Adjustment Costs and Incentives to Work: Evidence from a Disability Insurance Program

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Abstract

How important are adjustment costs for individuals when they face incentives to work induced by a policy change? I provide the first estimate of heterogeneous adjustment costs by exploiting a unique policy change that induces large incentives to work. The policy change dramatically decreased marginal tax rates on earnings in a non-linear tax schedule on earnings in a disability insurance program in Canada. Individuals continue to bunch at the location of a kink even when the kink no longer exists, suggesting that they face adjustment costs when changing their labor supply. I use the amount of bunching at the kinks before and after the policy change to estimate the size of adjustment costs that vary by individuals' ability to work. The estimated adjustment costs are higher for individuals with lower ability; varying from zero to 8 percent of their potential earnings. The estimated elasticity of earnings with respect to tax rates – accounting for heterogeneous adjustment costs – is 0.2 which is double the size of the one estimated with no adjustment costs. The policy change also decreased the marginal tax rates far away from the kinks. I then evaluate the overall effects of the policy change on the labor supply using a Difference-in-Differences design. I find that some individuals work more and some others start working in response to the large induced incentives to work. Accounting for the adjustment costs then might explain the disparate findings on the effects of increase in incentives to work on labor supply in disability insurance programs. My findings therefore have important implications for designing policies and targeting heterogeneous groups to increase labor supply in disability insurance programs.

JEL classification: H53, I138, J22

Keywords: Adjustment costs, Incentive to Work, Disability Insurance, Bunching

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1 Introduction

A common assumption in labor supply models is that individuals can costlessly adjust their labor supply; even though facing adjustment costs affects their labor supply responses to policy changes.[1] Adjustment costs are broadly described as factors that make it harder for individuals to change their labor supply such as, time and financial costs of searching for a new job, negotiating hours of work with a current employer, understanding tax systems and policy changes, needing workplace accommodations or simply emotional costs of mental stress from working more. The size of the adjustment costs is important for evaluating welfare effects of policy changes (Chetty, 2009). Adjustment costs can also explain the differences in estimated elasticity of earnings in micro versus macro studies (Chetty et al., 2011; Chetty, 2012; Chetty et al., 2012). There is, however, very little empirical evidence on existence and magnitude of the adjustment costs except for Gelber, Jones, Sacks and Song (2016).

In this paper, I empirically examine the interaction between adjustment costs and incentives to work and its effects on the labor supply. I exploit a unique policy change that provides large incentives to work by dramatically decreasing marginal tax rates on earnings. More specifically, I use a policy change in the Assured Income for the Severely Handicapped (AISH), a provincial Disability Insurance (DI) program in Alberta, Canada. The earnings below the exemption threshold in AISH do not affect the DI benefits; but DI benefits are gradually deducted for the earnings accumulated above the exemption threshold. This is comparable to a non-linear tax schedule on earnings. The marginal taxes below and above the exemption threshold are respectively zero and 50%, creating a kink at the exemption threshold. The kink generates incentives to locate – bunch – right below the exemption threshold in order to avoid the high marginal tax rate above the exemption threshold. The policy change in AISH doubled the exemption threshold and increased the maximum DI benefits by 35 percent. Individuals bunch right below the exemption threshold where the marginal tax on the earnings is zero; suggesting strong behavioral responses to the induced incentives to work. The puzzling observation, however, is that individuals continue to bunch at the location of the old threshold even when the threshold is changed. This observation suggests that individuals face adjustment costs when changing their labor supply. I use the amount of bunching at the exemption threshold before and after the policy change to provide the first estimate of heterogeneous adjustment costs. I extend Gelber, Jones, Sacks and Song (2016) by allowing for heterogeneous adjustment costs that vary by individuals' ability to work, measured by their potential earnings if no taxes had been imposed on them.

