34.6 ** | -28.6 ** |
| | (3.81) | (5.51) | (5.44) |
| C. 2SLS: Including Processing Time | -45.6 ** | -41.8 ** | -50.6 ** |
| | (6.92) | (9.73) | (9.09) |
| D. Processing Time Bias in Labor Supply Estimate: Rows C - B | -13.9 * | -7.2 | -22.0 ** |
| | (5.80) | (8.88) | (9.12) |
| Mean Dep. Variable | 22.4 | 24.6 | 20.1 |
| | II. Six Years Later (2011) | | |
| A. OLS | -27.5 ** | -24.4 ** | -36.8 ** |
| | (0.10) | (0.12) | (0.16) |
| B. 2SLS: Excluding Processing Time | -21.4 ** | -25.9 ** | -16.5 ** |
| | (3.43) | (5.10) | (5.14) |
| C. 2SLS: Including Processing Time | -26.5 ** | -21.3 ** | -35.0 ** |
| | (5.94) | (8.45) | (7.99) |
| D. Processing Time Bias in Labor Supply Estimate: Rows C - B | -5.1 | 4.6 | -18.5 ** |
| | (4.98) | (6.25) | (7.50) |
| Mean Dep. Variable | 16.9 | 18.4 | 15.5 |
| N | 1,009,382 | 504,691 | 504,691 |

Notes: Sample includes non-survivors. Row D estimates the bias from excluding processing time from estimates of the causal effect of SSDI allowance on labor supply by contrasting coefficients in rows B and C of the corresponding columns. Prior earnings measured six years before initial decision (1999). Standard errors calculated by bootstrap ($S = 100$ simulations). ** p<0.01, * p<0.05, ˜ p<0.1

Row B of Table 8 implements the instrumental variables strategy in which benefit receipt is instrumented with examiner allowance propensity as in MMS. Following the 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

with lower allowance propensities both allow fewer applicants and *induce longer* total processing times through their higher denial rates. Row C of Table 8 presents our preferred estimates (from Table 6) where both processing time and SSDI receipt are instrumented by examiner speed and allowance propensity, respectively. Row D reports the difference between our preferred estimate (including processing time) and the 2SLS estimate excluding processing time. To obtain standard errors that account for the correlation between the two estimators, we bootstrap the distribution of the difference by sampling observations clustered by examiner with replacement $S = 100$ times.[45]

Comparing the three estimates in column 1 of Table 8 indicates that processing time bias is of first order importance in the short run (three years later, in 2008), though less so over the longer run (six years later, in 2011, shown in the lower panel). In year three following application, the column 1 estimate of the causal effect of SSDI receipt on employment, holding processing time constant, is substantially larger than either the conventional 2SLS estimate or the canonical OLS estimate. In year six (lower panel), the causal effect estimate that holds processing time constant is slightly smaller in magnitude than the OLS estimate, though not significantly so. Taken together, these results confirm 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 causal effect.

The bias that arises from excluding processing time in these estimates is shown in sharp relief in columns 2 and 3 of Table 8, where we report analogous comparisons separately for applicants with above- and below-median pre-onset earnings at year three (upper panel) and year six (lower panel) following initial application. Both the OLS estimate (Row A) and the 2SLS estimate that accounts for processing time (Row C) indicate that benefit receipt reduces subsequent labor force participation by substantially more for high than low pre-onset earners in both years three and six following the initial determination. Yet, the 2SLS estimate that does *not* account for processing time (Row B) erroneously indicates the opposite (i.e., point estimates of $-34.6$ and $-28.6$ for low and high pre-onset earners in year three, respectively). The reason for this discrepancy is intuitive given our results in Table 7 above: processing time has a substantially larger depressive effect on subsequent employment for applicants with high relative to low pre-onset earnings, and as above, applicants who are ultimately denied have on average far longer total processing times than those who are allowed; thus, the confounding effect of processing time (which reduces labor supply) and denial (which increases labor supply) is particularly severe for applicants with relatively high pre-onset earnings. Accounting for this bias raises the estimated impact of allowances on employment among high pre-onset earners from $-29$ percentage points in year three to $-51$ percentage points in year three (a 75 percent difference), and from $-17$ percentage points in year six to $-35$ percentage points in year six (a 110 percent difference). Both of these contrasts are highly significant, as shown in Row D of column 3.

