Potential Earnings and Labor Supply of Disability Insurance Recipients

An Investigation of Norwegian Disability Insurance Applicants

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Abstract

Disability Insurance (DI) programs have long been criticized for their apparent work disincentives. As such, there has been a large debate of whether individuals on DI receipt are capable of work. In this thesis, I provide new estimates of the additional earnings and labor supply potentials of Norwegian DI recipients. By using a propensity score matching method, I reweight the sample of rejected DI applicants in order to estimate the counterfactual outcomes of DI beneficiaries if they had not been awarded DI benefits. I find that Norwegian DI recipients exhibit limited earnings and labor supply potentials. I also find evidence of rejected applicants not necessarily serving as a valid control group for allowed applicants. In the years after the final allowance decision, I find that the fraction of recipients participating in the labor force would at most have been 20-25 percentage points higher if the recipients were not awarded DI benefits. I also find greater responsiveness to the allowance decision of younger applicants, suggesting greater responses to economic incentives of younger applicants.

The liberalizations of the disability screening processes in most countries have led to a debate of whether the DI programs do not only serve as insurance against health shocks, but also have become a gateway for voluntary early retirement. Therefore, I investigate the behavior of Norwegian DI recipients around the transition to the retirement program. Around this transition, the individuals are eligible for the same amount of benefits, but work incentives change significantly. I find that approximately 2% of the recipients who were 62-65 years of age when awarded DI benefits increase earnings as they are transferred to the retirement program, and are no longer bound by the earnings restrictions implied by the DI program. I also find strong evidence of bunching behavior of DI recipients below the maximum allowed level of earnings for DI beneficiaries.

Keywords: Disability Insurance, disincentive effects, potential earnings and labor supply, retirement, bunching.

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Preface

Working with this thesis has been both inspiring and instructive. Although being challenging at times, the work has really contributed to improve my understanding in the particular field of interest, and also given me valuable experience in general in the field of economics. The work also sums up a great time enrolling the master's program in economics at the University of Oslo.

First, I want to thank the Research Council of Norway for the making of this thesis to be possible. Through the project "Causes and Consequences of the Rise in Disability Insurance Receipt", I have been given the opportunity to work as a research assistant at Statistics Norway. Without their contribution, I would not have had access to the data needed to carry out the important estimations. The work as a research assistant has also contributed to raising my level of skill needed for writing this thesis. In relation to this project, I would like to thank Andreas Kostøl for valuable help and suggestions for the thesis. I also want to thank Tarjei Havnes who has been my supervisor at the University. He has contributed with valuable insights, suggestions, and has always offered a great deal of assistance when I have needed it. ESOP has provided a scholarship including a workspace for me at the University, and I am truly grateful for their contribution as this has made my workday easier. I would also like to thank my fellow students for supporting me, and also contributing with valuable help as well. Without them, the time of when writing this thesis would not have been as much fun.

Although getting valuable help from these great people, I do not hold them responsible for any errors that may occur in this thesis. The errors, obscurities or inaccuracies that may occur are only myself to blame. If the reader would want to cross-check the results of this thesis, all Stata-codes used for the estimations are available from the author upon request.

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Contents

1 Introduction

In most developed countries, there have been significantly rising rates of participation in disability insurance (DI) programs during the last half century. Such programs have often been criticized for being one of the primary reasons for increased social security spending, but also for disincentivizing work (Autor & Duggan 2006). In Norway, the fraction of the adult population on disability rolls has grown from less than 2% to almost 10% during the last half century.[1] Participation rates are expected to reach 7% in the US by 2018, and more than 7% of the working age population is already receiving disability benefits in the UK (Kostol & Mogstad 2015; OECD 2010). Because of this, DI has become a considerable expenditure for the society as a whole, amounting to approximately 4-5% of GDP in Norway (OECD 2010). In addition, the liberalization of the disability screening processes have lead to a debate on whether the DI programs do not only serve as insurance against health shocks, but also have become a gateway for voluntary early retirement (Autor & Duggan 2006). Prominent researchers have argued that the expenditures are increasing at rates which are unsustainable in the long run, especially as the average DI recipient gets younger and has longer life expectancy.[2]

The research has traditionally focused on the disincentive effects of DI, and the potential earnings and labor supply of allowed DI applicants in particular. Most of the research comes from the US, investigating US applicants. To assess external validity of the US research, there are two particularly important concerns. Firstly, there may be differences between the programs and the requirements for enrolling in the programs. Secondly, there may be differences between US and Norwegian applicants. As such, the US findings are not necessarily transferable to Norwegian applicants.

This thesis aims to provide more knowledge about the behavior of Norwegian DI applicants, and in particular of the potential earnings and labor supply of DI beneficiaries. To achieve this, I investigate two different age-groups of DI applicants from the same initial sample. The first method investigates DI applicants aged 18-61 years, which represents the majority of all applicants in Norway. I use the initial starting point of Bound (1989), who uses rejected applicants as a control group for allowed applicants. The validity of Bound's approach relies on the assumption of rejected applicants being healthier than

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[1]See Appendix Figure A.1 for details about the development of individuals on DI receipt in Norway.
[2]See for instance Autor & Duggan (2003) and Autor & Duggan (2006).

allowed applicants. Bound argued that if there were no further differences between allowed and rejected applicants other than health, the earnings and labor supply of rejected applicants serve as upper-bound estimates of the potential earnings and labor supply of allowed applicants. In order to investigate the validity of this hypothesis, I use an approach similar to the one of Singleton (2012), who reweights the sample of rejected applicants and controls for differences in observable pre-application characteristics between allowed and rejected applicants. By doing this, I also get new estimates of the potential earnings and labor supply of Norwegian DI recipients.

An advantage of my data, is that I am able to go beyond the usual measures of labor supply. In most of the traditional literature, labor supply has been measured by earnings being greater than the maximum allowed level of earnings in order to be eligible for DI benefits, known as the SGA (substantial gainful activity) threshold. An important part of this thesis has been to provide data on working hours, allowing for important new estimates of the labor supply of DI recipients both at the extensive and the intensive margin. A further advantage is that I am able to identify applicants who reapply for DI benefits. Because the initially rejected applicants are able to reapply for DI, the initially rejected applicants may not give correct indications of the effects of a DI rejection in the longer run, as some rejected applicants may get awarded DI benefits at a later stage. This is a particular issue in Norway, where the majority of the initially denied applicants are eventually awarded DI benefits. The literature has dealt with this problem in different ways. One approach has been to disregard the applicants that are allowed DI benefits at a later stage.[3] However, this approach only allows for interpretations of a restricted sample of DI recipients, and in particular the initially allowed applicants. Thus, one does not necessarily get the full picture of a DI award decision by only investigating the behavior of this group. To overcome these issues, I normalize the years of DI award on the final observed DI application of the respective applicants. This approach allows for investigating the behavior of the full sample of allowed applicants (including those who were initially rejected, but were allowed at a later stage), and also the behavior of rejected applicants conditional on not reapplying.

The insights of the empirical analysis include several important findings. First, I find that Norwegian DI recipients exhibit limited earnings and labor supply potentials. One year after the award decision, the fraction of recipients participating in the labor force would at most have been 21 percentage points higher if the recipients were not awarded DI benefits. Three and five years after the award decision, the fraction of recipients participating in the labor force would at most have been 22 and 24 percentage points higher,

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[3]See for instance von Wachter *et al.* (2011).

respectively. Secondly, there is significant heterogeneity in the behavior of applicants around the award decision. Among younger applicants aged 18-39 years, there is evidence of greater responsiveness to not being awarded DI benefits in the longer run. I also find significant responsiveness to not being awarded DI of the rejected applicants that are considered to be totally disabled. Because of the differences in observable pre-application characteristics, I also find evidence of rejected applicants not necessarily serving as valid upper-bound estimates of the potential earnings and labor supply of allowed applicants. However, there is evidence of Bound's assumption being valid for younger applicants aged 18-39 years, and also for totally disabled applicants.

This analysis complements a wide literature on the potential earnings and labor supply of DI recipients, and particularly of the papers that I use for estimation.[4] Bound (1989) finds that labor force participation rate of US DI recipients at most would have been 30 percentage points higher if they had not received DI benefits. Singleton (2012) finds supporting evidence of Bound's assumption, showing that the estimated earnings and labor supply of the rejected applicants once weighted were lower than of the observed rejected applicants. My findings do not support these findings. However, there are several reasons for the limited comparability of my investigation to the US findings. First, these analyses investigate applicants from a different period of time. Also, they define allowed applicants only as initially allowed applicants, while I include those who were awarded DI benefits at a later stage. My investigation most of all serves as evidence of the behavior of Norwegian DI applicants, and complements a growing literature on the behavior of Norwegian DI recipients. Kostol & Mogstad (2014) finds that the labor force participation rate is 24-30 percentage points higher among rejected applicants compared to DI beneficiaries. I find somewhat lower estimates, which may be due to the differences between observable pre-application characteristics of allowed and rejected applicants.

In the second part of the thesis I investigate allowed DI applicants aged 62-65 years at the DI award decision, and in particular the behavior of these individuals as they were transferred to retirement benefits at the age of 67 years. As the Norwegian DI beneficiaries were eligible for the same amount of retirement benefits as DI benefits, the level of public transfers that the individuals received did in general not change. The earnings restrictions that applied for Norwegian DI recipients during the time period of interest, however, involved strong disincentives of work for DI recipients. These restrictions did not apply to the former DI recipients as they were transferred to the retirement program. Because of this,

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[4]Other recent studies that investigate the potential earnings and labor supply of DI recipients are e.g. Chen & van der Klaauw (2008), von Wachter *et al.* (2011), French & Song (2014) and Maestas *et al.* (2013).

the work incentive effects of the recipients changed significantly. These changes in work incentives are similar to the recently adopted rules in Norway that applied from the 1st of January 2015. Thus, the responsiveness of retired beneficiaries could give us some indications of the effects of the new rules of the Norwegian DI program. However, the effects are not directly comparable as there would most likely be significant differences in the responsiveness of individuals on DI receipt and retired beneficiaries.

By investigating the DI recipients being transferred to the retirement program, I find significant responsiveness to the changes in work incentives around the transition. First, at least 2% of the recipients do exhibit additional earnings potentials. Thus, these individuals may also exhibit additional work capacity. Although I find greater responsiveness of younger applicants in the upper-bound analysis, this section proves that even the oldest DI beneficiaries may respond to improved work incentives. As DI beneficiaries keep the same amount of benefits as they are transferred to the retirement program, this estimate may be interpreted as a lower-bound estimate of the fraction of DI recipients who exhibit additional earnings potentials. This relies on the assumption of greater responsiveness of DI beneficiaries compared to retired recipients, which would be consistent with my findings in the upper-bound analysis. However, the fraction of recipients exhibiting additional earnings and labor supply potentials could be higher considering the counterfactual state of not being awarded DI benefits (as the upper-bound analysis do). The earnings restrictions implied by the rules of the DI program suggest that some recipients may bunch below the maximum allowed level of earnings. I find clear evidence of bunching behavior of DI recipients below the particular threshold before being transferred to the retirement program. This behavior was no longer evident after the transition as the earnings restrictions did not apply for individuals receiving retirement benefits. Finally, there is evidence of individuals with a positive labor supply increasing labor supply at the intensive margin post the transition. I find no evidence of individuals increasing labor supply at the extensive margin because of the improved work incentives.

As the DI programs have been criticized for being gateways to early retirement, this investigation intends to complement a fairly small literature on the behavior of DI recipients that are awarded DI benefits at a rather late stage. Maestas & Yin (2008) find that labor force participation increased as the US recipients were transferred to retirement benefits. I find no such evidence of recipients increasing labor supply at the extensive margin, suggesting limited external validity of the US findings. This investigation also adds to the Norwegian literature by showing significant bunching behavior of Norwegian DI beneficiaries. In addition, this investigation also complements a small literature on how Norwegian

DI beneficiaries respond to financial incentives. Kostol & Mogstad (2014) take advantage of a policy change that induce Norwegian DI benefits to work, and find that beneficiaries aged 18-49 years increase labor supply as they were able to keep a certain fraction of the DI benefits. I show that even the older DI beneficiaries may respond to economic incentives.

The remainder of the thesis proceeds as follows. In section 2, I review some of the relevant existing literature, and I also review some important background material regarding the Norwegian DI program. Section 3 describes the data, and the sample selection used for the econometric analysis. In section 4, I outline the econometric approach and provide estimates of the additional earnings and labor supply potentials of DI recipients. In section 5, I investigate the behavior of DI recipients being automatically transferred to the retirement program at the age of 67 years. Section 6 sums up the results and concludes.

2 Background

In this section I start by reviewing some of the existing literature regarding disability insurance, and of the disincentive effects of DI in particular. Because I investigate Norwegian DI applicants, I will also review some important aspects about the DI program in Norway.

2.1 Related Literature

As DI rolls have grown heavily over the last decades, a wide literature on the causes and consequences has developed as well. The disincentive effects of DI have traditionally been a very challenging field of investigation as there have been few possibilities of using experimental data. As such, the early literature relied on strict assumptions and often used regression methods that have been heavily criticized in retrospect as they have proved to overestimate the disincentive effects.

Bound (1989) was the first to suggest using rejected applicants as a control group for allowed applicants. He argued, that if the rejected applicants were healthier than the allowed applicants, then the potential labor supply of the rejected applicants would be greater than for the allowed applicants. Thus, the observed earnings and labor supply of the rejected applicants would serve as upper-bound estimates of the potential earnings and labor supply of allowed applicants. This assumption was heavily debated, in particular by Bound and Parsons,[5] but has nevertheless influenced the subsequent literature to a great extent. A more recent paper using the same starting point is the one of von Wachter *et al.* (2011), who

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[5]See Bound (1991) and Parsons (1991).

contribute with updated results and a few extensions to Bound's original approach. Singleton (2012) provides a short paper using the same framework as Bound (1989), but in addition tries to control for the differences in pre-application characteristics between allowed and rejected applicants.

Another heavily debated area has been whether the decline in labor force participation during the last decades can be attributed to the growth in DI rolls. Autor & Duggan (2003) estimate that the growth in DI rolls doubled the labor force exit propensity of displaced high school dropouts in the period 1984-2001. A more recent paper connecting DI application to unemployment rates in the US is the one of Maestas *et al.* (2015). They find that the number of DI applications increased significantly as the unemployment rates rose in the aftermath of the great recession, but that almost the entire growth in DI applications could be attributed to the increase in applications that were rejected.

Maestas & Yin (2008) take advantage of US DI recipients being transferred to retirement benefits when reaching the full retirement age. They estimate that labor force participation would have been around 10 percentage point greater for these recipients in the absence of DI award. The authors argue that their estimates can be interpreted as lower bound estimates of the disincentive effects of DI as retiring people should have lower potential labor supply than younger individuals. Chen & van der Klaauw (2008) also provide estimates of the potential labor supply of allowed applicants taking advantage of age-based discontinuities in the eligibility determination process in the US. They find that labor force participation would have been at most 20% higher in the absence of DI award.

In the more recent literature it has become popular to take advantage of random assignment of examiners with different levels of leniency deciding whether people are eligible for DI or not. Maestas *et al.* (2013) use the variation of initial examiners in the US to show that the incidence of DI receipt reduces earnings and employment among allowed applicants. French & Song (2014) use the same approach exploiting the leniency of US appeal judges, and get very similar results as to those of Maestas *et al.* (2013). Both papers estimate that labor force participation would have been around 27% greater in the absence of DI for the so called marginal applicants (those who not only get DI because of their health conditions, but also because of the leniency of the examiners). This instrumental variable strategy has also been used for other purposes in the DI research, as judicial decisions potentially affect a wide range of variables at the individual as well as the family level. Dahl *et al.* (2013) deploy the same strategy in order to investigate how the usage of DI benefits are reinforced between generations in Norway.