The estimates using the amount of bunching around the exemption threshold provide

[1] See for instance Chetty, 2009; Chetty, Friedman, Olsen and Pistaferri, 2011; Chetty, 2012; Chetty, Guren, Manoli and Weber, 2012; Chetty, Friedman and Saez, 2013; Kleven and Waseem, 2013; Kleven, 2016.

an incomplete picture of the effects of the policy change on labor supply; since the policy change also deceased the marginal tax rate on earnings far away from the exemption threshold. Furthermore, the policy change might also have extensive margin effects, inducing some individuals start working. Examining the overall effects of increase in incentives to work on the labor supply in a DI program is however challenging. First, individuals' labor supply is endogenous since, the selection process into a DI program strongly depends on having low labor supply. Second, adjustment costs attenuate the induced incentives to work by a policy change. The policy change in AISH creates an opportunity to investigate the potential to induce greater labor supply when individuals face adjustment costs. I estimate the causal effects of the policy change on the labor supply using Difference-in-Differences (DD) design. I use DI recipients of the Ontario Disability Support Program (ODSP) – another provincial DI program in Canada – as a control group. The ODSP is an appropriate control group since its benefit scheme is similar to – but less generous than – AISH; and ODSP did not go under major policy changes during the period of my analysis.

I use administrative data on monthly earnings of DI recipients in AISH and ODSP from the Governments of Alberta and Ontario within two years of the policy change in AISH. The datasets also have information on individuals' characteristics including sex, age, marital status, family size, age entering into the DI program and the location of residence. These datasets furthermore include ICD-9 codes[2] of DI recipients' disability conditions. This allows me to investigate the effects of incentives to work on labor supply of DI recipients with non-physical disabilities. Individuals with non-physical disabilities are believed to be the marginal entrants to DI programs and therefore are expected to be responsive to incentives to work.

My empirical analysis provides three conclusions. First, there are strong behavioral responses to the incentives to work in the form of sharp bunching at the exemption threshold. However, bunching at the location of the old threshold when the threshold no longer exists, suggests that individuals face adjustment costs when changing their labor supply. Individuals with lower ability to work face higher adjustment costs, varying from zero to 8 percent of their potential earnings. The adjustment costs are estimated for a sub-sample of individuals who bunch at the exemption threshold and are relatively more flexible in changing their labor supply. The evidence on existence of adjustment costs for individuals who bunch, suggests that adjustment costs might be even larger for those who do not bunch. My estimates are therefore, a lower bound on the adjustment costs that DI recipients face when changing their labor supply.

[2]The ICD-9 is the 9^{th} revision of the International Statistical Classification of Diseases Related Health Problems, a medical classification list by the World Health Organization. It contains codes for diseases, signs and symptoms, abnormal findings, complaints, social circumstances and external causes of injury or diseases.

Second, the estimated elasticity of earnings with respect to net-of-tax ratio[3] at the exemption threshold – accounting for the adjustment costs – is 0.2 which is double the size of the one estimated with no adjustment costs. Adjustment costs therefore make significant differences in responses to the policy changes.

Third, policies that provide incentives to work in DI programs increase labor supply only if the induced incentives to work are large enough to offset the adjustment costs. My estimate of the effects of the increased incentives to work induced by the policy change in AISH is twelve percent increase in earnings, and one percentage point increase in the labor force participation rate. This finding suggests that the induced substitution effects of the policy change is relatively larger than the induced income effects[4]; and the policy change therefore might be welfare improving. The induced increase in labor force participation also provides evidence on importance of the adjustment cost on extensive margins of the labor supply. If the induced incentive to work is large enough to offset the fixed costs of the labor force participation (i.e. monetary costs like transportation, clothing and child care or non-monetary costs like emotional costs due to stress and additional responsibilities associated with work). My findings are all robust to a set of specification tests.[5]

Findings from my empirical analysis have important implications in designing policies and targeting heterogeneous groups to increase labor supply in DI programs. DI programs are among the largest social insurance programs in advanced countries.[6] These programs provide benefits to individuals with health conditions that limit the kind or amount of work they can perform. There have been concerns about governments' high expenditure on DI programs. In most of DI programs benefit recipients lose all or part of their benefits if they work. Losing DI benefits is a disincentive to work. Many countries therefore have recently implemented – or are considering – policies to generate incentives to work.[7] In

[3]The net-of-tax ratio is defined as the ratio of one minus the marginal tax rates below (τ_0) and above (τ_1) a kink as $\frac{1-\tau_0}{1-\tau_1}$.