These substantial discrepancies among causal effects estimates underscore why it has proved challenging to obtain reliable estimates of the effect of SSDI program on the labor force partici-

[45] As MMS document, the examiner assignment instrument causally affects the final allowance decisions of about 15 percent of applicants, with the remainder of applicants being always or never takers. The estimates in Rows B and C of Table 8 should be read as local average treatment effects (LATEs) for this 15 percent of applicants.

pation on applicants. Simple comparisons of allowed versus denied applicants confound the causal effect of allowances on labor supply with profound differences in the labor force attachment of applicants who are ultimately allowed versus ultimately denied. Conversely, while conventional 2SLS estimates potentially purge underlying differences in labor force attachment between allowed versus denied applicants, they do not account for the systematic differences in processing time between these two groups, which it turns out, have a depressing effect on subsequent labor force participation—particularly for applicants with high pre-onset earnings. By simultaneously accounting for the impact of both programmatic features—waiting time and benefit receipt—on the labor supply of SSDI applicants, we obtain a more accurate and also more comprehensive estimate of the total impact of SSDI application on labor force participation. Perhaps most consequentially, we show the SSDI application process affects the subsequent labor supply of both allowed and denied applicants due to the dampening effect of waiting time on subsequent employment. Since applicants who are ultimately denied spend longer on average awaiting a final determination outcome than applicants who are ultimately allowed, these dampening effects are largest among applicants who ultimately do not receive benefits.

# 5 Discussion and Conclusion

A prominent 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 extended application processing times, during which applicants must not earn more than $\$1,000$ per month, affect the subsequent employment of SSDI applicants? And how does accounting for processing time affect estimates of the SSDI receipt effect? 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 disability determination. Our main estimates indicate that a one-month increase in processing time reduces the annual employment rate three years later by 0.314 points (1.4 percent) among all applicants, and by 0.391 points (4 percent) among applicants who are initially allowed. The decay effect in the full sample wanes by six years after the initial decision, but persists with mild attenuation both for applicants with above-median pre-onset earnings (suggesting relatively high residual earnings capacity or labor force attachment) and for those applicants who are initially allowed. Extrapolating to total processing times, we estimate that the SSDI determination process directly reduces the post-decision employment of SSDI applicants by 4.2 points (19 percent) in the short run and 1.6 points (9.5 percent) in the long run, on average. These 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.

We further document that, due to the confounding of allowance odds and processing times, the existing literature has underestimated the labor supply effects of SSDI awards on beneficiaries. Using the instrumental variables methodology of Maestas, Mullen and Strand (2013), the estimated effect of SSDI receipt on employment *ignoring processing time* is −32 points in the short run and −21 points in the long run. By definition, the benefit receipt effect only affects SSDI beneficiaries—in particular, those SSDI beneficiaries who would work in the absence of SSDI benefits. If we assume the "always takers" (whose treatment assignment is not affected by the examiner leniency instrument) are unable to work in the absence of SSDI, then this implies the benefit receipt effect is concentrated among the 5.4 percent of applicants, or 7.8 percent of incoming SSDI beneficiaries, induced to receive an allowance by initial examiner assignment. This in turn implies that the SSDI program reduces the post-decision employment of all applicants by an average of 1.7 points (7.5 percent) in the short run and 1.1 points (6.7 percent) in the long run.[46] Using the unbiased estimates of the SSDI receipt effect from this paper, −46 points in the short run and −27 points in the long run, increases the estimated effect of the SSDI program on post-decision employment to 2.4 points (10.8 percent) in the short run and 1.4 points (8.3 percent) in the long run. Thus, correcting the bias in the estimated SSDI receipt effect increases the estimated short (long) run effect of the SSDI program on employment by 43 (24) percent.

However, both sets of benefit receipt estimates ignore the additional effect of the SSDI program on post-decision employment arising from the newly identified delay channel, which affects *all* applicants regardless of whether they are ultimately allowed or denied. Adding the delay effect implies the SSDI program reduces post-decision employment among all applicants by 6.7 points (30 percent) in the short run and 3 points (18 percent) in the long run.[47] That is, combining the delay 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's effect on employment is 2.7 to 3.9 times larger than previous estimates have suggested. Moreover, we estimate that labor supply decay during processing delays accounts for approximately 50 to 60 percent of the total effect of the SSDI program on the post-decision employment of SSDI applicants-–at least as much as the benefit receipt effect that has dominated the literature. A key implication of our findings is that the design of social insurance programs should account for not only the work disincentives that arise from benefit receipt but also those that arise from the eligibility determination process itself.