The research in Norway has also picked up in recent years. Kostol & Mogstad (2014) take advantage

of a policy change based on past enrollment dates which creates a sharp RD design. The beneficiaries that were granted DI before a particular cut-off date were able to keep approximately $0.4 for every $1 they earned above the SGA threshold, and thus got significantly more incentives to return to work. The paper show that three years after the implementation of the program, labor force participation had increased by 8.5 percentage points for recipients aged 18-49 years. Dahl *et al.* (2013) find that welfare receipt in one generation significantly causes more participation in the next generation. By using exogenous variation in the allocation of judges, they find that the participation of the children whose parents have been awarded DI increase with 6 percentage points within 5 years, and 12 percentage points within 10 years after the allowance decision of their respective parents. Investigations about the insurance value and welfare effects of DI in Norway have also picked up, and longer-term projects studying these issues are currently ongoing. Kostol & Mogstad (2015) investigate the behavior of applicants around the years of decision, and find relatively smooth consumption and disposable income for the different types of applicants around these years.

2.2 The Norwegian DI program

The Norwegian DI program is designed to provide partial earnings replacements to adults in the working age population that are incapable of work. More specifically, it provides cash transfers to workers under the full retirement age that are unable to engage in substantial gainful activity (SGA) because of a physical or medical condition that have lasted for at least a year. Only individuals aged 18-67 years are eligible for DI benefits. When DI recipients turn 67 years, they are automatically transferred to retirement benefits.

As a replacement for lost earnings, the recipients receive benefits based on past earnings history. The proportion of income that is replaced decreases as past earnings increase so that low-wage workers get a larger share of their earnings replaced compared to high-wage workers. If a recipient has no earnings history he will be guaranteed a minimum level of benefits. Special rules apply to the young and disabled. The program is part of a broader social security system and is one of the largest transfer programs in Norway. It is financed through taxes paid by i.e. employers.

The application and determination process goes through several steps. To apply for DI benefits, an individual must first get permission from his family doctor before submitting the application to a social security administration office. If the non-medical criteria are met (such as being below the regular

retirement age of 67 years), the disability examiners review the medical condition of the individual. This process is short if the individual is obviously disabled, but it could also be quite extensive if there is doubt about the condition of the individual and how much it affects the individual's ability to work. The examiners then look at factors such as health, age, education and transferability of the applicant's skills. If the examiners decide that the impairment makes the individual unable to participate in any substantial gainful activities, a disability award is made.

Of all initial applications, around 85% of these are allowed.[6] If an applicant does not get awarded DI benefits he can decide to appeal the decision. Around 25% of the initial denials are appealed, but only around 15% of these claims are allowed at this level. This is very different from the US system, where only approximately 33% of all applicants are initially allowed. However, the appeal process plays a much more important role in the US, amounting to approximately half of the initial denials. Of those who appeal, approximately 67% are eventually allowed. This means that around half of the DI awards in the US are allowed on appeal.[7]

In 2004, the Norwegian government introduced new rules that allowed for the possibility of DI to be awarded for a restricted period of time. In order to be eligible for this program, the disorders of the individuals must have been expected to last for at least 5 years. These kinds of temporary DI benefits were mainly targeted to individuals whose health conditions were not sufficient to participate in substantial gainful activity, but whose conditions were expected to improve. Temporary DI benefits were phased out in 2010, and the program was instead merged with the new program of sick pay.

From the 1st of January 2015 there have been substantial changes in the rules of the DI program. In short, the new rules involve changes in the taxation of earnings and DI benefits of recipients, and also changes in the way that the benefits are calculated. With the new rules, earnings and DI benefits are taxed by the same rates as labor income for non-recipients. Perhaps more importantly, the new rules adapt a version of a return-to-work program that intends to reduce the work disincentives. With the new rules, individuals on DI receipt are able to keep parts of their DI benefits if annual earnings are greater than the SGA level (which is approximately $10,000 measured in 2005 dollars), so that increasing labor supply will always be beneficial. Similar programs have been proposed in many countries, and some countries have already implemented such programs. In the US, the proposed return-to-work program is

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[6]Based on the initial award rate (not including appeals) of the applicants aged 18-61 years using the Norwegian data of DI applicants applying for DI benefits between 1998-2003.

[7]For the US award rates I use the results of Maestas *et al.* (2013) investigating US DI recipients applying for DI benefits between 2005-2006.

known as the "$1 for $2 offset" which reduces benefits with $1 for every $2 of earnings above the SGA threshold which is quite similar to the Norwegian version.

3   Data

The initial data comes from social security registers and consists of complete records of all individuals who applied for DI in Norway during the period 1992-2008. It contains all important information about the applications. That is, whether the application was initially allowed or denied, the degree of disability[8] and also the level of benefits actually achieved.[9] The initially denied applicants who reapply will appear multiple times in the data so that all applications of the respective individuals are observed in the respective time horizon of interest.

Through unique identifiers for each individual I link the application data with administrative registers provided by Statistics Norway, using a longitudinal database covering all residents from 1967 to 2010. The data contains information about individual characteristics such as age, gender, number of children, years of education and also economic data such as earnings, taxes and public cash transfers. Together these data create a rich set of longitudinal data for every year that the respective individuals are observed.

One of the main outcome variables I consider is earnings of allowed and rejected applicants. This is also standard in the literature. I define earnings as labor income plus business income. In addition to this I also do what is common in the literature, which is making an indicator variable equal to one if earnings are above the maximum allowed level of earnings for individuals on DI receipt. This threshold is known as the SGA threshold for those who get full level of benefits, and applies to most applicants.[10] This threshold is set at approximately $10,000 in annual earnings measured in 2005 dollars.[11] For those who do not get full level of benefits (particularly partially disabled applicants), the threshold is calculated as a function of past earnings.[12]

The other main outcome I consider is labor supply. In order to measure labor supply I use records consisting of details about all positions that were registered in Norway during 1992-2010, also provided

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[8]Some recipients are classified as partially disabled and are therefore not eligible for the same amount of benefits as the totally disabled

[9]Some applicants get a reduced level of benefits although they are classified as totally disabled. The maximum level of earnings allowed (the SGA threshold) is different for this group compared to those who get full level of benefits.

[10]Approximately 65.44% of the full sample of allowed applicants are awarded the full level of DI benefits.

[11]Specifically, this threshold is set to 1G (the public pension base rate) which was 60,699 NOK in 2005. This becomes approximately $10,000 by using an exchange rate of $/NOK = 6.

[12]In particular, the threshold is given by: $SGA(g) = (1-g)E + 1G$ where g is the degree of disability (measured from 0 to 1), E is annual earnings in the year prior to disability onset and $1G$ is the public pension base rate.

by Statistics Norway. These records contain information about the exact starting dates and durations of all positions, and the average working hours per week for each position. By using this information I measure average working hours per year for each individual, and link this data with the data of DI applicants through the standard unique identifiers. I define labor force participation as positive working hours for each year. Thus, the individuals not matched with the labor data are considered to not have positive working hours in the respective years of interest. In this way, I am are able to investigate labor supply of DI applicants at the intensive as well as the extensive margin for each year. This is not common in the literature as data on working hours of DI applicants are often unavailable.

3.1 Sample restrictions

For estimation purposes I consider all individuals who submitted their final DI application during the years of 1998-2003. Because the temporary benefit-scheme was not yet introduced during these years, the sample only contains individuals who applied for permanent DI benefits. The final DI application is defined as the last observed application for DI benefits (if more than one application is observed). Since all DI applications of the individuals are observed throughout the period 1992-2008, the rejected applicants in the estimation sample did not reapply for DI benefits within 5 years after the final application. As applicants in the main sample of applicants aged 18-61 years are not observed for more than 5 years after the final application, the outcomes of the rejected applicants (the control group) can loosely be interpreted as the behavior of finally rejected applicants. In the years after the final application, the outcomes of the allowed applicants (the treatment group) can be interpreted as the behavior of all allowed applicants post the year of their respective DI award decisions.

For both econometric analyses I make use of the same baseline sample, only different age groups. Particularly, I use the applicants who were of 18-61 years of age by the final application for the upper-bound analysis, and the applicants who were 62-65 years of age for the analysis of DI recipients being transferred to the retirement program. Appendix Figure A.2 shows the distribution of age by the final DI application for the full initial sample of applicants 18-65 years of age. The figure shows that the majority of applicants are of the upper age-segment.

For both groups I make two notable sample restrictions. Because we are interested in the economic behavior of the individuals of interest, it would not make sense to take into account the outcomes of deceased individuals. Therefore, I restrict the sample to those who did not die by the end of the observed

sample.[13] I also drop those who have been observed to receive DI benefits prior to the initial observed application in the sample of the respective individuals.[14] Thus, the characteristics of applicants prior to the DI award decisions can be interpreted as pre-application characteristics.

Sample of Applicants Aged 18-61 years by the Final DI Application

For the upper-bound analysis I consider applicants that were of 18-61 years of age by the final application for DI benefits. The main reason for this age restriction is that Norwegian workers can receive early retirement benefits at the age of 62, while the individuals younger than 18 years of age are not eligible for DI benefits. The upper age restriction also ensures that DI beneficiaries are not yet eligible for retirement benefits during the time horizon of the sample as DI beneficiaries are automatically transferred to retirement benefits at the age of 67. This amounts to 122,683 applicants that are observed in the common time horizon of 5 years prior and 5 years post the final DI application. In this way we are able to observe the behavior of allowed and rejected applicants around the decision of DI receipt, and of particular interest post the final DI award decision. Using these restrictions, all applicants are observed within the years of 1993-2008. This leaves us with a balanced sample.

The way of calculating the maximum allowed level of earnings for DI beneficiaries that are not eligible for the full amount of benefits, requires knowledge about the earnings of applicants in the year prior to disability onset. This level is not necessarily observable for the particular groups of applicants in the respective years of interest, as the year of disability onset may be several years prior to the final application. Luckily, this does not apply to the majority of applicants.[15] Therefore, I disregard this minority of applicants who were not awarded the full amount of DI benefits, and where the maximum allowed level of earnings was not observed when estimating the fraction of applicants whose earnings were greater than the SGA threshold.

Sample of Applicants Aged 62-65 years by the Final DI Application

By using the sample of applicants aged 62-65 by the final application I investigate the behavior of DI recipients when reaching the full retirement age of 67 years. The main reason for the age restriction is due to the time horizon of the sample. As applicants are only observed until 2010, applicants younger

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[13]Approximately 10.93% of the applicants aged 18-61 years and 14.83% of the applicants aged 62-65 years were observed as deceased by the end of the sample, that is until 2010.

[14]This group only amounted to approximately 1.74% of the initial sample.

[15]Particularly, this applies to approximately 2.38% of the sample of applicants aged 18-61.

than 62 years by the final application would not be observed for a desired number of years after being automatically transferred to the retirement program. Restricting the sample to applicants 65 years or younger by the final application ensures that all recipients participate in the DI program for at least a year before being transferred to pension benefits. I drop the few applicants that are observed to receive DI benefits after the age of 67.[16]

In addition to the joint restrictions of the initial sample, I restrict the sample to those who entered the retirement program by 2005 (applicants born in 1938 or earlier). The reason why I do this is twofold. First, the Norwegian government introduced a new return-to-work program for DI beneficiaries in January 2005 which applied to recipients who were awarded DI by the 1st of January 2004 (this would apply to all the respective recipients of the estimation sample). In addition, the Norwegian government introduced new rules of earnings restrictions for individuals aged 67-69 years who received pension benefits in 2008 and 2009. The new rules provide larger work incentives for the particular age group, and the labor supply of retired individuals eligible for the new rules would not be comparable to the rest of the sample. In order to keep work incentives and the budget constraints of DI recipients that are transferred to the retirement program consistent and comparable across different years, I make this sample restriction.

Because we are interested in the behavior of DI recipients around the years of being transferred from the DI program to the retirement program, I restrict the sample to the years strictly greater than the year of the final application for the respective beneficiaries. I also restrict the sample to the allowed applicants who were awarded the full level of benefits. By doing this, I am able to investigate the behavior of individuals whose work incentives change identically. The recipients who did not receive the full amount of DI benefits faced different earnings restrictions, and generally received larger amounts of pension benefits compared to DI benefits. Thus, the change in work incentives would be different for this group, and would not have been comparable to the individuals who received the full amount of DI benefits. The restricted sample used for estimation purposes consists of 11,286 individuals.

3.2 Descriptive evidence

Table 1 displays important characteristics of allowed and rejected applicants for the respective samples of interest. Because I only consider allowed applicants who were awarded the full level of benefits in the second analysis, I only show characteristics of this particular group of applicants for the sample of

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[16]This only amounted to approximately 1.08% of the initial sample.

applicants aged 62-65 years. Note that the characteristics of the allowed applicants for the different age-groups are not directly comparable, as the sample of applicants aged 18-61 years also includes DI recipients who were awarded reduced levels of benefits. Unless otherwise is stated, the characteristics are measured the year before the initial application.

Table 1: Summary Statistics of Allowed and Rejected Applicants, Applicants Aged 18-65 by the Final Decision

	Applicants aged 18-61			App. aged 62-65
	All applicants	Allowed	Rejected	Allowed
Individuals	122,683	116,036	6,647	11,286
% of full sample	100.00 %	94.58 %	5.42 %	95.14 %
% initially allowed	81.13 %	85.78 %	-	94.67 %
% reapplied - allowed	13.45 %	14.22 %	-	5.33 %
% reapplied - denied	0.72 %	-	13.30 %	-
% initially denied - no reapplication	4.70 %	-	86.70 %	-
Individual Characteristics				
Age at final decision	48.57	48.82	44.19	63.59
Female	0.58	0.58	0.60	0.48
Foreign	0.08	0.08	0.23	0.05
Married at final decision	0.57	0.57	0.53	0.73
Children below 18 years of age	0.54	0.52	0.97	0.02
Years of schooling	10.78	10.83	9.80	10.74
Experience 10 years prior	8.36	8.45	6.79	9.61
Avg. earnings 1 year before	25.52	25.88	19.24	41.04
Labor force participation 1 year before	0.57	0.57	0.45	0.75
Hours of work 1 year before	7.10	7.12	6.67	5.38
Type of Disorder				
Musculoskeletal disorder	0.39	0.38	0.44	0.46
Mental disorder	0.27	0.27	0.23	0.12
Cardiovascular disorder	0.08	0.08	0.04	0.16
Other disorder	0.28	0.29	0.29	0.26

Notes: Applicants are divided into 2 groups: Those who were allowed DI benefits and those who applied, but were not allowed DI. An applicant is considered as allowed if initially allowed or allowed by reapplying for DI benefits. If an applicant is not observed to have been allowed DI benefits by the end of the sample (by 2010), the applicant is defined as a rejected applicant. The sample consists of the Norwegian applicants that were 18-65 years of age and filed their final observed DI application during the years of 1998-2003, did not die by the end of the sample and have not been observed to receive DI benefits prior to the initial observed application. For the sample of applicants 62-65 years, only the allowed applicants who received the full level of benefits, entered the retirement program by 2005 and were observed to receive DI benefits in the year prior to reaching the retirement age of 67 years are included. Characteristics are measured in the year before the initial DI application unless otherwise is stated. The types of disorders are based on ICD-10 codes. Labor force participation is defined as working hours greater than zero. Earnings are measured in 2005 dollars in units of $1,000 using an exchange rate of $/NOK = 6, and are defined as labor income plus business income.