[4]In Appendix C, I provide suggestive evidence that the induced income effects of the policy change in AISH is negligible.

[5]I also investigate whether a large increase in incentives to work in a DI program could induce benefit recipients to increase their labor supply. I quantify the effects on earnings and labor force participation using a sharp discontinuity in the induced incentives to work at the month of the policy change in AISH. Using administrative data, I document that large incentives to work could induce beneficiaries to increase their labor supply both in intensive and extensive margins. For more details, see Zaresani (2018).

[6]In the OECD countries, the average total expenditure on DI programs accounts for 2.5 percent of the GDP (OECD, 2010).

[7]The US., UK., Norway and Switzerland are among the countries that recently implemented policies in their DI programs. In the UK.'s program DI recipients are allowed to keep fifty percent of their benefits for up to twelve months if they work. In Norway's program benefits are reduced by \$0.6 for every \$1 earned above a pre-set threshold (see Kostol and Mogstad (2014) for an evaluation of the program). The U.S. is currently testing a program where benefits are reduced by \$1 for every \$2 of earnings accumulated above a pre-set threshold, rather than fully suspending the benefits (see Benitez-Silva et al. (2011) for a calibrated life-cycle model to forecast the effects of the policy. See also Weathers II and Hemmeter (2011); Wittenburg et al. (2015) for evaluations of the pilot project). Switzerland tested a program which

the new policies benefits are reduced more gradually if DI recipients work. More gradual reduction of DI benefits generates incentives to work and therefore benefit recipients work more and might eventually exit the DI program.

While policies that provide incentives to work are intended to increase the labor supply in DI programs, empirical findings on effectiveness of such policies are not conclusive. Hoynes and Moffitt (1999), Benitez-Silva, Buchinsky and Rust (2011), Weathers II and Hemmeter (2011) and Bütler, Deuchert, Lechner, Staubli and Thiemann (2015) find no effects of financial incentives to work in the U.S. and Switzerland. While Campolieti and Riddell (2012), Kostol and Mogstad (2014) and Ruh and Staubli (2016) find positive responses respectively in Canada, Norway and Austria. Beyond change in financial incentives, medical reassessment of DI recipients and trial work periods in the US. do not appear to have effects on the labor supply (Autor and Duggan, 2006). Moore (2015) finds positive effects on labor supply of those who lost their benefits after removal of drug and alcohol addictions as qualifying conditions for DI programs in the US. Borghans, Gielen and Luttme (2014) and Staubli (2011) examine the effects of terminating benefits and stricter eligibility criteria in DI programs in respectively Netherlands and Austria. They find that individuals substitute DI benefits by collecting more from other social assistance programs. Lemieux and Milligan (2008), Fortin, Lacroix and Drolet (2004) and Gruber (2000) find negative effects of providing more generous benefits on labor supply in social assistance programs in Canada. The induced incentive to work from a policy change must be large enough to offset the adjustment costs to cause an increase in the labor supply in a DI program. Better understanding of the heterogeneous adjustment costs has also important policy implications as how to target individuals for the policy changes. There might be groups of DI recipients who need more support to be able to work whereas some others would not work regardless of the provided supports and incentives to work. Accounting for adjustment costs then might explain the mixed findings on the effects of incentives to work on labor supply in DI programs.