[46] The percent of applicants affected by benefit receipt is $p\pi_1^d * 100$, where $p = 0.36$ is the average examiner allowance propensity (also the initial allowance rate) from Table 1 and $\pi_1^d$ is the estimated fraction of applicants on the margin of SSDI receipt due to initial examiner assignment from Table 2. The percent of beneficiaries affected by benefit receipt is $\frac{p\pi_1^d}{0.688} * 100$, where 0.688 is the ultimate allowance rate ("always takers" plus induced marginal applicants) from Table 1. The estimated effect of the SSDI program ignoring the delay channel is $p\pi_1^d\gamma^{MMS}$, where $\gamma^{MMS}$ is the benefit receipt effect (at either three or six years post-decision) from Table 8, obtained by applying the MMS methodology to the current sample.

[47] Our estimate of the effect of the SSDI program is $p\pi_1^d\gamma + \delta\bar{T}$ where estimates of $\gamma$ and $\delta$ are taken from Table 6 and $\bar{T}$ is average total processing time for all applicants, reported in Table 1. This may be an underestimate if SSDI receipt also affects the employment outcomes of the always takers.

# 6 References


Angrist, Joshua D. and Jörn-Steffen Pischke. (2009). *Mostly Harmless Econometrics: An Empiricist's Companion.* Princeton, NJ: Princeton University Press.

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

Autor, David H. and Mark G. Duggan. (2010). "Supporting Work: A Proposal for Modernizing the U.S. Disability Insurance System." Washington, DC: Center for American Progress and The Hamilton Project, December.

Ben-shalom, Yonatan, Maura Bardos, and David Stapleton (2012). "Longitudinal Statistics for New Longitudinal Statistics for New Supplemental Security Income: Final Report" *Mathematica Policy Research*, #08977.933, November, Washington, DC.

Blau, David M and Philip K. Robins (1990). "Job Search Outcomes for the Employed and Unemployed," *Journal of Political Economy*, 98(3), 637-655.

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

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

Chen, Susan and Wilbert van der Klaauw (2008). "The Work Disincentive Effects of the Disability Insurance Program in the 1990s." *Journal of Econometrics*, 142, pp. 757-784.

Davidson, Russell and James G. MacKinnon. (2003). "Econometric Theory and Methods." New York: Oxford University Press.

Davis, Steven J. and Till von Wachter (2011). "Recessions and the Costs of Job Loss." *Brookings Papers on Economic Activity*, 2011(2), 1–72.

Dhrymes, P.J. (1970). *Econometrics: Statistical Foundations and Applications*, New York: Springer-Verlag.

French, Eric and Jae Song (2014). "The Effect of Disability Insurance Receipt on Labor Supply." *American Economic Journal: Economic Policy*, 6(2), 291-337.

Heckman, James J. and Richard Robb (1985). "Alternative Methods for Evaluating the Impact of Interventions." *Journal of Econometrics*, 30, 239-267.

Imbens, Guido W, and Joshua D Angrist (1994). "Identification and Estimation of Local Average Treatment Effects." *Econometrica*, 62 (2), 467-475.

Guryan, Jonathan, Kory Kroft, and Matthew J Notowidigdo (2009). "Peer Effects in the Workplace: Evidence from Random Groupings in Professional Golf Tournaments." *American Economic Journal: Applied Economics,* 1(4), 34–68.

Kroft, Kory, Fabian Lange and Matthew J. Notowidigdo (2013). "Duration Dependence and Labor Market Conditions: Evidence from a Field Experiment." *Quarterly Journal of Economics*, 128(3), 1123–1167.

Ljungqvist, Lars and Thomas J. Sargent (1998). "The European Unemployment Dilemma," *Journal of Political Economy*, 106(3), 514-550.

Maestas, Nicole, Kathleen Mullen and Alexander Strand (2013). "Does Disability Insurance Receipt Discourage Work? Using Examiner Assignment to Estimate Causal Effects of SSDI Receipt." *American Economic Review*, 103(5), 1797–1829.