The table shows that the majority of applicants are initially allowed DI benefits. Out of those who are initially denied, most applicants reapply at a later stage. In the main sample of applicants that are 18-61 years of age by the DI award decision, more than two thirds of the initially denied applicants are observed to eventually get awarded DI benefits. Thus, the award rate when reapplications are taken into account is much higher than the initial award rate, and is approximately 95% for both samples.

The table also indicates that allowed and rejected applicants aged 18-61 years have different characteristics. This is a potential problem when using rejected applicants as a control group for allowed applicants, as addressed by Bound (1989). On average the allowed applicants are older, have more years of schooling and work experience prior to the initial application, have more children below 18 years of age, are more likely to be born in Norway, have higher pre-application earnings and were more likely to participate in the labor force prior to the initial decision compared to rejected applicants. Also, the rejected applicants are more likely to suffer from musculoskeletal disorders.

4   Comparing Allowed and Rejected Applicants using Propensity Score-Matching

Since Bound (1989) first suggested using rejected applicants as a control group for allowed applicants, it has not been clear whether rejected applicants accurately measure the potential outcomes such as earnings and labor supply of DI beneficiaries. Bound argued that rejected applicants are healthier and therefore more capable of work than allowed applicants, and thus have higher potential earnings and labor supply. However, it is not clear that this have to be the case. An objection to Bound's method, as he also addresses, is that other factors than health may account for low levels of earnings and labor supply of rejected applicants. Although rejected applicants may be healthier, they also may differ in other important characteristics such as ability, motivation and education.

Table 1 shows evidence that this also is the case for the Norwegian applicants aged 18-61 years. Among others, rejected applicants are less educated, have less work experience and are more likely to be foreign than allowed applicants. The fact that rejected applicants have lower pre-application earnings also indicate that they may have lower earnings potential. As such, it is not clear whether rejected applicants understate or overstate the potential earnings and labor supply of allowed applicants.

To address these issues, I use a method based on the approach of Singleton (2012), who reweights the pool of rejected applicants and controls for differences in observable pre-application characteris-

tics between allowed and rejected applicants. The estimates of the reweighted applicants can then be interpreted as the potential outcomes of rejected applicants if they were to have the same observable characteristics as allowed applicants. Under some assumptions, the reweighted applicants can also be used to measure potential outcomes of allowed applicants if they had been rejected, and detect the treatment effects of DI award.

4.1 Research Design

The differences in observable characteristics between allowed and rejected applicants suggest that rejected applicants are not directly comparable to allowed applicants. To address this issue, I use a propensity score-based weight in order to reweight the pool of rejected applicants. The weights are positively related with benefit award, and are estimated using a logit model where DI award at the final application is the dependent variable.[17] The control variables are only based on fixed pre-application characteristics in order to avoid endogenous controls. The results of the logit reveal that the likelihood of award is decreasing in age until around 30 years of age, but from then on increases. It also increases in past earnings, increases in years of schooling, decreases if foreign (not born in Norway) and increases if female. For more information about the logit and the results of the model, see Appendix Table A.1.

Based on specific assumptions, the logit predicts the probability of benefit award conditional on individual characteristics such as age, gender, educational attainment and past earnings. These individual probabilities can then be used to estimate the counterfactual outcomes of allowed applicants if they had been rejected. If there are no further differences between allowed and rejected applicants affecting the probability of disability award, and in particular of observable as well as unobservable differences in the health conditions of applicants, then the counterfactual outcomes of an allowed applicant is given by:

$$E[Y_{it}^0|A_i = 1] = E[w(x_i)Y_{it}|A_i = 0] \tag{1}$$

Where Y_{it}^0 is the potential outcome (such as earnings or labor force participation) of applicant i in period

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[17]Controls for the model are Age, its square, Female, Foreign (not born in Norway), years of schooling prior to initial application, its square, years of work experience 10 years prior to the initial decision, its square, being married, number of children below 18 years of age, degree of disability indicators (totally disabled, partially disabled or missing degree indicator), an indicator for receiving social assistance, an indicator for reapplying, number of reapplications, its square, years between initial and final application, its square, state fixed effects and diagnostic code fixed effects. To control for earnings and labor supply, I constructed 5 quantiles indicating the earnings of applicants and hours of work quantiles indicating days of work per week in the year prior to the initial application. In addition I allow for a linear time trend and several interaction variables (for details about the estimates of the logit model, see Appendix Table A.1).

t if rejected. The left side thus represents the counterfactual outcome of allowed applicants, and the right side is the reweighting estimator using a propensity score weight $w(x_i)$. The propensity score weight is as follows:

$$w(x_i) = \frac{1-\pi}{\pi} \frac{P(A_i = 1|x)}{1 - P(A_i = 1|x)} \tag{2}$$

Where $\pi = P(A = 1)$ is the share of finally allowed applicants over the whole sample, $P(A_i = 1|x)$ is the probability of being allowed conditional on controls for each individual i, and is estimated by the logit model of DI award. The weights, and therefore the estimated potential outcomes of allowed applicants are increasing in the estimated likelihood of disability award. Because the probability of award necessarily has to be higher if a larger part of the sample is allowed DI benefits, the weights are adjusted with the observed sample likelihood of award. Hence, the weights can be interpreted as the respective potential outcomes of allowed applicants relative to the rejected applicants under the initial assumptions of the model.

However, there may be differences in observables as well as unobservables that violate these assumptions, and particularly differences in health of allowed and rejected applicants. Since I do not have qualified data to measure health, the estimated outcomes of the reweighted applicants then may serve as biased estimates of the potential outcomes of allowed applicants. There are, however, reasons to believe that allowed applicants are hit by a larger health shock than rejected applicants, and thus have worse health after the application decision.[18] If this is the case, the weighted applicants could potentially overestimate the potential outcomes of allowed applicants. In particular:

$$E[Y_{it}^0|A_i = 1] \leq E[w(x_i)Y_{it}|A_i = 0] \tag{3}$$

Under this assumption, the estimated outcomes of weighted applicants can be treated as upper-bound estimates. Subtracting the observed outcomes of allowed applicants will then give us upper-bound estimates of the treatment effect, that is, the effect of DI award. In particular, the treatment effect can be expressed as:

$$TreatmentEffect_t \leq E[w(x_i)Y_{it}|A_i = 0] - E[Y_{it}^1|A_i = 1] \tag{4}$$

In addition, this approach makes us able to investigate Bound's initial hypothesis of using rejected

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[18]Based on the assumption of Bound (1989), who argued that rejected applicants are healthier than allowed applicants.

applicants as a control group for allowed applicants, as we can compare the weighted estimates with the observed outcomes of rejected applicants. If the estimated outcomes of the weighted applicants are smaller than or equal to the observed outcomes of the rejected applicants, then there is strong evidence that rejected applicants serve as a desirable control group interpreting the estimated outcomes as upper-bound estimates. Under the assumptions of the model, Bound's hypothesis can be expressed by the following:

$$E[Y_{it}^0|A_i = 0] = E[Y_{it}|A_i = 0] \geq E[w(x_i)Y_{it}|A_i = 0] \tag{5}$$

Important to note, is that larger estimates for the rejected applicants once weighted compared to the observed rejected applicants do not necessarily imply that the potential outcomes of allowed applicants are larger than those of rejected applicants, under the assumptions of the model. As allowed applicants may have worse health, their true potential outcomes could be lower than the weighted estimates. This bias may then dominate the difference between the weighted estimates and the outcomes of the rejected applicants. On the other hand, we cannot rule out the possibility of allowed applicants having higher potential outcomes than rejected applicants because of differences in characteristics. In this sense, comparing the rejected applicants once weighted with the observed rejected applicants only serves as an upper-bound test of rejected applicants as a control group for allowed applicants.
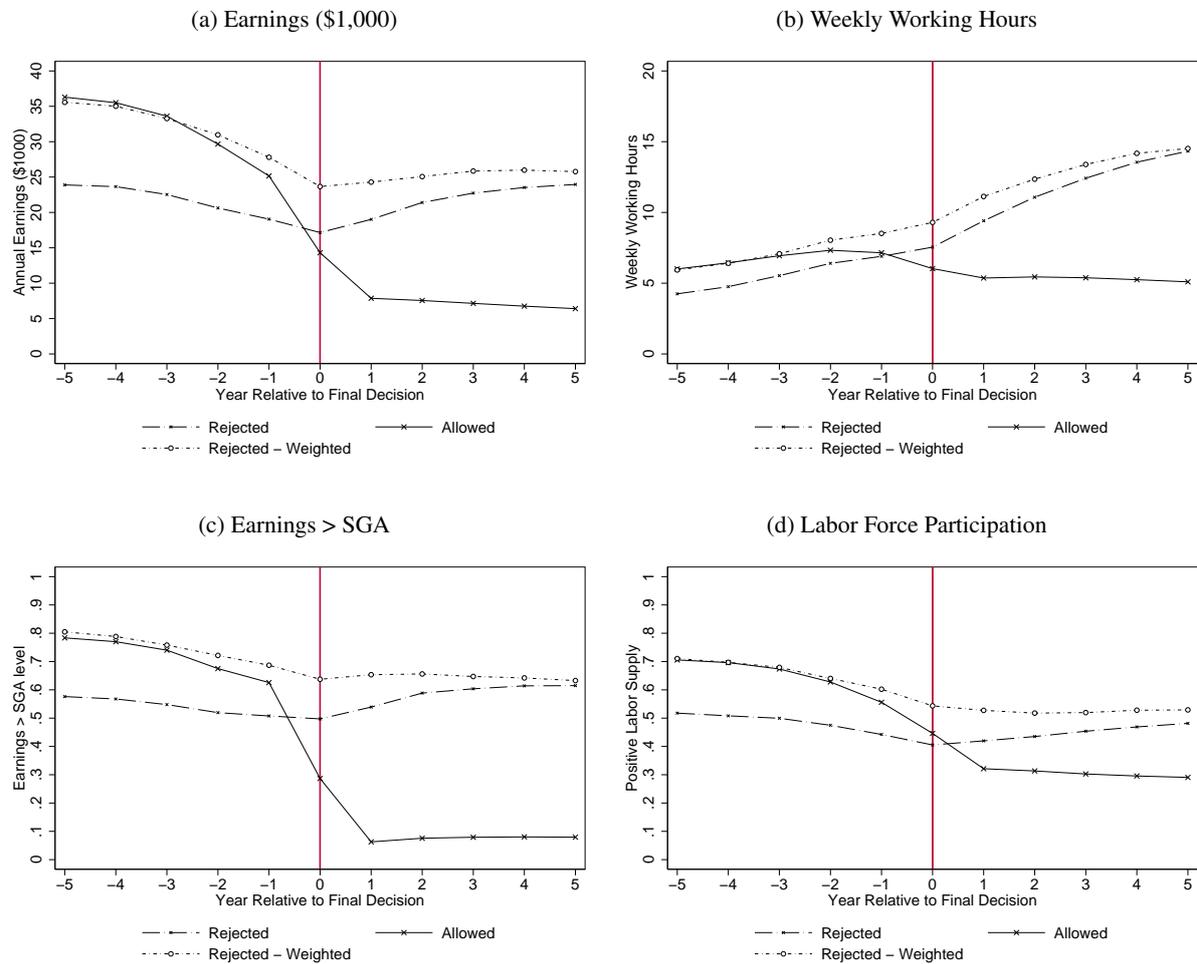
4.2   Results

I begin my presentation of results by providing graphical evidence of economic outcomes of allowed and rejected applicants along with the rejected applicants once weighted around the year of the final DI award decision. This makes us able to compare the behavior of the respective applicants, and also gives us an indication of the estimated upper-bound treatment effects. Importantly, we also get a picture of whether rejected applicants serve as a desirable control group for allowed applicants.

Figure 1 displays the patterns of earnings, weekly working hours, earnings above the SGA threshold (the fraction of applicants having earnings greater than the level of substantial gainful activity), and labor force participation (the fraction of applicants with working hours greater than zero) for the full sample of 122,683 applicants aged 18-61 years. Since all applicants are observed for all years of interest, the figures should give us a correct indication of the average behavior of applicants with respect to the economic outcomes. Appendix Figure A.3 shows the public transfers and DI benefits during the same years, indicating a significant increase in such transfers for allowed applicants around the year of DI

award. This figure also confirms that the allowed applicants indeed do get DI benefits in the application

year, while the rejected applicants do not.

Figure 1: Economic Outcomes of Allowed and Rejected Applicants Aged 18-61 by Final Decision, Before and After Final Decision

(a) Earnings ($1,000)

(b) Weekly Working Hours

(c) Earnings > SGA

(d) Labor Force Participation

Notes: The figures show the behavior of allowed, rejected and the estimated rejected applicants once weighted around the year of the final DI award decision. The final DI award decision is defined as the last observed DI application that is observed for each individual. An applicant is considered as allowed if initially allowed or allowed by reapplying for DI benefits. If an applicant is not observed to have been allowed DI benefits by the end of the sample (by 2010), the applicant is defined as a rejected applicant. The sample includes all Norwegian applicants that filed their final observed DI application during the years of 1998-2003 and were of 18-61 years of age, did not die by the end of the sample and have not been observed to receive DI benefits prior to the initial observed application. Labor force participation is defined as working hours greater than zero. Earnings are measured in 2005 dollars in units of $1,000 using an exchange rate of $/NOK = 6, and are defined as labor income plus business income.

The first thing to note is the remarkably similar outcomes of the rejected applicants once weighted compared to allowed applicants prior to the year of DI award. Because allowed applicants should be relatively unaffected by the DI award decision in the years prior to the application, the weighted estimates should be around the same. However, the figures suggest there may be a small treatment effect in the year prior to the decision. This could represent a smoothing-effect as the applicants may take into account the possibility of DI award. On the other hand, it could also represent declining health of allowed applicants relative to rejected applicants prior to the application year. Under the assumption of equation 3, the potential earnings and labor supply of allowed applicants could be smaller than the weighted estimates of rejected applicants.

In the years post the final allowance decision, the patterns of earnings and labor supply of allowed applicants appear to remain fairly stable after dropping in the years around the decision. This is in stark contrast with the patterns of rejected applicants whose earnings and labor supply indicate increasing trends. Also, the estimated outcomes of the rejected applicants once weighted follow similar patterns as those of the observed rejected applicants. However, the estimated outcomes appear to be consistently larger than those of the rejected applicants. As it seems, we cannot rule out the possibility of allowed applicants having greater potential earnings and labor supply than rejected applicants.

I now turn to the quantitative analysis of the treatment effects as well as the analysis of rejected applicants as a control group for allowed applicants. Table 2 displays the estimated difference between the economic outcomes of allowed and rejected applicants once weighted (the estimated upper-bound treatment effect) and the difference between the rejected applicants and the estimated outcomes of the weighted rejected applicants, respectively. The outcome variables considered are the same as those of Figure 1 (earnings, weekly working hours, earnings above the SGA threshold and labor force participation). In order to get an impression of how these effects evolve in the years post the DI decision, I include estimates 1, 3 and 5 years after the final decision. In addition, I include estimates of the differences between allowed and rejected applicants once weighted in the year prior to the decision. These estimates give us an indication of whether there may be a treatment effect prior to the decision.