My paper is also related to the literature on adjustment costs. The effects of search costs, hours constraint and institutional constraints on labor supply decisions are discussed in earlier work (Pencavel, 1986; Altonji and Paxson, 1988; Dickens and Lundberg, 1993; Blundell and Mccurdy, 1999; Chetty, Friedman, Olsen and Pistaferri, 2011; Tazhitdinova, 2016). Altonji and Paxson (1992) suggests that individuals face adjustment costs changing their labor supply since the change in hours of work are lumpy. Several other works also suggest that individuals face adjustment costs changing their behavior to policy changes (Chetty, 2009; Chetty, Friedman, Olsen and Pistaferri, 2011; Chetty, 2012; Chetty, Guren, Manoli and Weber, 2012; Chetty, Friedman and Saez, 2013; Kleven and Waseem, 2013). Chetty, Friedman, Olsen and Pistaferri (2011) show that adjustment

offers a conditional cash payment if DI recipients start to work or increase their earnings (see Bütler et al. (2015) for an evaluation of the program).

costs affect estimates of elasticity of labor supply. None of the previous works however provide an estimate of the adjustment costs. Gelber, Jones, Sacks and Song (2016) are the first to specify a model to empirically estimate fixed adjustment costs. I contribute to this literature by extending the model for estimating fixed adjustment costs by allowing for heterogeneous adjustment costs.

For the remainder of the paper, I proceed as follows. I describe the institutional background on AISH and ODSP and the data I use for my empirical analysis in Section 2. I present my model for estimating heterogeneous adjustment costs and elasticity of earnings in Section 3. In section 4, I present my estimates of the effects of incentives to work on labor supply using DD design. Finally, I provide conclusions and policy implications in Section 5.

2 Institutional background and data

2.1 Disability insurance programs in Canada

The federal and provincial DI programs in Canada are designed to provide benefits to individuals who due to a medically verifiable physical or non-physical disability are limited in the kind or amount of work they can do. Access to the federal DI programs are based on individuals' employment history or the benefits are available only for a short period of time.[8] Most of the individuals with lifelong and severe disabilities therefore would not be eligible for the federal DI programs; and the eligible individuals would need more assistance since the federal programs provide benefits only for a short period of time. Provincial DI programs provide long term benefits for those who are not eligible for the federal DI programs or need more assistance.[9] Alberta, Ontario, British Columbia and Saskatchewan are among Canadian provinces that have provincial DI programs. Each of these programs are operated under different ministries, but they all provide similar DI benefits. Amount of the benefits and the size of the programs, however, differ

[8] Federal government's benefits include Employment Insurance (EI), Sickness benefits (one must have accumulated at least 600 hours of insurable employment in the qualifying period to receive up to 15 weeks of benefits), Canada Pension Plan (CPP) and Quebec Pension Plan (QPP) disability benefits (to be eligible, one must have enough contributions to the CPP/QPP), Child Disability benefit (CDB) (a tax-free benefit for families who care for a child under 18 with a severe and prolonged disability), Special Benefits for Parents of Critically Ill Children (PCIC) (for eligible parents who take leave from work to provide care or support to their critically ill or injured child for up to 35 weeks) and Employment Insurance Compassionate Care Benefits (for those take time off work to provide care or support to a family member who is gravely ill and is at risk of dying within six months). More information on federal government's disability benefit programs: `http://www.fcac-acfc.gc.ca/Eng/forConsumers/lifeEvents/livingDisability/Pages/Federalp-Prestati.aspx`, Accessed on Feb 29, 2016.

[9] More information on provincial DI programs: `http://www.fcac-acfc.gc.ca/Eng/forConsumers/lifeEvents/livingDisability/Pages/Resource-Ressourc.aspx`, Accessed on Feb 29, 2016.

substantially within the provinces, with Alberta and Ontario's program are respectively the most generous and the largest ones.