___ (2015). "Disability Insurance and the Great Recession." *American Economic Review Papers & Proceedings*, 105(5), 177-182.

Nekoi, Arash and Andrea Weber. (forthcoming). "Does Extending Unemployment Benefits Improve Job Quality?" *American Economic Review*

Office of the Inspector General (2008). "Disability Claims Overall Processing Times." Audit Report A-01-08-18011.

Parsons, Donald (1980). "The Decline in Male Labor Force Participation." *Journal of Political Economy*, 88(1), 117–134.

Parsons, Donald (1991). "The Health and Earnings of Rejected Disability Insurance Applicants: Comment." *American Economic Review*, 81(5), 1419–1426.

Price, Brendan A. (2017). "The Duration and Wage Effects of Long-Term Unemployment Benefits: Evidence from Germany's Hartz IV Reform." MIT Working Paper, December.

Schmieder, Johannes F., Till von Wachter, and Stefan Bender 2016. "The Effect of Unemployment Benefits and Nonemployment Durations on Wages." *American Economic Review*, 106(3), 739–777

Social Security Advisory Board (2006). "Disability Decision Making: Data and Materials." Washington, DC (available at www.ssab.gov).

von Wachter, Till, Jae Song and Joyce Manchester (2010). "Trends in Employment and Earnings of Allowed and Rejected Applicants to the Social Security Disability Insurance Program." *American Economic Review*, 101, 3308–3329.

Weathers, Robert R. II and Jeffrey Hemmeter (2011). "The Impact of Changing Financial Work Incentives on the Earnings of Social Security Disability Insurance Beneficiaries." *Journal of Policy Analysis and Management*, 30(4), 708-728.

# Appendix A: Monotonicity with Downstream Treatment Variables

## Monotonicity of initial examiner leniency for final allowances and total processing time

First, we need to show that

$$D_i^{1z''} \geq D_i^{0z''} \; \forall i; \forall z''. \tag{A1}$$

That is, each applicant $i$ who is initially assigned to a lenient examiner is weakly more likely to *ultimately* (after any appeals) receive SSDI than if $i$ were counterfactually assigned initially to a strict examiner. Substituting equation (2) from above, and assuming $A1$ and $A2$ (see section 2.1), we can rewrite

$$D_i^{1z''} - D_i^{0z''} = \left(D_{1i}^1 - D_{1i}^0\right)\left(1 - A_i D_{2i}\right). \tag{A2}$$

The first expression is weakly positive since $D_{1i}^1 \geq D_{1i}^0$. (A2). Invoking assumptions $(A1)$ and $(A2)$ above—that is, that the likelihood of appeal and allowance upon appeal are independent of initial examiner leniency conditional on the initial denial—implies that $A_i D_{2i}$ does not depend upon $z_i = \{z_i', z_i''\}$ conditional on $D_{1i}$. Thus, the second expression in (A2) is independent of the first (and is weakly positive since $A$ and $D_2$ are Boolean). Therefore $D_i^{1z''} \geq D_i^{0z''} \; \forall i; \forall z''$.

Second, we need to show

$$T_i^{1z''} \leq T_i^{0z''} \; \forall i; \forall z''. \tag{A3}$$

That is, assignment to a lenient (strict) examiner weakly decreases (increases) total processing time for all applicants. Substituting equation (3) and assuming $A1$ and $A3$, we can rewrite

$$T_i^{1z''} - T_i^{0z''} = \left(D_{1i}^1 - D_{1i}^0\right) A_i T_{2i}. \tag{A4}$$

The first expression is zero or negative, $A_i$ equals zero or one and is independent of $D_{1i}$, and $T_{2i}$ is positive. Therefore, examiner leniency decreases total processing time for all applicants.