In order to get correct indications of the standard errors, I estimate bootstrap standard errors using 500 replications. This approach ensures that the stochastic component of the estimated probabilities are taken into account when calculating the standard errors. More generally, the differences between allowed and weighted rejected applicants indicate the estimated (upper-bound) average treatment effect

of the treated (ATT). In this particular case, the standard errors would be upward biased if we did not take into account that the estimated probabilities were stochastic. The same is true considering the estimated differences between the rejected applicants and the weighted rejected applicants. Obviously, the estimated outcomes of the weighted rejected applicants are positively related with the observed outcomes of the rejected applicants. Taking this into account give reduced standard errors compared to the case of calculating standard errors only based on differences in means. Because of this, the bootstrap standard errors are not only more correct, but also conduce more precision.

Table 2: Upper-Bound and Control Group of Rejected Applicants Estimates, Applicants Aged 18-61 Years by the Final Decision

	1 year pre final decision	1 year post final decision		3 years post final decision		5 years post final decision	
Difference between:							
Allowed & Weighted	✓	✓		✓		✓	
Rejected & Weighted			✓		✓		✓
Outcomes:							
Earnings	-2.64***	-16.43***	-5.28***	-18.70***	-3.12***	-19.37***	-1.82***
	(0.704)	(0.660)	(0.563)	(0.616)	(0.537)	(0.667)	(0.573)
Working Hours	-1.37***	-5.76***	-1.72***	-8.01***	-0.97***	-9.42***	-0.19
	(0.315)	(0.374)	(0.319)	(0.369)	(0.292)	(0.394)	(0.313)
Earn > SGA	-0.06***	-0.59***	-0.11***	-0.57***	-0.04***	-0.55***	-0.02*
	(0.016)	(0.014)	(0.013)	(0.013)	(0.011)	(0.013)	(0.011)
Labor Force	-0.05***	-0.21***	-0.11***	-0.22***	-0.07***	-0.24***	-0.05***
Participation	(0.015)	(0.015)	(0.013)	(0.012)	(0.011)	(0.013)	(0.011)
Observations	122,683	122,683	13,294	122,683	13,294	122,683	13,294

*** significant at 1% level, **significant at 5% level, *significant at 10% level.
Standard errors (shown in parentheses) are clustered on the individual level. All estimates report bootstrap standard errors using 500 replications.
Notes: The table displays the differences in means between the estimated outcomes of weighted applicants and the allowed and rejected applicants, respectively. The estimates are shown for the respective years relative to the final DI award decision of applicants. The final DI award decision is defined as the last observed DI application that is observed for each individual. An applicant is considered as allowed if initially allowed or allowed by reapplying for DI benefits. If an applicant is not observed to have been allowed DI benefits by the end of the sample (by 2010), the applicant is defined as a rejected applicant. The sample includes all Norwegian applicants that filed their final observed DI application during the years of 1998-2003 and were of 18-61 years of age, did not die by the end of the sample and have not been observed to receive DI benefits prior to the initial observed application. Labor force participation is defined as working hours greater than zero. Earnings are measured in 2005 dollars in units of $1,000 using an exchange rate of $/NOK = 6, and are defined as labor income plus business income.

The estimated upper-bound treatment effects are all significant at the 1% level, and indicate that allowed applicants may exhibit additional earnings and labor supply potentials. However, these estimates do not prove that the treatment effects are significantly greater than zero under the assumption of equation 3. What the estimates do tell us, are that the earnings of individuals on DI receipt at most would have been approximately $16,430, $18,700 and $19,370 greater if they had not been awarded DI benefits 1, 3 and 5 years after the final decision, respectively. Also, the estimates indicate that labor force participation rate of allowed applicants at most would have been 20-25 percentage points higher if they had not been awarded DI benefits. As predicted, the estimates confirm that there may be apparent treatment effects in the year prior to the decision. Considering earnings, working hours and labor force participation, the estimates suggest that the treatment effects may be increasing in time post the decision. This should come as no surprise as rejected applicants indicate upward sloping trends post the final decision. This may be a result of rejected applicants getting healthier, but could also indicate greater responsiveness to economic incentives in the longer run.

The estimates also confirm that the outcomes of the rejected applicants once weighted in general are significantly different from those of the observed rejected applicants. Because the outcomes of the weighted rejected applicants are greater than those of the rejected applicants, allowed applicants may exhibit greater earnings and labor supply potentials compared to rejected applicants. In other words, the hypothesis of Bound (1989) may be violated for the Norwegian applicants. However, the estimated differences tend to decrease with years after the final DI decision, and the estimated differences are not significant at the 5% level 5 years after the decision considering working hours and earnings above the SGA threshold. This finding may indicate that using rejected applicants as a control group for allowed applicants works better some years after the final allowance decision.
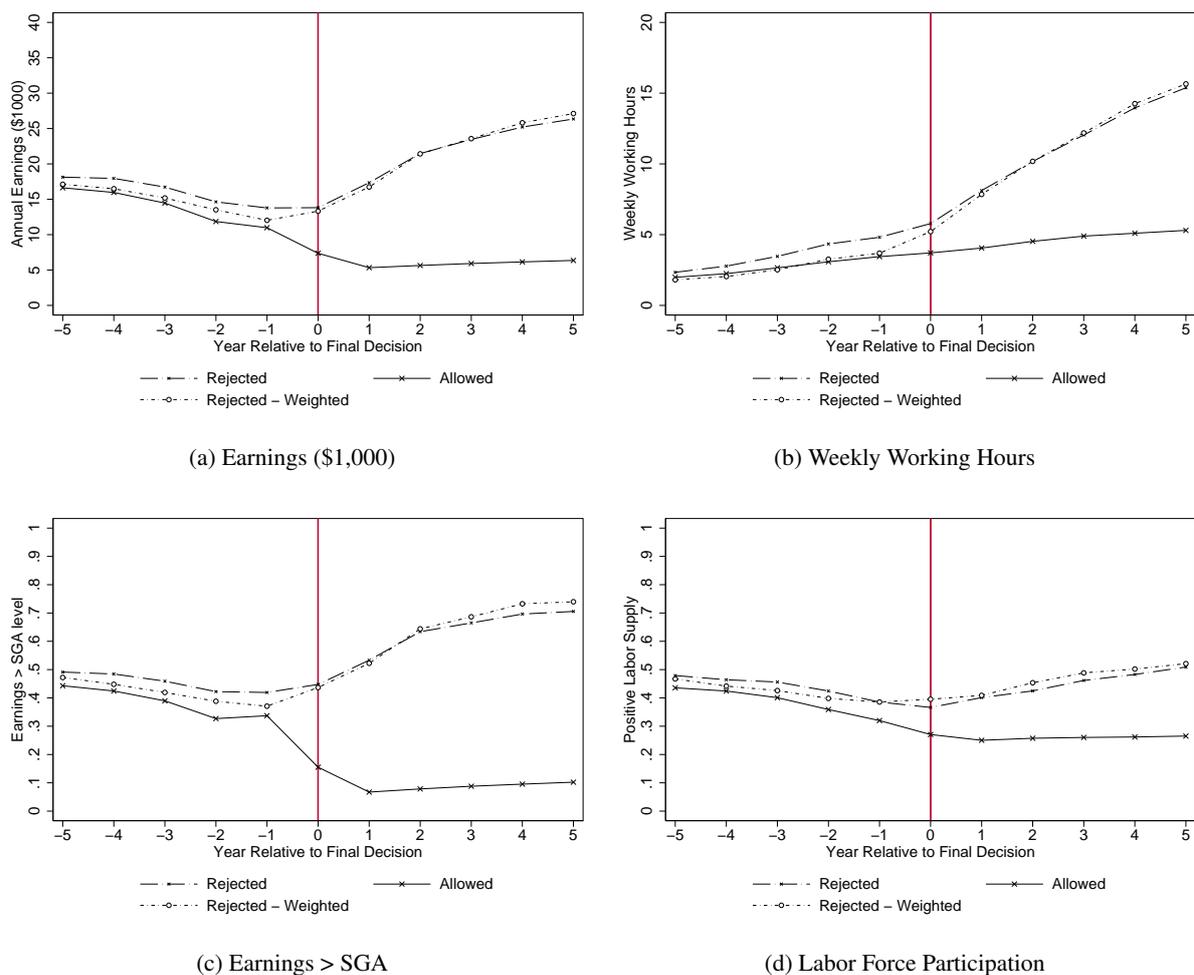
4.3 Heterogeneity

Figure 1 demonstrated the behavior of allowed and rejected applicants around the year of the final DI award decision. However, there are reasons to believe that the effects of interest are different for different types of applicants. Particularly, I investigate whether the effects are heterogeneous with respect to age and the degree of disability. Getting a better understanding of heterogeneity in age makes us better equipped to compare these effects with the effects of older beneficiaries in the second analysis.

4.3.1 Applicants Aged 18-39 Years by the Final DI award Decision

Figure 2 reports the exact same outcomes as those of the full sample, but restricting the sample to applicants aged 18-39 years by the final decision. Table estimates of the upper-bound treatment effects and the estimated differences between the weighted rejected applicants and the rejected applicants are shown in Appendix Table A.2.

Figure 2: Economic Outcomes of Allowed and Rejected Applicants Aged 18-39 by Final Decision, Before and After DI Decision

(a) Earnings ($1,000)

(b) Weekly Working Hours

(c) Earnings > SGA

(d) Labor Force Participation

Notes: The figures show the behavior of allowed, rejected and the estimated rejected applicants once weighted around the year of the final DI award decision. The final DI award decision is defined as the last observed DI application that is observed for each individual. An applicant is considered as allowed if initially allowed or allowed by reapplying for DI benefits. If an applicant is not observed to have been allowed DI benefits by the end of the sample (by 2010), the applicant is defined as a rejected applicant. The sample includes all Norwegian applicants that filed their final observed DI application during the years of 1998-2003 and were of 18-39 years of age, did not die by the end of the sample and have not been observed to receive DI benefits prior to the initial observed application. Labor force participation is defined as working hours greater than zero. Earnings are measured in 2005 dollars in units of $1,000 using an exchange rate of $/NOK = 6, and are defined as labor income plus business income.
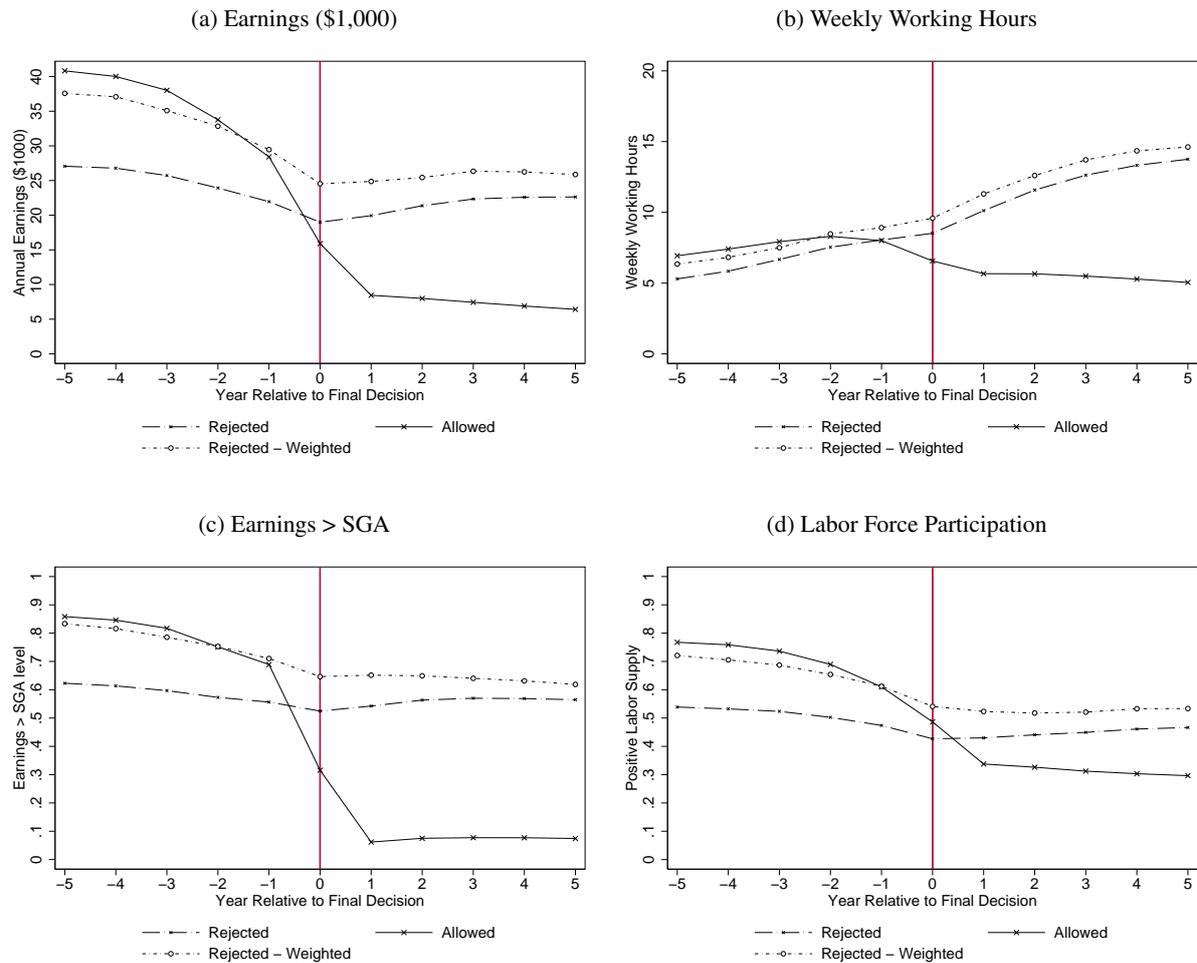
The outcomes of this particular group of applicants are very different from those of the full sample. The first thing to note, is that the pre-trends of allowed and rejected applicants are nearly identical. In fact, the outcomes of rejected applicants are slightly greater than those of the allowed applicants, completely different from the full sample of applicants. Also, the outcomes of the weighted rejected applicants are almost identical to those of the observed rejected applicants, and none are significant at the 10% level. Under the assumptions of the model, these estimates suggest that rejected applicants could be a desirable control group when only considering applicants 18-39 years. In addition,

The estimates of Appendix Table A.2 indicate that the upper-bound treatment effects are similar to those of the full sample, but to a greater extent increase in years after the final DI award decision. 1 year post the decision, the estimated upper-bound treatment effect of labor force participation is 16%, but increases to 26% after 5 years. These findings suggest a greater responsiveness of younger applicants to not being awarded benefits in the longer run. This could be a result of increasing health of rejected applicants, but it could also represent a greater responsiveness to economic incentives of younger applicants. As younger applicants benefit from reentry to the labor force over a longer period of time, they face greater incentives of work than older applicants. In addition, they are likely to have fewer options to replace lost income than older applicants, and may also face smaller losses in human capital, which may induce a larger share of younger applicants to work.

4.3.2 Applicants Aged 40-61 Years by the Final DI award Decision

Figure 3 reports the estimated outcomes of the sample of applicants aged 40-61 years by the final decision. Table estimates of the upper-bound treatment effects and the estimated differences between the weighted rejected applicants and the rejected applicants are shown in Appendix Table A.3.