2.1.1 Assured Income for the Severely Handicapped program in Alberta

The Assured Income for the Severely Handicapped (AISH) is Alberta's provincial DI program with about 40 thousands benefit recipients (about 1.5 percent of Alberta's adult population at 2008).[10] About half of the benefit recipients in AISH have non-physical disabilities. The education level of more than 80 percent of the benefit recipients is high school or less and more than 90 percent of the benefit recipients do not have dependents. Eligible individuals for the program must have a disability where no remedial therapy is available to materially improve their condition. AISH provides benefits to individuals and their family whom a disability causes a substantial limit in their ability to earn a living and are in financial needs. The program aims to enable benefit recipients to live as independently as possible in their communities.[11]

Determination Process AISH is a means tested DI program where eligible individuals are entitled to a prescribed amount of assistance. Eligibility is determined based on individuals' disability, age, income and assets. Eligible individuals must be 18 years and older and live in Alberta and be a Canadian citizen or permanent resident; where a permanent disability is the main cause limiting amount or kind of the work they can do and earn a living. Total assets of an eligible benefit recipient and their partner can not be worth more than \$100 thousands.[12] Individuals cannot collect Old Age Security (OAS) pension while they are in the program; benefits are transferred to the OAS pension once individuals are eligible to collect it. A final decision on individuals' application file is made by a social worker, after receiving all the relevant medical reports from a qualified health professional. Entitled individuals receive monthly benefits and supplemental assistance (i.e. health benefits, child care and subsidized transit).[13]

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[10] The following information on the AISH and ODSP programs is available from Human Resources and Skill Development Canada, Social Assistance Statistical Report: 2008, available on-line at `http://publications.gc.ca/collections/collection_2011/rhdcc-hrsdc/HS25-2-2008-eng.pdf`. Accessed at December 26, 2016.

[11] Provincial government of Alberta has also other programs to provide more support to disabled individuals. Employment First, Family Support for Children with Disabilities (FSCD), Fetal Alcohol Spectrum Disorder (FASD) initiatives, Persons with Developmental Disabilities (PDD), Provincial Disability Supports Initiatives and Residential Access Modification Program (RAMP) are provided in Alberta. More information on Alberta's DI programs: `http://www.humanservices.alberta.ca/disability-services/pdd.html`, Accessed at May 26, 2016.

[12] Verification of the financial assets of the benefit recipients is based on a honor system. Each benefit recipient must declare any monetary assets (i.e. saving accounts, bonds) by submitting monthly bank statement of the banking account which their DI benefits is deposited into.

[13] More information on eligibility criteria in AISH: `http://www.alberta.ca/aish-eligibility.aspx`, Accessed on Nov 8, 2016.

Duration of the benefits Once an individual is entitled to AISH, there are two main pathways out of the program. First, a benefit recipient may die. Second, they may no longer be eligible to receive the benefits. A benefit recipient may reach the retirement age (65 years) and be eligible to receive Guaranteed Income Support (GIS) or OAS pensions. A benefit recipient may no longer meet the medical or income and asset criteria to receive the benefits. Eligibility based exits account for a very small fraction of the exits from AISH.

The policy change in AISH The AISH program allows benefit recipients to work while they receive DI benefits. The earnings below an exemption threshold in AISH do not affect the DI benefits; but DI benefits are gradually deducted for the earnings accumulated above the exemption threshold. This is comparable to a non-linear tax schedule on earnings. The marginal tax rate on earnings below the exemption threshold is zero. The earnings above the exemption threshold up to the second earnings threshold are taxes at 50%; DI benefits are deducted \$1 for every \$2 earnings accumulated between exemption threshold and the second threshold. Earnings above the second threshold are taxed at 100%; DI benefits are deducted \$1 for every \$1 earnings accumulated above the second threshold. The earnings thresholds are higher for DI recipients with dependents. Effective from April 2012, the exemption threshold doubled and the maximum monthly DI benefits increased by 35 percent.[14] This policy change is comparable to decreasing marginal taxes in a non-linear tax schedule on earnings that induces incentives to work.

Panel (a) of Figure 1 presents the budget constraint of DI recipients in AISH with no dependents before and after the policy change. The horizontal axis denotes the monthly earnings and the vertical axis denotes the total income including DI benefits and net monthly earnings. The maximum monthly DI benefits before the policy change is \$1,188; it is increased by \$400 to \$1,588 after the policy change (35 percent increase). The earnings exemption threshold before the policy change is \$400; in the new policy it is doubled to be at \$800. The second earnings threshold has been at \$1,500 since July 2008.[15] Panel (b) of Figure 1 presents the budget constraints for DI recipients with dependents. The maximum monthly DI benefits are the same as that for individuals with no dependents. The earnings thresholds before the policy change are at \$975 and \$2,500; the exemption threshold increased to \$1,950 in the new policy.