## Monotonicity of initial examiner speed for total processing time and final allowances

We first need to show that assignment to a slow (fast) examiner weakly increases (decreases) total processing time:

$$T_i^{z'1} \geq T_i^{z'0} \; \forall i; \forall z'. \tag{A5}$$

Assume that the likelihood of appeal conditional on initial denial (satisfying $A1$; see section 2.1) is:

$$\Pr\left(A_i = 1 | D_{1i} = 0, T_{1i}\right) = f\left(T_{1i}\right), \tag{A6}$$

where $f(\cdot) \in [0,1]$. Substituting the equation above into equation (2) and invoking assumption $A3$, we have

$$T_i^{z'1} - T_i^{z'0} = \left(T_{1i}^1 - T_{1i}^0\right)\left(1 + \left(1 - D_{1i}^{z'}\right) f\left(T_{1i}\right) T_{2i}\right), \tag{A7}$$

The first expression is zero or positive since $T_{1i}^1 \geq T_{1i}^0$. The second expression is one if $D_{1i}^{z'} = 1$. In the case where $D_{1i}^{z'} = 0$, a sufficient condition for the second expression to be non-negative is that $f'\left(T_{1i}\right) \geq 0 \; \forall i$, that is, longer waiting times weakly increase the probability of appeal. As shown in Table 5, this assumption is supported by the data.

Finally, we need to show that longer examiner time weakly increases SSDI receipt for all applicants:

$$D_i^{z'1} \geq D_i^{z'0} \; \forall i; \forall z'. \tag{A8}$$

Substituting equation (2) and invoking assumption $A2$ we can rewrite

$$D_i^{z'1} - D_i^{z'0} = \left(1 - D_{1i}^{z'}\right) f\left(T_{1i}\right)\left(T_{1i}^1 - T_{1i}^0\right) D_{2i}. \tag{A9}$$

The first expression is zero or one. We assumed above $f\left(T_{1i}\right), f'\left(T_{1i}\right) > 0 \; \forall i$, and that $T_{1i}^1 - T_{1i}^0 \geq 0$. $D_{2i}$ equals zero or one. Therefore, because longer examiner time weakly increases the probability of appealing an initial denial, and appeal increases the probability of receipt, longer examiner time weakly increases the probability of SSDI receipt for all applicants.

# Appendix Tables

Table A-1: SSDI Processing Times in Months

A. Months at the Disability Determination Service (DDS), by Processing Step

| | % Cases | Mean | Std. Dev. | P50 | P90 |
|---|---|---|---|---|---|
| All claims | 100.0 | 2.9 | 1.7 | 2.6 | 5.1 |
| Step 1. Allowed: meets listings | 16.5 | 2.3 | 1.7 | 1.9 | 4.6 |
| Step 2. Denied: not severe | 16.5 | 2.6 | 1.5 | 2.3 | 4.6 |
| Step 3. Denied: capacity for past work | 23.1 | 3.1 | 1.6 | 2.8 | 5.2 |
| Step 4. Allowed (denied) because (no) capacity for any work | 43.9 | 3.1 | 1.7 | 2.8 | 5.3 |

B. Cumulative Months from Filing to Decision, by Latest Observed Decision

| | % Cases | Mean | Std. Dev. | P50 | P90 |
|---|---|---|---|---|---|
| Initial | 59.0 | 3.6 | 2.2 | 3.2 | 6.1 |
| Reconsideration | 7.9 | 8.7 | 3.5 | 8.0 | 13.1 |
| ALJ Hearing | 29.4 | 33.5 | 19.0 | 28.6 | 63.9 |
| Higher Appeals* | 0.3 | 49.1 | 17.4 | 51.5 | 70.3 |
| Reapplication | 3.3 | 21.5 | 12.0 | 17.4 | 39.7 |
| Final Decision | 100.0 | 13.5 | 17.3 | 5.2 | 36.1 |