Figure 3: Economic Outcomes of Allowed and Rejected Applicants Aged 40-61 by Final Decision, Before and After DI Decision

(a) Earnings ($1,000)

(b) Weekly Working Hours

(c) Earnings > SGA

(d) Labor Force Participation

Notes: The figures show the behavior of allowed, rejected and the estimated rejected applicants once weighted around the year of the final DI award decision. The final DI award decision is defined as the last observed DI application that is observed for each individual. An applicant is considered as allowed if initially allowed or allowed by reapplying for DI benefits. If an applicant is not observed to have been allowed DI benefits by the end of the sample (by 2010), the applicant is defined as a rejected applicant. The sample includes all Norwegian applicants that filed their final observed DI application during the years of 1998-2003 and were of 40-61 years of age, did not die by the end of the sample and have not been observed to receive DI benefits prior to the initial observed application. Labor force participation is defined as working hours greater than zero. Earnings are measured in 2005 dollars in units of $1,000 using an exchange rate of $/NOK = 6, and are defined as labor income plus business income.

These outcomes are much like the outcomes of Figure 1 which uses the full sample of applicants. Also, the table estimates of the upper-bound treatment effects are quite similar to those of the full sample. This should come as no surprise as most applicants in the full sample are in this age segment.[19] However, the differences between the outcomes of the weighted rejected applicants and the observed

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[19]More precisely, applicants aged 40-61 years by the final decision amount to approximately 80% of the sample.
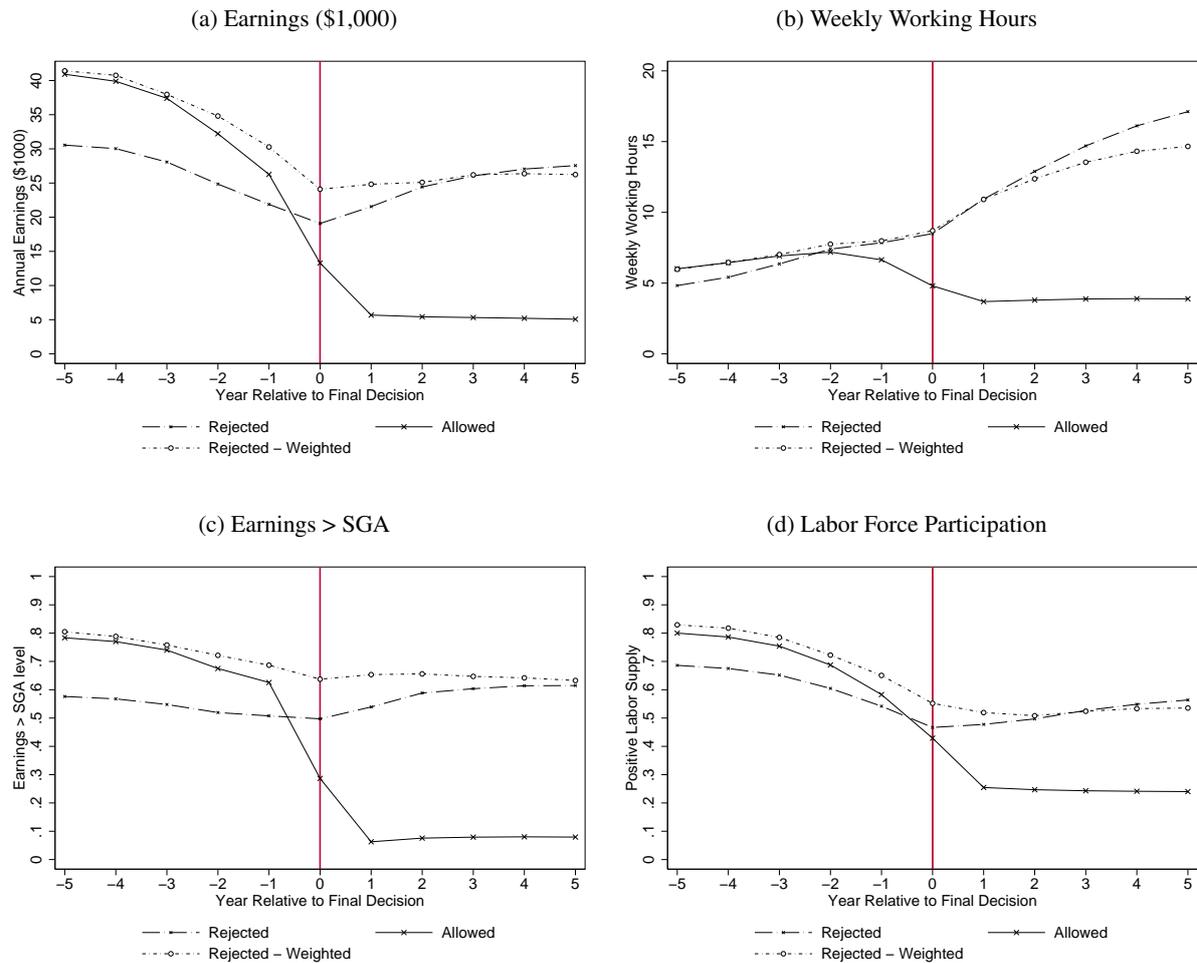
rejected applicants appear to be somewhat greater in this subsample. This is also evident in Appendix Table A.3 as all but one of these estimates are significant at the 1% level. The differences appear to be quite consistent over time. The pre-decision outcomes of particularly earnings, earnings above the SGA threshold and labor force participation appear to be more different between allowed and rejected applicants compared to the full sample. More specifically, pre-application differences in observable characteristics between allowed and rejected applicants appear to be an even bigger issue when considering the sample of applicants 40-61 years. Together with the results of applicants aged 18-39 years, these estimates indicate that rejected applicants work much better as a control group if pre-application characteristics are not too different, as one would expect. This statement backs up the arguments of Bound (1989).

The rejected applicants do not show the same responsiveness to not being awarded DI benefits as the applicants aged 18-39 years in the longer run. This may indicate a lower degree of response to economic incentives of older applicants. As it appears, most of the long run-response to not being awarded DI benefits in the main sample can be attributed to younger applicants.

4.3.3 Totally Disabled Applicants Aged 18-61 Years by the Final DI award Decision

Figure 4 displays the estimated outcomes of the sample of applicants classified as totally disabled (applicants who are eligible for the full amount of DI benefits) and aged 18-61 years by the final decision. Table estimates of the upper-bound treatment effects and the estimated differences between the outcomes of the rejected applicants once weighted and the observed outcomes of the rejected applicants are shown in Appendix Table A.4.

Figure 4: Economic Outcomes of Totally Disabled Allowed and Rejected Applicants Aged 18-61 by Final Decision, Before and After DI Decision

(a) Earnings ($1,000)

(b) Weekly Working Hours

(c) Earnings > SGA

(d) Labor Force Participation

Notes: The figures show the behavior of allowed, rejected and the estimated rejected applicants once weighted around the year of the final DI award decision. The final DI award decision is defined as the last observed DI application that is observed for each individual. An applicant is considered as allowed if initially allowed or allowed by reapplying for DI benefits. If an applicant is not observed to have been allowed DI benefits by the end of the sample (by 2010), the applicant is defined as a rejected applicant. The sample includes all Norwegian applicants classified as totally disabled that filed their final observed DI application during the years of 1998-2003 and were of 18-61 years of age, did not die by the end of the sample (by 2010) and have not been observed to receive DI benefits prior to the initial observed application. Labor force participation is defined as working hours greater than zero. Earnings are measured in 2005 dollars in units of $1,000 using an exchange rate of $/NOK = 6, and are defined as labor income plus business income.

The outcomes are similar to those of the full sample, and particularly the pre-decision trends of allowed and rejected applicants. For this subsample, rejected applicants appear to work quite well as a control group considering the upper-bound treatment effects. According to the table estimates of Appendix Table A.4, none of the estimates of the differences in outcomes between the weighted estimates and the rejected applicants are significantly smaller than zero when considering outcomes 3

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and 5 years post the decision. In fact, the patterns of the rejected applicants once weighted appear to be much more stable than those of the observed rejected applicants, and consistent with the patterns of the allowed applicants.

The outcomes of the rejected applicants increase consistently more steeply in the years after the final decision compared to the full sample. Also, the estimates of the upper-bound treatment effects are greater than those of the full sample. Particularly, the estimates suggest that labor force participation at most would have been 26%, 28% and 30% greater if the totally disabled applicants would not have been awarded DI benefits. These findings give no indications of totally disabled applicants responding less to economic incentives than partially disabled applicants. However, it could be that the totally disabled allowed applicants are hit by larger health shocks than partially disabled applicants, and that these estimates give false indications of larger treatment effects of totally disabled applicants. These estimates are, after all, upper-bound estimates under the assumption of the model. Nonetheless, the greater responsiveness of rejected applicants may indicate that even the applicants classified as totally disabled exhibit considerable potential earnings and labor supply.

5   Behavior of DI recipients around Full Retirement Age

In Norway, DI beneficiaries are automatically transferred from the DI program to the retirement program at the age of 67. This is also evident in Appendix Figure A.4 as the full restricted sample of allowed applicants aged 62-65 years stop receiving DI benefits at the age of 67. The level of benefits that the individuals receive, however, does in general not change because of this transition. Importantly, the work incentives of the prior beneficiaries change substantially as they no longer face the same earnings restrictions implied by the DI program. In this way, this transition allows us to find out about whether individuals on DI receipt exhibit additional earnings and labor supply potentials, and to what extent the earnings restrictions implied by the DI program provide work disincentive effects.

5.1   Background

An important feature of the Norwegian welfare system, is that individuals are eligible for the same amount of DI benefits and retirement benefits. Thus, the level of public transfers received should in

general not change as the DI recipients are transferred to the retirement program.[20] Appendix Figure A.4 shows evidence of public transfers being quite stable at the same level before and after the transition (the minor increase is due to the fact that some DI recipients have earnings levels above the SGA threshold, and get a reduced level of benefits). However, the participants of the respective programs face very different earnings restrictions, which determine the levels of benefits actually received. This creates a major difference in the work incentives of the two programs.

Figure 5 shows the budget constraint of a typical DI recipient as he is transferred to retirement benefits.[21] The line AFG (slope equal to one) applies in the absence of any DI or retirement program. If the individual does not receive any benefits, total income equals earnings. For a DI recipient receiving the full level of benefits, the budget constraint is given by BCDEFG. Benefits are provided in full at the budget segment BC. If earnings are greater than the SGA threshold of $10,000 in annual earnings, benefits are phased out at a rate of approximately $0.6 for every $1 in earnings. This leads to a discontinuous reduction in DI benefits, and creates the notch in the budget constraint represented by the line CD. The individual becomes ineligible for DI benefits if annual earnings are greater than approximately $32,000, creating the second notch represented by EF. These discontinuous reductions in DI benefits then may incentivize DI beneficiaries to reduce earnings and/or labor supply compared to what they would have done in the absence of the earnings restrictions.

When the DI recipient is transferred to the retirement program, the budget constraint changes to BHI given that the pension benefits are the same as the benefits received on the DI program. At $20,000 in annual earnings, retirement benefits are phased out at a rate of approximately $0.4 for every $1 in earnings, but only for earnings above this level. However, the main work disincentive effects of the DI program disappear. When the individuals turn 70, the budget constraint becomes BHJ as retirement benefits are no longer phased out when annual earnings are greater than $20,000.

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[20]Provided that the individuals receive the full amount of DI benefits, and does not have earnings levels above the SGA threshold.

[21]Because the budget constraint of DI recipients depends on the amount of benefits received, the budget constraint will look different for recipients receiving different amounts of benefits. Therefore, I show the budget constraint for a DI recipient receiving the average level of benefits. Importantly, the level of earnings that leads to a reduction in DI benefits, is the same for all beneficiaries (the SGA threshold).

Figure 5: Budget Constraint
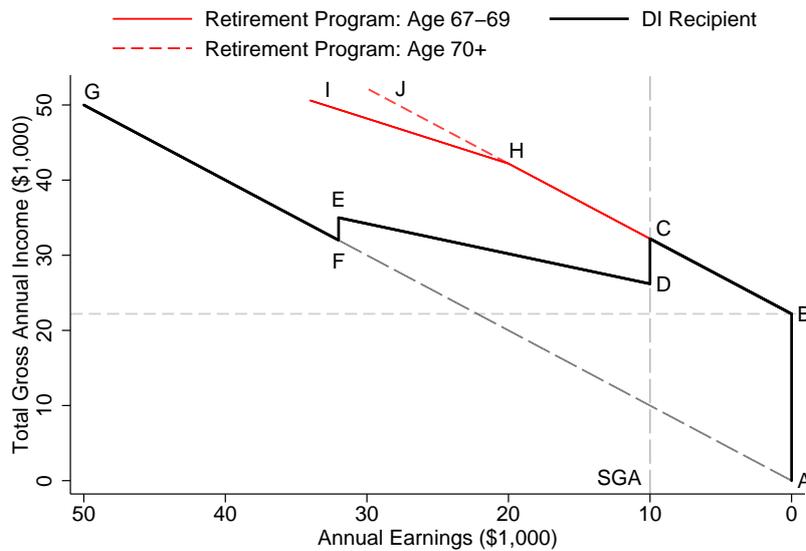
Notes: The black solid line represents the set of earnings and total gross income for a typical DI recipient who were awarded the full level of benefits during the years of 1998-2003, and were 62-65 years of age by the final DI award decision. The red lines represent how the budget constraint changes as the the DI recipients are transferred to the retirement program, keeping the baseline level of benefits constant. For simplicity, the figure disregards income taxation and dependent benefits. Total annual gross income thus represents earnings plus DI benefits. Earnings are measured in 2005 dollars in units of $1,000.

This change in work incentives is similar to the recently introduced rules of the Norwegian DI program (and also the proposed "$1 for $2 offset" program in the US), which also eliminates the first notch in the budget constraint. Thus, the responsiveness of retired beneficiaries could give us some indications of the effects of the new rules of the Norwegian DI program. However, the effects are not directly comparable as there most likely would be significant differences in the responsiveness of individuals on DI receipt and retired beneficiaries. Furthermore, the retired DI beneficiaries face even stronger work incentives in terms of total income as the retirement benefits are not phased out in the same way as earnings increase.