[14] After Alberta's 2012 provincial election, the new premier of Alberta decided to shift the ministry responsible for AISH program from Seniors (to which it is now part of the new Health ministry) to the new Human Services ministry and implement the new policy in AISH.

[15] At July 2008, the second earnings threshold in AISH increased by \$500 to \$1,500 for DI recipients with no dependents and to \$2,500 for those with dependents.

2.2 Ontario Disability Support program

The Ontario Disability Support program (ODSP) is a comparable DI program to AISH in Ontario. The ODSP provides benefits to disabled individuals in Ontario whom a disability causes a substantial limit in their ability to earn a living. The eligibility criteria and determination process in ODSP are quite similar to those in AISH; and beneficiaries receive monthly benefits and supplementary assistance (i.e. health benefits, child care and subsidized transit).[16] The ODSP also allows benefit recipients to work while receiving DI benefits; but DI benefits are reduced by $1 for every $2 earnings. This is comparable to a flat 50% tax on all earnings. The maximum monthly DI benefits in the ODSP depend on the number of dependents varying from $1,086 to $1,999. Figure 2 shows the budget constraint of DI recipients in the ODSP.[17]

2.3 Data and sample selection

I use administrative data on monthly earnings of DI recipients in AISH and ODSP from the Governments of Alberta and Ontario within two years of the policy change in AISH from March 2010 to April 2014. I use the data from AISH to estimate heterogeneous adjustment costs. I then combine the data from AISH and ODSP for my DD analysis. Observing monthly earnings is essential for estimating adjustment costs since the earnings thresholds are monthly based. Both datasets also have detailed longitudinal information on individuals' characteristics including sex, age, marital status, family size, age entering into the DI program and the location of residence. These datasets furthermore include ICD-9 codes of DI recipients' disability conditions. This allows me to investigate the effects of incentives to work on labor supply of DI recipients with non-physical disabilities. Individuals with non-physical disabilities are believed to be the marginal entrants to DI programs and therefore are expected to be responsive to incentives to work. My study sample then includes 18 to 64 years old individuals with non-physical disabilities within two years of the April 2012 policy change in AISH from March 2010 to April 2014. The sample sizes in AISH and ODSP are respectively 452 thousands (10 thousands individuals over four years) and 6.9 millions (150 thousands individuals over four years). These sample sizes might look quite different but they are comparable in terms of percentage of the adult population in each province (about one percent).

Table 1 describes the data from DI recipients with non-physical disabilities in AISH

[16] More information on Ontario's DI programs: `http://www.mcss.gov.on.ca/en/mcss/programs/social/odsp/index.aspx`, Accessed on May 26, 2016.

[17] This policy has been in effect since November 2006. At September 2013, a new policy implemented in the ODSP where an exemption threshold for monthly earnings is introduced at $200. Earnings above the exemption threshold are still subject to 50% marginal tax rate. In my DD analysis in Section 4, I also do my analysis using a shorter time horizon to isolate the effects of this policy change. My main findings do not change.

and ODSP.[18] "Before" refers to the period before the policy change in AISH from April 2010 to March 2012 and "After" refers to the period after the policy change from April 2012 to March 2014. The first panel presents the labor market statistics. The mean monthly DI benefit in the both programs are quite similar before the policy change whereas it is higher in AISH after the policy change. The labor supply in AISH both before and after the policy change are higher than the ODSP; about half of the DI recipients in AISH have positive earnings whereas it is less than ten percent in the ODSP. The mean inflation adjusted monthly earnings are also higher in AISH than ODSP. The labor supply in AISH after the policy change are higher than that before the policy change.