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

Table A-2: Covariate Balance Tests

| | Without Assignment Variables | | With Assignment Variables | |
|---|---|---|---|---|
| | Examiner Allowance Rate (EXALLOW) | Examiner Allowance Time (EXTIME) | Examiner Allowance Rate (EXALLOW) | Examiner Allowance Time (EXTIME) |
| | (1) | (2) | (3) | (4) |
| Age dummies | | | | |
| Age 18-24 | -0.00068 | -0.03540 ** | -0.00021 | -0.00373 |
| | (0.00088) | (0.00654) | (0.00044) | (0.00381) |
| Age 25-29 | -0.00583 ** | -0.01310 * | -0.00050 | -0.00164 |
| | (0.00079) | (0.00549) | (0.00036) | (0.00318) |
| Age 30-34 | -0.00817 ** | 0.00797 | 0.00011 | -0.00268 |
| | (0.00082) | (0.00512) | (0.00035) | (0.00334) |
| Age 35-39 | -0.00646 ** | 0.01560 ** | -0.00050 | -0.00051 |
| | (0.00076) | (0.00437) | (0.00034) | (0.00290) |
| Age 40-44 | -0.00649 ** | 0.01540 ** | -0.00044 | -0.00191 |
| | (0.00070) | (0.00414) | (0.00030) | (0.00278) |
| Age 45-49 | -0.00771 ** | 0.01920 ** | -0.00054 ~ | 0.00119 |
| | (0.00068) | (0.00389) | (0.00030) | (0.00269) |
| Age 50-54 | -0.00672 ** | 0.02720 ** | -0.00038 | 0.00423 ~ |
| | (0.00061) | (0.00361) | (0.00030) | (0.00246) |
| Age 55-59 | -0.00429 ** | 0.02590 ** | -0.00030 | 0.00356 |
| | (0.00049) | (0.00353) | (0.00026) | (0.00221) |
| values | | | | |
| Earnings t-6 | 0.00019 ** | -0.00023 ** | 0.00000 | -0.00007 |
| | (0.00001) | (0.00009) | (0.00001) | (0.00005) |
| Earnings t-7 | 0.00008 ** | 0.00001 | 0.00001 | 0.00009 |
| | (0.00001) | (0.00010) | (0.00001) | (0.00007) |
| Earnings t-8 | 0.00002 | -0.00009 | -0.00001 | -0.00004 |
| | (0.00002) | (0.00011) | (0.00001) | (0.00007) |
| Earnings t-9 | -0.00001 | 0.00029 ** | 0.00000 | 0.00000 |
| | (0.00001) | (0.00009) | (0.00001) | (0.00006) |
| $R^2$ | 0.005 | 0.000 | 0.622 | 0.513 |
| F test p values | | | | |
| Age vars | 0.000 | 0.000 | 0.426 | 0.156 |
| Prior earnings vars | 0.000 | 0.000 | 0.048 | 0.682 |
| Age + prior earnings | 0.000 | 0.000 | 0.112 | 0.328 |

Notes: $N = 1,009,382$. 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-3: P-Values from Overidentification Tests of Causal Pathways

| | All Applicants | | | Initially Allowed |
|---|---|---|---|---|
| | EXALLOW only | EXTIME only | EXALLOW & EXTIME | EXTIME only |
| | (1) | (2) | (3) | (4) |
| 3 Years Later (2008) | 0.2471 | 0.0039 | 0.2933 | 0.5745 |
| 6 Years Later (2011) | 0.1936 | 0.0218 | 0.2040 | 0.2139 |

Notes: Notes: Dependent variable for all tests is Earn $\geq \$1,000$/Year.

Table A-4: OLS, Reduced Form and Two-Stage Least Squares Estimates of Effect of Examiner Assignment on Labor Supply Outcomes of Initially Allowed Applicants, Including Non-Survivors

| | Three Years Later (2008) | | | Six Years Later (2011) | | |
|---|---|---|---|---|---|---|
| | 100 × [Earn ≥ $1K] | 100 × [Earn ≥ SGA] | $ Earnings (1,000s) | 100 × [Earn ≥ $1K] | 100 × [Earn ≥ SGA] | $ Earnings (1,000s) |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | | | A. OLS | | | |
| Final time | -0.117 ** | -0.089 ** | -0.037 ** | -0.0922 ** | -0.063 ** | -0.027 ** |
| | (0.026) | (0.015) | (0.006) | (0.023) | (0.014) | (0.006) |
| | | | B. Reduced Form | | | |
| EXTIME | -0.143 ~ | -0.050 | -0.036 | -0.0948 | -0.058 | -0.023 |
| | (0.082) | (0.054) | (0.025) | (0.072) | (0.046) | (0.022) |
| | | | C. 2SLS | | | |
| Final time | -0.252 ~ | -0.088 | -0.064 | -0.167 | -0.101 | -0.040 |
| | (0.145) | (0.145) | (0.044) | (0.127) | (0.127) | (0.039) |
| Mean dep. variable | 9.68 | 3.36 | 1.47 | 7.49 | 2.74 | 1.22 |

Notes: Sample includes non-survivors. $N = 361,169$ in both 2008 and 2011. ** p<0.01, * p<0.05, ~ p<0.1