The change in the budget constraint of individuals thus creates a discontinuous change in work incentives for the individuals when turning 67 years, but keeping the level of benefits constant. However, it is not clear whether the DI recipients who participate in the labor force prior to the transition will change their behavior when reaching the retirement age of 67 years. First, the individuals get older when they are transferred to the retirement program, and it is reasonable to assume that their work capacity decline with age around these years. Also, there may be some DI recipients participating in the labor force prior to the transition who retire from work at the age of 67 (as the majority of individuals
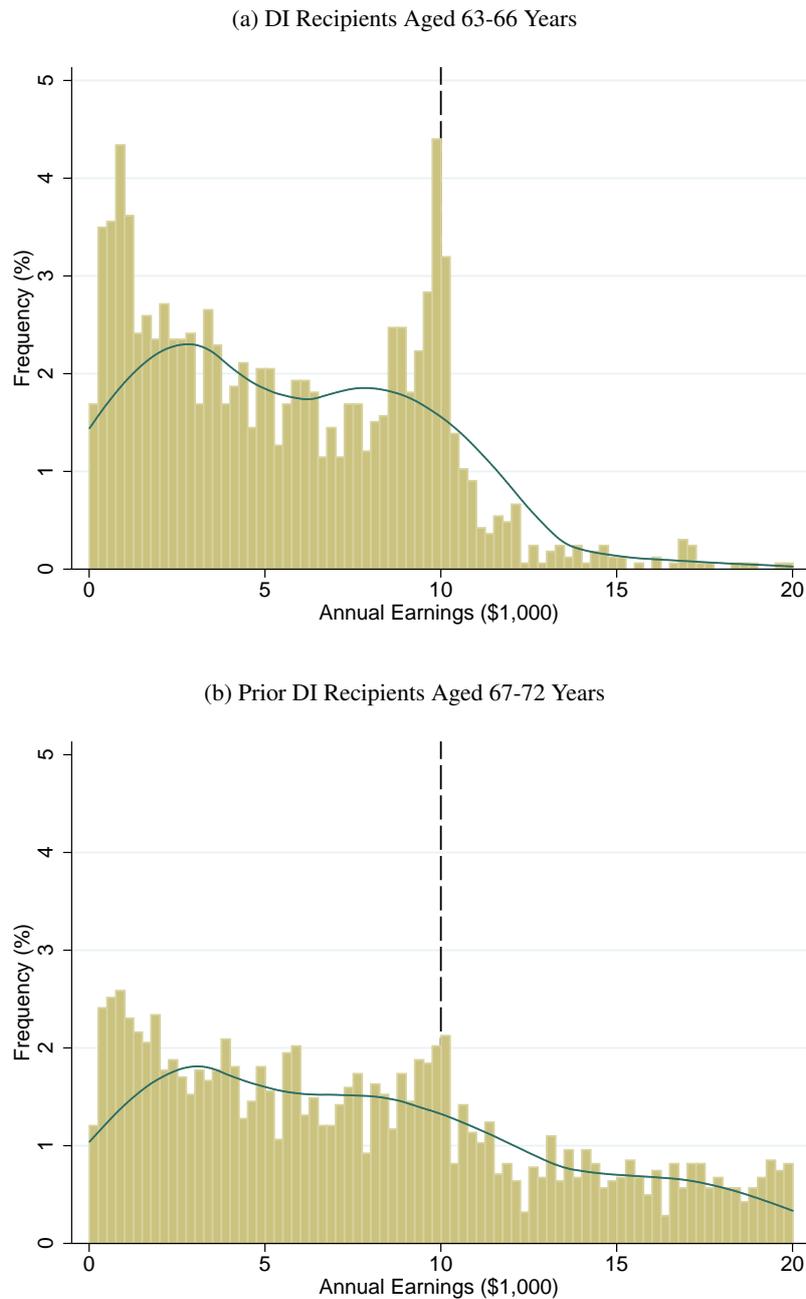
29

not on DI do). In addition, individuals may face difficulties participating in the labor force after the transition, as some enterprises allow for the possibility of dismissing employees when turning 67 years of age. However, most enterprises operate with an age restriction of 70 years before employees can be dismissed. In Norway, there is no employment protection for individuals above 70 years of age. In light of the improved work incentives after individuals turn 70 years (as retirement benefits are no longer phased out when annual earnings exceed $20,000), this leaves an ambiguous effect on earnings and labor supply after individuals turn 70 years.

Differences in the tax schemes of the respective programs could also potentially affect the work incentives of individuals, and bias the estimated effects of DI recipients being transferred to the retirement program. However, the individuals on DI receipt face similar tax deductions as those on retirement benefits, and both groups also face lower tax rates on labor income compared to individuals not on DI. Thus, the taxation on labor income for individuals should not affect the behavior of the individuals by too much.

5.2 Bunching

Because individuals on DI receipt face incentives to keep the level of earnings below the SGA threshold of $10,000, some recipients may "bunch" below this level. Figure 6 shows the earnings distributions of DI recipients in the years prior to being transferred to retirement benefits and in the years after the transition, respectively. For simplicity, only the individuals with positive levels of working hours and earnings are included, and only earnings levels between $0 and $20,000 are being shown.

Figure 6: Earnings Distributions of DI Recipients Before and After being Transferred to the Retirement Program, All Years

(a) DI Recipients Aged 63-66 Years

(b) Prior DI Recipients Aged 67-72 Years

Notes: The figures show the earnings distributions of the respective age-groups of DI recipients as they are transferred to retirement benefits at the age of 67. Only individuals with positive levels of earnings and a positive level of working hours are included. The green lines report Kernel densities using a bandwidth of 1.6. The sample includes all Norwegian applicants that were awarded the full level of DI benefits during the years of 1998-2003 and were of 62-65 years of age, entered the retirement program by 2005, received DI benefits in the year prior to being transferred to retirement benefits, did not die by the end of the sample (by 2010) and have not been observed to receive DI benefits prior to the initial observed application. Earnings are measured in 2005 dollars in units of $1,000 using an exchange rate of $/NOK = 6, and are defined as labor income plus business income.

Figure a) displays the earnings distribution of the individuals on DI receipt post the final decision, and shows that there appears to be excessive mass in the segment just below the SGA threshold. Considering the mass above the indicated frequency of the Kernel density in the earnings segment of $8,000 - $10,000, the estimated excessive mass is around 5%, indicating that around 5% of the individuals with a positive labor supply and earnings reduce earnings and/or labor supply in order to keep the full amount of DI benefits. In addition, there may be individuals on DI receipt not working because of the earnings restrictions, but would have done so in the absence of the restrictions.

This bunching behavior is no longer evident when the recipients reach the full retirement age, and are no longer bound by the SGA threshold as displayed in Figure b). Importantly, there is clear evidence of increased mass in the segment $10,000 - $20,000. This suggests that some of the individuals who were bound by the earnings restrictions prior to the transition increase earnings when receiving retirement benefits, as the SGA restriction no longer applies.

The behavior becomes even more evident when considering the earnings distributions of those in Appendix Figure A.5, which reports the earnings distributions for each year of the respective ages of individuals. The bunching behavior below the SGA threshold is clearly evident before the transition (when individuals are 65 and 66 years of age). When the DI recipients are transferred to the retirement program at the age of 67 years, there is little evidence of such behavior (considering the earnings distribution of retired DI beneficiaries aged 67 and 68 years). One can also see that the mass in the segment $10,000 - $20,000 clearly increases in these years.

5.3 Graphical Evidence

Figure 7 provides a descriptive look at the behavior of DI recipients when reaching the retirement age, displaying economic outcomes before and after the transition. Graph a) shows annual earnings, graph b) displays average working hours per week, graph c) shows the fraction of individuals whose earnings are greater than the SGA threshold, and the fraction of individuals with working hours greater than zero is displayed in graph d). Prior to reaching the retirement age, only the years strictly greater than the year of the final application for each allowed applicant are included. Thus, the economic outcomes displayed in the figure can be interpreted as the average behavior of the respective sample of individuals on DI receipt being transferred to the retirement program.

Figure 7: Economic Outcomes of Allowed Applicants Aged 62-65 by Final Decision, Before and After Year of Retirement

(a) Earnings ($1,000)	(b) Weekly Working Hours

(c) Earnings > SGA	(d) Labor Force Participation
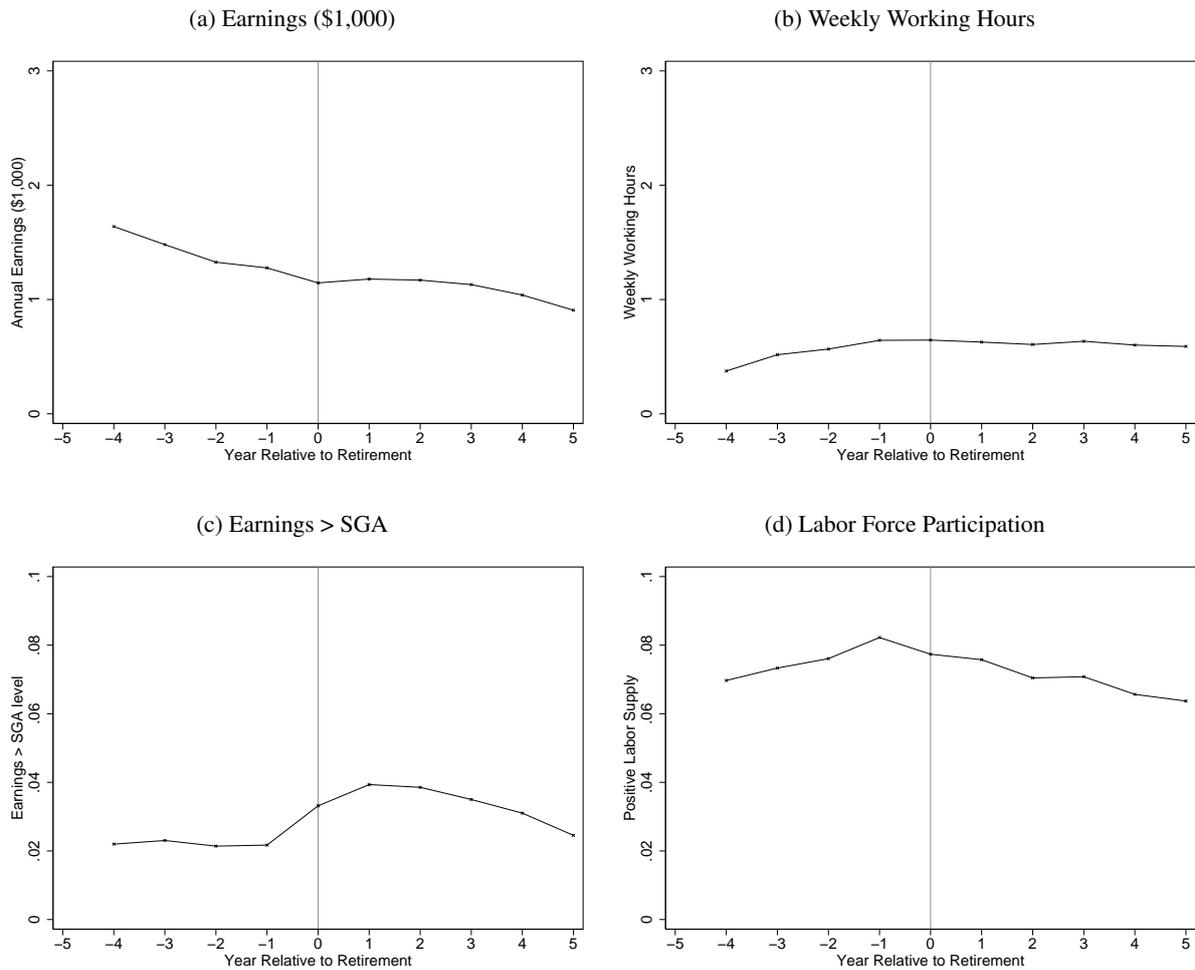
Notes: The figures show economic outcomes of individuals on DI receipt around the years of being automatically transferred to retirement benefits at the age of 67. The sample includes all Norwegian applicants that were awarded the full level of DI benefits during the years of 1998-2003 and were of 62-65 years of age, entered the retirement program by 2005, received DI benefits in the year prior to being transferred to retirement benefits, did not die by the end of the sample (by 2010) and have not been observed to receive DI benefits prior to the initial observed application. Labor force participation is defined as working hours greater than zero. Earnings are measured in 2005 dollars in units of $1,000 using an exchange rate of $/NOK = 6, and are defined as labor income plus business income.

Figure a) indicates a downward sloping trend in the earnings of DI recipients prior to the transition. However, the trend does not continue to slope downwards after the transition, suggesting that some recipients may respond to the improved work incentives. Figure c) shows a significant jump in the fraction of DI recipients whose earnings are greater than the SGA threshold as the DI recipients reach the full retirement age. This is consistent with the findings of the bunching analysis, and confirms that a certain fraction of individuals increase earnings when the earnings restrictions no longer apply. In the

years prior to the transition, the fraction of recipients above the SGA threshold is quite stable around 2%. In the year of when recipients turn 67 years, the fraction of individuals whose earnings are greater than the SGA threshold jumps to approximately 3.3%. The fraction increases to approximately 4% of all individuals as the individuals turn 68 and 69 years, respectively. As individuals turn 67 years at different points of time in the year of when they retire, it is not completely clear how the earnings restrictions apply in the year of retirement. Because of this, some individuals may still have incentives to reduce earnings compared to their optimal level in this particular year, explaining why the fraction jumps once more as the individuals turn 68.

These findings suggest heterogeneous responsiveness of recipients to the transition. Although the trend in average earnings of individuals is non-increasing, the increase in the fraction of individuals above the SGA threshold suggests that some individuals respond to the work incentives, and increase earnings and/or labor supply. This fact also supports the hypothesis of an underlying downward-sloping trend in earnings if the work incentives remained unchanged. Assuming that the fraction of recipients above the SGA threshold would have remained at 2% if the earnings restrictions still applied to the individuals above 67 years of age, these findings suggest that approximately 2% of recipients aged 63-66 years reduce earnings (and potentially labor supply) when on DI receipt because of the earnings restrictions. In addition, there may be individuals whose earnings were above the SGA threshold prior to retirement, but below the threshold in the year of turning 67 years. The fraction of recipients who exhibit additional earnings potentials then may exceed 2%.

The observed levels of working hours and labor force participation tell us a different story of the behavior of the individuals. Considering figure b), the trend in working hours appears to be upward sloping prior to the decision, but seems to be fairly flat after the decision. This pattern is not consistent with the trends in earnings, but may have alternative explanations. First, individuals may have higher wages on average before the transition. Since earnings are defined as labor income plus business income, individuals may also have higher levels of business income prior to the transition on average. Another explanation could be errors in the data. As the data on working hours refer to reported working hours of employers, individuals on DI receipt may have incentives to misreport work activity in order to keep the full amount of DI benefits.

Figure d) shows a similar pattern of labor force participation as the level of working hours, and suggest that around 7-8% of the DI recipients have a positive labor supply prior to the transition. Post

the transition, there appears to be a downward sloping trend in the fraction of individuals with a positive labor supply. This may indicate that the "retirement effects" (some of the individuals with a positive labor supply prior to the transition may voluntary retire at the age of 67, and some individuals may face difficulties participating in the labor force when being older than 67 years) dominate the effects of the improved work incentives when considering labor supply at the extensive margin. Taking the labor force participation-rate into account, average working hours of the individuals are strictly increasing as the individuals are transferred to the retirement program. This may indicate that most of the response to the improved work incentives is due to individuals increasing labor supply at the intensive margin. Despite the ambiguous effects on labor supply, there is no clear evidence of individuals increasing labor supply at the extensive margin because of the improved work incentives considering these findings.

5.4 Estimation

The change in work incentives when DI recipients reach the retirement age of 67 years suggest that some recipients may increase earnings and/or labor supply post the transition. In order to estimate the effects of the improved work incentives, I consider a standard panel-data regression model trying to capture an underlying age-effect. Motivated by the relatively linear pre-trends in Figure 7, I estimate a regression model of the following form:

$$Y_{it} = \alpha + Age_{it}\beta + \sum_{t=67}^{72} D_t \gamma_t + u_i + \varepsilon_{it} \tag{6}$$

Where Y_{it} denotes the outcome variable (earnings, weekly working hours, earnings above the SGA threshold or labor force participation) for individual i between time period $t-1$ and t, Age_{it} denotes the age of individual i between time period $t-1$ and t, D_t denote indicators for each year of the changed work incentives, u_i denotes an individual-specific constant term and ε_{it} is an individual-specific error term for each time period t. Thus, β is the effect of a one unit increase in age, and captures the underlying linear age-effect of DI recipients prior to the transition. The coefficients γ_t denote the estimated effects for each year of DI recipients being transferred to retirement benefits (when age is being held constant), and thus face different work incentives.

The model specification implicitly assumes that the age-effects prior to the transition would have remained constant if there were no changes in work incentives. This assumption may be violated for several reasons (discussed below), and should be kept in mind when considering the results of this

model. The assumption seems more reasonable considering the fraction of individuals above the SGA threshold as the outcome variable, as the pre-trend in Figure 7 appears to be quite straight and stable. Considering working hours and labor force participation as the outcome variables, the assumption may not be as reliable as the pre-trends are upward sloping. As mentioned earlier, there may be some issues with these trends. This should be kept in mind when interpreting the estimates of the model.

The assumption of a constant age-effect will be violated if the underlying age-trends are not linear. Also, the "retirement effects" may imply that the underlying trends are not continuous around the particular year of transition. As some individuals may retire from work at the age of 67, and some individuals may face difficulties participating in the labor force after turning 67 years of age, the coefficient estimates of the $D'_t s$ then may underestimate the effects of the improved work incentives. Thus, if interpreting the $D'_t s$ as the effects of the improved work incentives for each year, the coefficient estimates can be interpreted as lower-bound estimates of the improved work incentives under the assumptions of the model.

With this standard panel-data set-up, I allow for the possibility of individuals having different levels of potential earnings and labor supply. Particularly, this is captured by the individual-specific constant term u_i. Under this hypothesis, OLS will in general provide inefficient estimates of the coefficients of interest because of the correlation between u_i and ε_{it}. If there is correlation between the individual-specific term u_i and age (or the indicator variables), the OLS estimates will also be biased. I allow for these correlations to be nonzero, and estimate the regression model using fixed-effects.

5.4.1 Results

Table 3 shows the results of the FE regression model represented in equation 6 for the full restricted sample of DI recipients being 62-65 years of age by the final application. I consider the same outcome variables as those represented in Figure 7. That is earnings, weekly working hours, earnings above the SGA threshold (the fraction of applicants having earnings greater than the level of substantial gainful activity), and labor force participation (the fraction of applicants with working hours greater than zero).

Table 3: FE Regression Model

	Earnings	*Working Hours*	Earn > SGA	*Labor Force Participation*
Constant	10.48***	-3.31**	0.048	0.190**
	(1,427)	(1.341)	(0.067)	(0.092)
Age	-0.14***	0.06***	-0.000	-0.002
	(0.022)	(0.020)	(0.001)	(0.001)
Age dummies:				
D_{67}	0.02	-0.08**	0.012***	-0.004*
	(0.047)	(0.033)	(0.002)	(0.002)
D_{68}	0.19***	-0.15***	0.018***	-0.004
	(0.066)	(0.056)	(0.003)	(0.004)
D_{69}	0.32***	-0.24***	0.018***	-0.008
	(0.091)	(0.077)	(0.004)	(0.005)
D_{70}	0.42***	-0.27***	0.015***	-0.006
	(0.112)	(0.098)	(0.005)	(0.007)
D_{71}	0.47***	-0.36***	0.011*	-0.009
	(0.133)	(0.119)	(0.006)	(0.008)
D_{72}	0.48***	-0.43***	0.005	-0.009
	(0.154)	(0.140)	(0.007)	(0.009)
R^2	0.0016	0.0002	0.0016	0.0003
Observations	94,889	94,889	94,869	94,889

*** significant at 1% level, **significant at 5% level, *significant at 10% level.
Standard errors (shown in parentheses) are clustered on the individual level.

Notes: The table show the results of the regression model represented in equation 6 for the full restricted sample of DI recipients 62-65 years of age. The sample includes all Norwegian applicants that were awarded the full level of DI benefits during the years of 1998-2003 and were of 62-65 years of age, entered the retirement program by 2005, received DI benefits in the year prior to being transferred to retirement benefits, did not die by the end of the sample (by 2010) and have not been observed to receive DI benefits prior to the initial observed application. Labor force participation is defined as working hours greater than zero. Earnings are measured in 2005 dollars in units of $1,000 using an exchange rate of $/NOK = 6, and are defined as labor income plus business income.

The results reveal, among other, some evidence of increased earnings of DI recipients being transferred to retirement benefits under the assumptions of the model. Note that the standard errors increase as the years after the transition increase, indicating more uncertainty about the impact of the improved work incentives in the longer run. Considering earnings as the outcome variable, the estimated coefficient on the underlying age-trend implies that the earnings of recipients decrease with approximately $140 for each year because of recipients getting older. All the estimated coefficients on the indicator variables of being transferred to pension benefits are positive. This may indicate that the effects of the improved work incentives dominate the "retirement effects". However, there is no clear evidence of

response to the improved work incentives of retired beneficiaries when turning 70 years, as retirement benefits are no longer phased out for annual earnings levels above $20,000. This also may be due to negated employment protection when individuals turn 70 years.

The model predicts that the earnings of at least 1.8% of all individuals increase so that the level of earnings becomes greater than the SGA threshold (considering the years of when the individuals are 68 and 69 years of age). These estimates are very similar to the proposed 2% increases earlier on. Also, there is no indication of any nonzero age-effect. These estimates then seem to be more robust to the assumptions of the model as stated earlier.

The model yields no significant results of labor force participation after the transition, which could be because of the "retirement effects". Nonetheless, there is no evidence of individuals increasing labor supply at the extensive margin because of the improved work incentives. Considering working hours as the outcome variable, all results are negative and significant. These findings could have several explanations. First, the age-trend is significant and upward sloping, which may be an issue as stated earlier. Also, it could be that the "retirement effects" dominate. Furthermore, these estimates do not take into account the labor force participation-rate. Considering working hours of the individuals with a positive labor supply, the model predicts positive results of the work incentive-effects (not shown). In other words, the work incentives seem to only have an impact on the intensive margin when considering labor supply.

6   Conclusion

Bound (1989) argued that rejected DI applicants form a natural control group for allowed applicants, and that the observed outcomes of this group serve as upper-bound estimates of the potential earnings and labor supply of DI recipients. By using a reweighting approach similar to the one of Singleton (2012), I have investigated Bound's initial hypothesis for Norwegian DI recipients, and also provided upper-bound estimates of the potential earnings and labor supply of Norwegian DI recipients. I find evidence of rejected applicants not necessarily indicating an upper-bound of the potential earnings and labor supply of allowed applicants. I also find evidence of Norwegian DI recipients aged 18-61 years by the award decision exhibiting limited earnings and labor supply potentials.

By using the same initial sample of Norwegian applicants, I have also investigated an area which has not been given much attention in the literature. When Norwegian DI recipients are transferred to

the retirement program at the age of 67, the individuals are eligible for the same amount of pension benefits as the prior amount of DI benefits. The work incentives of the former DI recipients, however, change significantly. I investigate Norwegian DI recipients who were 62-65 years of age when awarded DI benefits, and find evidence of some individuals responding to the improved work incentives. Also, I find significant evidence of bunching behavior of DI recipients before being transferred to the retirement program. There is no evidence of such behavior after the transition, and evidence of increased mass in the segment above the earnings threshold.

A caveat of my first analysis is that the estimates only can be interpreted as upper-bound estimates. Although giving certain indications, the estimates do not get the complete picture of whether some DI recipients may be able to work, and how DI recipients respond to financial incentives. I investigate this topic in the next section, but the findings of this analysis apply to older DI recipients who were awarded the full level of benefits. Therefore, they do not necessarily give satisfactory indications about the behavior of younger DI recipients. Also, the analysis of retiring DI beneficiaries investigates individuals that are allowed to keep the same amount of benefits. Therefore, this analysis does not add too much information about the potential earnings and labor supply of DI recipients in the counterfactual state of not being awarded DI benefits.

Taken as a whole, we still do not know enough about the behavior of Norwegian DI beneficiaries. Also, little is yet known about the effects of so called return-to-work programs that have already been introduced in Norway, and which still is under consideration in the US. Although this thesis may helps closing that gap, further investigations are needed to understand the various effects of the Norwegian DI program.

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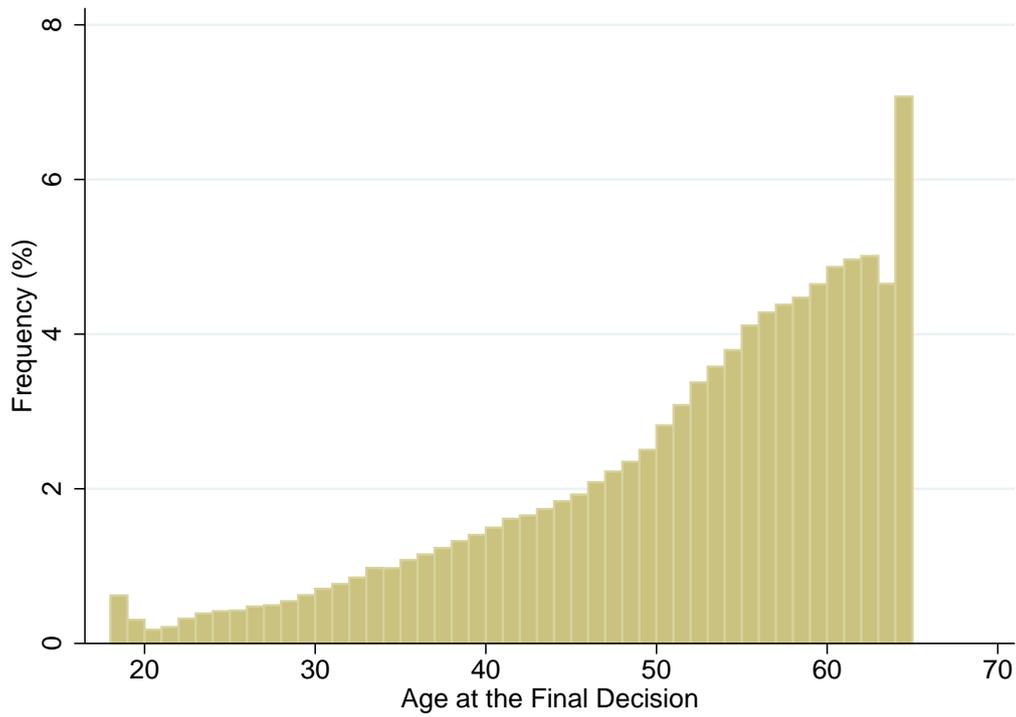
Appendix Graphs and Tables

Figure A.1: Trends in the incidence of DI receipt in Norway
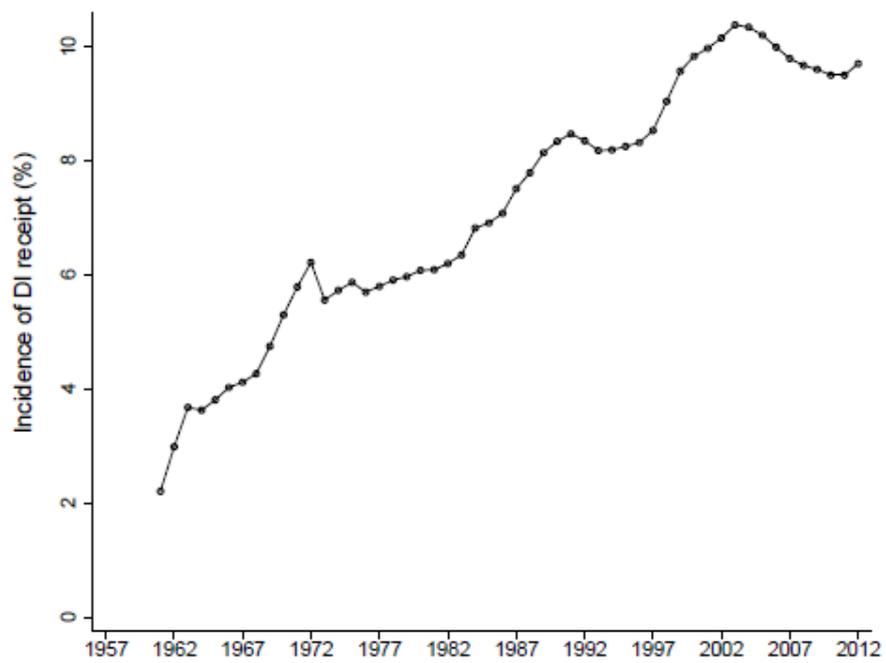
Notes: The Norwegian DI trends are based on those of Kostol & Mogstad (2014). Incidence of DI receipt is defined as the fraction of the adult population (individuals aged 18-67 years) receiving DI benefits.

Figure A.2: Age Distribution of the Full Sample of DI applicants 18-65 Years of Age

Notes: The figure shows the age distribution of the full unrestricted sample of Norwegian DI applicants. The sample consists of all Norwegian applicants who were of 18-65 years of age by the final DI award decision, and were last observed to apply for DI benefits between 1998-2003. The final DI award decision is defined as the last DI application that is observed for each individual. Applicants are observed until 2010.

Figure A.3: Economic Outcomes of Allowed and Rejected Applicants Aged 18-61 by Final Decision, Before and After DI Decision ($1,000)

(a) Transfers and DI Benefits
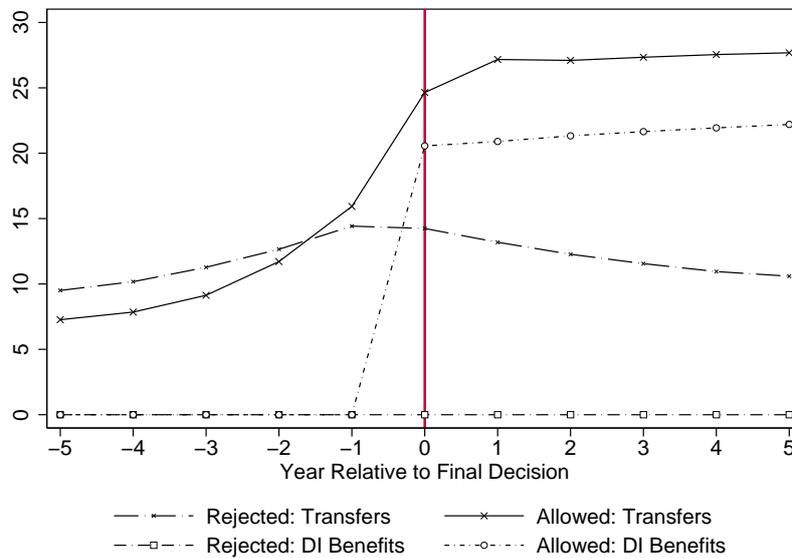
(b) DI Indicator