Table A-5: Summary Statistics, by Level of Pre-Onset Earnings

| | | Initially Allowed | | Full Sample | |
|---|---|---|---|---|---|
| | All | Below Median | Above Median | Below Median | Above Median |
| | (1) | (2) | (3) | (4) | (5) |
| % of sample | 100.0% | 13.8% | 21.9% | 50.0% | 50.0% |
| Initially allowed | 35.8% | 100.0% | 100.0% | 27.7% | 43.9% |
| Continue claim \| initial denial | 63.8% | -- | -- | 59.0% | 69.9% |
| Allowance rate \| continued claim | 69.8% | -- | -- | 62.8% | 77.4% |
| Finally allowed | 68.8% | 100.0% | 100.0% | 59.2% | 78.4% |
| Finally denied | 31.2% | 0.0% | 0.0% | 40.9% | 21.6% |
| Time at DDS (months) | 2.87 | 2.82 | 2.58 | 2.94 | 2.81 |
| | (1.67) | (1.79) | (1.71) | (1.67) | (1.66) |
| Total Processing Time | 13.53 | 3.75 | 3.42 | 14.54 | 12.51 |
| | (17.26) | (2.34) | (2.14) | (18.29) | (16.11) |
| Total Processing Time \| Continue Claim after Initial Denial[c] | -- | -- | -- | 29.03 | 26.46 |
| | | | | (20.27) | (18.26) |
| Examiner processing time (EXTIME), months | 2.87 | 2.85 | 2.85 | 2.87 | 2.88 |
| | (0.80) | (0.81) | (0.80) | (0.80) | (0.80) |
| Examiner allowance rate (EXALLOW) | 0.36 | 0.38 | 0.39 | 0.35 | 0.36 |
| | (0.11) | (0.11) | (0.11) | (0.10) | (0.11) |
| Concurrent claim | 49.2% | 56.9% | 26.5% | 64.4% | 34.0% |
| Musculoskeletal | 36.5% | 21.2% | 27.2% | 33.9% | 40.5% |
| Mental | 20.3% | 31.3% | 18.4% | 24.6% | 15.9% |
| Age | 46.8 | 47.4 | 53.0 | 43.7 | 49.9 |
| | (10.95) | (12.25) | (8.19) | (11.84) | (8.96) |
| Earnings (2008$, thousands) | | | | | |
| 6 years before | 23.937 | 7.252 | 44.492 | 6.752 | 41.121 |
| | (25.012) | (6.134) | (27.275) | (5.983) | (24.995) |
| 3 years later | 3.760 | 1.163 | 1.661 | 3.142 | 4.379 |
| | (11.268) | (5.326) | (10.563) | (8.015) | (13.745) |
| 6 years later | 3.062 | 1.048 | 1.321 | 2.623 | 3.501 |
| | (10.457) | (5.476) | (8.791) | (7.970) | (12.441) |
| 6 years later \| Finally allowed | 1.085 | -- | -- | 0.869 | 1.249 |
| | (6.914) | -- | -- | (4.756) | (8.170) |
| 6 years later \| Finally denied | 7.419 | -- | -- | 5.164 | 11.686 |
| | (14.743) | -- | -- | (10.575) | (19.730) |
| Employed (earning more than $1,000) | | | | | |
| 6 years before | 79.2% | 72.0% | 100.0% | 71.0% | 100.0% |
| 3 years later | 22.4% | 10.9% | 8.9% | 24.6% | 20.1% |
| 6 years later | 16.9% | 8.4% | 6.9% | 18.4% | 15.5% |
| 6 years later \| Finally allowed | 7.2% | -- | -- | 7.7% | 6.9% |
| 6 years later \| Finally denied | 38.3% | -- | -- | 34.0% | 46.5% |
| Performing SGA (earning more than SGA threshold) | | | | | |
| 6 years before | 57.3% | 33.7% | 100.0% | 29.8% | 100.0% |
| 3 years later | 11.4% | 3.1% | 3.5% | 10.7% | 12.2% |
| 6 years later | 9.0% | 2.7% | 2.8% | 8.6% | 9.4% |
| 6 years later \| Finally allowed | 2.5% | -- | -- | 2.2% | 2.7% |
| 6 years later \| Finally denied | 23.3% | -- | -- | 17.8% | 33.7% |
| No. observations | 1,009,382 | 139,681 | 221,488 | 504,691 | 504,691 |

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