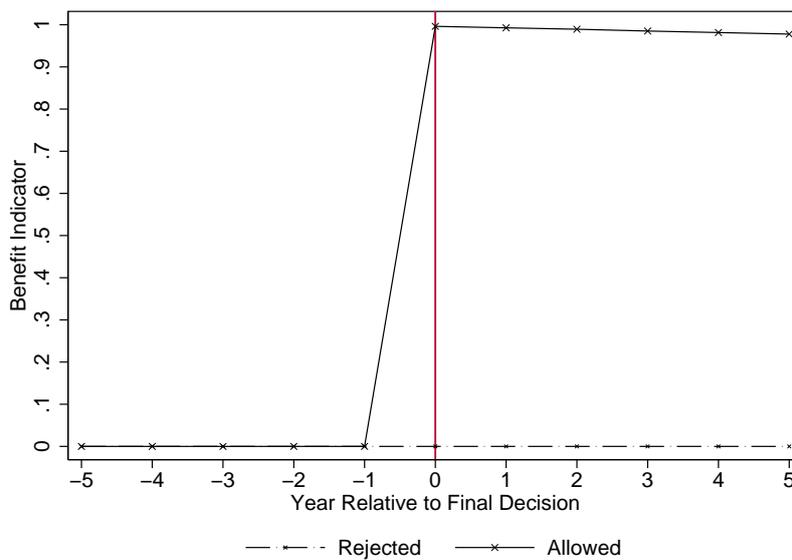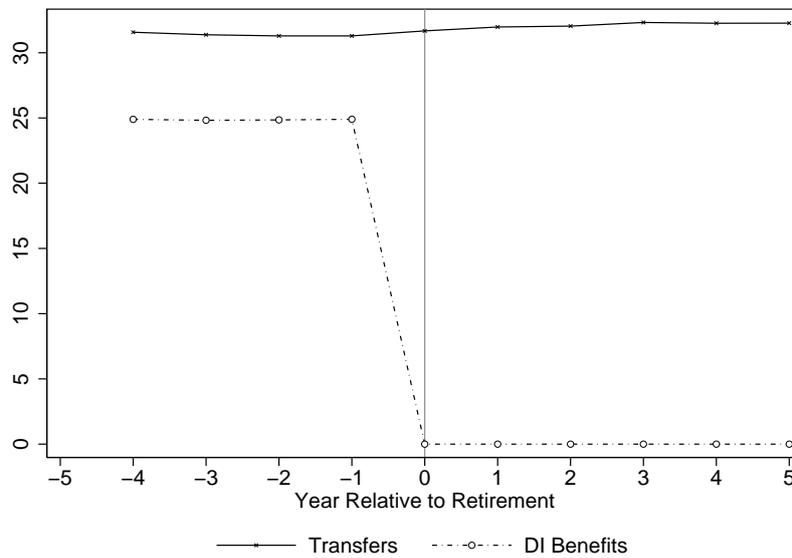*Notes:* The figures show the amounts of transfers, DI benefits and the fraction of applicants on DI receipt of allowed and rejected applicants around the year of their final DI award decision. The final DI award decision is defined as the last observed DI application that is observed for each individual. An applicant is considered as allowed if initially allowed or allowed by reapplying for DI benefits. If an applicant is not observed to have been allowed DI benefits by the end of the sample (by 2010), the applicant is defined as a rejected applicant. The sample includes all Norwegian applicants that filed their final observed DI application during the years of 1998-2003 and were of 18-61 years of age, did not die by the end of the sample and have not been observed to receive DI benefits prior to the initial observed application. Transfers are measured in 2005 dollars in units of $1,000 using an exchange rate of $/NOK = 6, and are defined as all cash transfers received by the government (including DI benefits). The DI indicator is equal to one if DI benefits are greater than zero.

Figure A.4: Economic Outcomes of Allowed and Rejected Applicants Aged 62-65 by Final Decision, Before and After Year of Retirement ($1,000)

(a) Transfers and DI Benefits

(b) DI Indicator

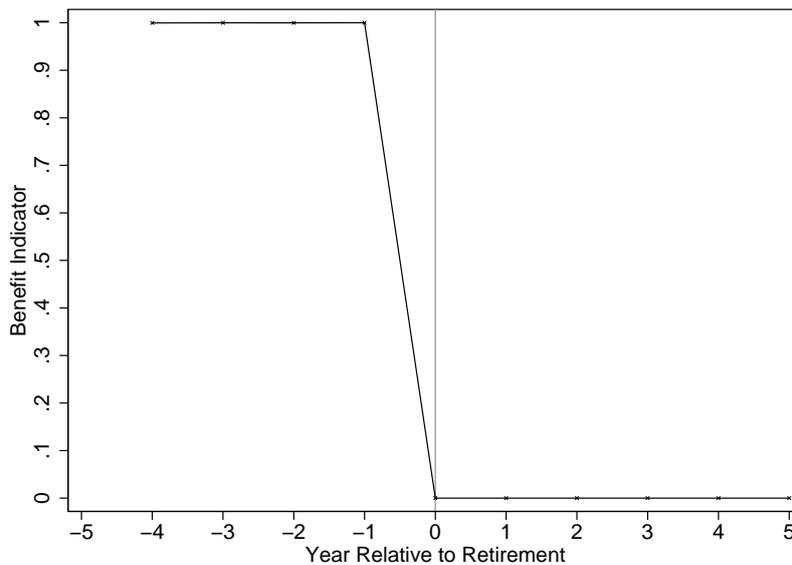*Notes:* The figures show the amounts of transfers, DI benefits and the fraction of applicants on DI receipt of DI recipients around the year of reaching the retirement age of 67 years. The sample includes all Norwegian applicants that were awarded the full level of DI benefits during the years of 1998-2003 and were of 62-65 years of age, entered the retirement program by 2005, received DI benefits in the year prior to being transferred to retirement benefits, did not die by the end of the sample (by 2010) and have not been observed to receive DI benefits prior to the initial observed application. Transfers are measured in 2005 dollars in units of $1,000 using an exchange rate of $/NOK = 6, and are defined as all cash transfers received by the government (including DI benefits). The DI indicator is equal to one if DI benefits are greater than zero.

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Figure A.5: Earnings Distribution of Allowed Applicants in the Years around Retirement, by Age

(a) Individuals 65 Years of Age

(b) Individuals 66 Years of Age

(c) Individuals 67 Years of Age

(d) Individuals 68 Years of Age

Notes: The figures show the earnings distributions of the respective age-groups of DI recipients as they are transferred to retirement benefits at the age of 67. Only individuals with positive levels of earnings and a positive level of working hours are included. The green lines report Kernel densities using a bandwidth of 1.6. The sample includes all Norwegian applicants that were awarded the full level of DI benefits during the years of 1998-2003 and were of 62-65 years of age, entered the retirement program by 2005, received DI benefits in the year prior to being transferred to retirement benefits, did not die by the end of the sample (by 2010) and have not been observed to receive DI benefits prior to the initial observed application. Earnings are measured in 2005 dollars in units of $1,000 using an exchange rate of $/NOK = 6, and are defined as labor income plus business income.

Table A.1: Logit estimation: All Applicants Aged 18-61 by Final Decision

Variable	Coefficient	Robust Std. Error	t-stat
Age	-0.0782***	(0.0105)	-7.49
Age squared	0.0013***	(0.0001)	10.26
Female	0.1806***	(0.0469)	3.85
Married	0.0663	(0.0602)	1.10
Foreign	-0.4663***	(0.0716)	-6.51
Children	-0.8251***	(0.0629)	-13.13
Years of schooling	0.0352***	(0.0095)	3.71
Years of schooling squared	-0.0018***	(0.0006)	-3.24
Experience	0.1404***	(0.0188)	7.47
Experience squared	-0.0046***	(0.0016)	-2.90
Totally disabled	0.1881***	(0.0504)	3.73
Partially disabled	-0.3111***	(0.0617)	-5.04
Social Assistance	-0.9182***	(0.0490)	-18.73
Female*Foreign	-0.1013	(0.0682)	-1.49
Female*Married	-0.6549***	(0.0563)	-11.62
Female*Children	0.1533***	(0.0565)	2.71
Foreign*Married	-0.4251***	(0.0699)	-6.08
Foreign*Children	0.1186*	(0.0689)	1.72
Married*Children	0.4457***	(0.0633)	7.04
Social Assistance*Children	0.5055***	(0.0672)	7.52
Reapplied	0.6306**	0.3041	2.07
Number of reapplications	1.1818***	0.3985	2.97
Number of reapplications squared	-0.1866*	0.1103	-1.69
Years between initial and final decision	-0.6684***	0.0633	-10.54
Years between initial and final decision sq.	0.0680***	0.0095	7.15
Constant	342.17***	16.52	20.71
Linear time trend	X		
Diagnostics codes	X		
Earnings quantiles	X		
Hours of work quantiles	X		
State fixed-effects	X		
R^2	0.1263		
Observations	1,349,513		

*** significant at 1% level, **significant at 5% level, *significant at 10% level.
Standard errors (shown in parentheses) are clustered on the individual level.
Notes: The table displays the main estimates of the logit model where DI award at the final decision is the dependent variable. The final DI award decision is defined as the last observed DI application that is observed for each individual. An applicant is considered as allowed if initially allowed or allowed by reapplying for DI benefits. If an applicant is not observed to have been allowed DI benefits by the end of the sample (by 2010), the applicant is defined as a rejected applicant. The sample includes all Norwegian applicants that filed their final observed DI application during the years of 1998-2003 and were of 18-61 years of age, did not die by the end of the sample and have not been observed to receive DI benefits prior to the initial observed application.

Table A.2: Upper-Bound and Control Group of Rejected Applicants Estimates, Applicants Aged 18-39 Years by the Final Decision

	1 year pre final decision	1 year post final decision		3 years post final decision		5 years post final decision	
Difference between:							
Allowed & Weighted	✓	✓		✓		✓	
Rejected & Weighted			✓		✓		✓
Outcomes:							
Earnings	-1.05**	-11.40***	0.61	-17.65***	-0.12	-20.76***	-0.77
	(0.475)	(0.700)	(0.616)	(0.824)	(0.769)	(0.896)	(0.842)
Working Hours	-0.25	-3.79***	0.27	-7.29***	-0.14	-10.35***	-0.27
	(0.247)	(0.555)	(0.458)	(0.701)	(0.608)	(0.719)	(0.651)
Earn > SGA	-0.03**	-0.46***	0.01	-0.60***	-0.02	-0.64***	-0.03
	(0.015)	(0.020)	(0.017)	(0.023)	(0.021)	(0.024)	(0.022)
Labor Force	-0.07***	-0.16***	-0.01	-0.23***	-0.03	-0.26***	-0.01
Participation	(0.018)	(0.020)	(0.017)	(0.021)	(0.019)	(0.020)	(0.018)
Observations	24,069	24,069	4,722	24,069	4,722	24,069	4,722

*** significant at 1% level, **significant at 5% level, *significant at 10% level.

Standard errors (shown in parentheses) are clustered on the individual level. All estimates report bootstrap standard errors using 500 replications.

Notes: The table displays the differences in means between the estimated outcomes of weighted applicants and the allowed and rejected applicants, respectively. The estimates are shown for the respective years relative to the final DI award decision of applicants. The final DI award decision is defined as the last observed DI application that is observed for each individual. An applicant is considered as allowed if initially allowed or allowed by reapplying for DI benefits. If an applicant is not observed to have been allowed DI benefits by the end of the sample (by 2010), the applicant is defined as a rejected applicant. The sample includes all Norwegian applicants that filed their final observed DI application during the years of 1998-2003 and were of 18-39 years of age, did not die by the end of the sample and have not been observed to receive DI benefits prior to the initial observed application. Labor force participation is defined as working hours greater than zero. Earnings are measured in 2005 dollars in units of $1,000 using an exchange rate of $/NOK = 6, and are defined as labor income plus business income.

Table A.3: Upper-Bound and Control Group of Rejected Applicants Estimates, Applicants Aged 40-61 Years by the Final Decision

	1 year pre final decision	1 year post final decision		3 years post final decision		5 years post final decision	
Difference between:							
Allowed & Weighted	✓	✓		✓		✓	
Rejected & Weighted			✓		✓		✓
Outcomes:							
Earnings	-1.04	-16.42***	-4.94***	-18.91***	-4.00***	-19.45***	-3.23***
	(0.774)	(0.721)	(0.554)	(0.675)	(0.562)	(0.773)	(0.636)
Working Hours	-0.91***	-5.64***	-1.18***	-8.22***	-1.08***	-9.57***	-0.87**
	(0.303)	(0.389)	(0.301)	(0.433)	(0.346)	(0.448)	(0.350)
Earn > SGA	-0.02	-0.59***	-0.11***	-0.56***	-0.07***	-0.54***	-0.05***
	(0.016)	(0.016)	(0.013)	(0.013)	(0.012)	(0.015)	(0.013)
Labor Force	-0.00	-0.19***	-0.09***	-0.21***	-0.07***	-0.24***	-0.07***
Participation	(0.015)	(0.014)	(0.012)	(0.013)	(0.011)	(0.014)	(0.011)
Observations	98,614	98,614	8,572	98,614	8,572	98,614	8,572

*** significant at 1% level, **significant at 5% level, *significant at 10% level.

Standard errors (shown in parentheses) are clustered on the individual level. All estimates report bootstrap standard errors using 500 replications.

Notes: The table displays the differences in means between the estimated outcomes of weighted applicants and the allowed and rejected applicants, respectively. The estimates are shown for the respective years relative to the final DI award decision of applicants. The final DI award decision is defined as the last observed DI application that is observed for each individual. An applicant is considered as allowed if initially allowed or allowed by reapplying for DI benefits. If an applicant is not observed to have been allowed DI benefits by the end of the sample (by 2010), the applicant is defined as a rejected applicant. The sample includes all Norwegian applicants that filed their final observed DI application during the years of 1998-2003 and were of 40-61 years of age, did not die by the end of the sample and have not been observed to receive DI benefits prior to the initial observed application. Labor force participation is defined as working hours greater than zero. Earnings are measured in 2005 dollars in units of $1,000 using an exchange rate of $/NOK = 6, and are defined as labor income plus business income.

Table A.4: Upper-Bound and Control Group of Rejected Applicants Estimates, Totally Disabled Applicants Aged 18-61 Years by the Final Decision

	1 year pre final decision	1 year post final decision		3 years post final decision		5 years post final decision	
Difference between:							
Allowed & Weighted	✓	✓		✓		✓	
Rejected & Weighted			✓		✓		✓
Outcomes:							
Earnings	-4.01***	-19.15***	-3.27***	-20.88***	-0.15	-21.17***	1.32
	(1.254)	(0.999)	(0.879)	(1.069)	(0.940)	(1.060)	(0.951)
Working Hours	-1.34***	-7.22***	0.02	-9.66***	1.16**	-10.77***	2.46***
	(0.397)	(0.522)	(0.464)	(0.580)	(0.491)	(0.561)	(0.494)
Earn > SGA	-0.10***	-0.62***	-0.05**	-0.59***	0.04**	-0.56***	0.06***
	(0.026)	(0.023)	(0.021)	(0.021)	(0.019)	(0.020)	(0.019)
Labor Force Participation	-0.07***	-0.26***	-0.04**	-0.28***	0.00	-0.30***	0.03*
	(0.022)	(0.020)	(0.018)	(0.019)	(0.016)	(0.018)	(0.017)
Observations	78,637	78,637	6,680	78,637	6,680	78,637	6,680

*** significant at 1% level, **significant at 5% level, *significant at 10% level.
Standard errors (shown in parentheses) are clustered on the individual level. All estimates report bootstrap standard errors using 500 replications.

Notes: The table displays the differences in means between the estimated outcomes of weighted applicants and the allowed and rejected applicants, respectively. The estimates are shown for the respective years relative to the final DI award decision of applicants. The final DI award decision is defined as the last observed DI application that is observed for each individual. An applicant is considered as allowed if initially allowed or allowed by reapplying for DI benefits. If an applicant is not observed to have been allowed DI benefits by the end of the sample (by 2010), the applicant is defined as a rejected applicant. The sample includes all Norwegian applicants classified as totally disabled that filed their final observed DI application during the years of 1998-2003 and were of 18-61 years of age, did not die by the end of the sample and have not been observed to receive DI benefits prior to the initial observed application. Labor force participation is defined as working hours greater than zero. Earnings are measured in 2005 dollars in units of \$1,000 using an exchange rate of \$/NOK = 6, and are defined as labor income plus business income.