The second panel of Table 1 shows the individual background characteristics in AISH and ODSP before and after the policy change. There are no notable changes in DI recipients' characteristics after the policy change compared to those before the policy change in AISH and neither in the ODSP. About half of the DI recipients in both programs are female. The average age of DI recipients in AISH is 39 and the age of entering to the program is 29; whereas they are slightly higher in ODSP respectively at 43 and 42 years. In the both programs most of the benefit recipients do not have dependents. About half of the DI recipients in AISH live in metropolitan areas whereas it is about 30 percent in the ODSP.[19] I break down non-physical debilitates into three broad groups of psychic (i.e. Schizophrenia and Bipolar disorder), neurological (i.e. Autism and Down Syndrome) and mental conditions (i.e. Anxiety and Depression). The psychic and mental disabilities are respectively the largest and smallest groups.

3 Adjustment costs and elasticity of earnings

In this section, I first provide a conceptual framework to illustrate the interaction between adjustment costs and incentives to work, and its effects on individuals' labor supply decisions. I then provide suggestive graphical evidence that DI recipients in AISH face adjustment costs when changing their labor supply. I finally present my model for estimating heterogeneous adjustment costs using the amount of bunching at the exemption threshold before and after the policy change in AISH.

3.1 Conceptual framework

I follow Chetty et al. (2011) and assume that individuals' preferences are described by a quasi-linear utility function $u(C, z; \tau, \alpha)$, where C and z respectively indicate consumption

[18] The size of the AISH and ODSP programs is about one percent of the adult population in the corresponding provinces. In each program, about half of the DI recipients have non-physical disabilities.

[19] The metropolitan area in Alberta includes Calgary and Edmonton and in Ontario includes Toronto and Ottawa.

and earnings and α denotes individuals' ability to work. τ denotes the non-linear tax on earnings with a kink at z^*; the marginal tax on the earnings below and above z^* are respectively τ_0 and τ_1 where $\tau_1 > \tau_0$. Consumption C is:

$$C = \begin{cases} b + (1-\tau_0)z & \text{if } z \leq z^* \\ b + (1-\tau_0)z^* + (1-\tau_1)(z-z^*) & \text{if } z > z^* \end{cases}$$

where b denotes lump-sum benefit. Individuals in fact choose earnings z[20] to maximize their utility. Suppose a policy change decreased the marginal tax on earnings above the threshold at z^* to τ_2 from τ_1; this generates incentives to work more. Panel (a) of Figure 3 shows an individual whose initial earnings is z^*. If she does not face any adjustment costs when changing her earnings, after the policy change she would then increase her earnings to z'.

Suppose now that individuals face heterogeneous adjustment costs $\phi(\alpha)$ that vary by their ability to work α; a utility loss $\phi(\alpha)$ is associated with adjustment costs. Individuals with higher ability face lower utility loss changing their earnings; for instance, they might have better opportunity for finding a new job or better bargaining power negotiating their hours of work with a current employer. Individuals would change their earnings only if their utility gain is higher than the utility loss associated with the adjustment costs they face. Panel (b) of Figure 3 illustrates that an individual with initial earnings in the interval $(\underline{z}, \bar{z})$ would not change her earnings since the utility gain of increase in earnings z is smaller than the utility loss associated with adjustment costs $\phi(\alpha)$ where α denotes the ability of an individual with initial earnings z^*. $\underline{z}$ and $\bar{z}$ are described as:

$$u(C, z^*; \tau; \alpha) - u(C, \underline{z}; \tau; \alpha) = \phi(\alpha) \quad \text{with } \underline{z} < z^* \tag{1}$$

$$u(C, z^*, \tau; \alpha) - u(C, \bar{z}; \tau; \alpha) = \phi(\alpha) \quad \text{with } \bar{z} > z^* \tag{2}$$

Panel (c) of Figure 3 illustrate a case where a decrease in marginal tax rate above the kink is accompanied by an increase in lump-sum transfer of the amount of ψ; which increases individuals' utility by ψ. This might increase the gain of the relocation for some individuals with the initial earnings in the interval $(\underline{z}, \bar{z})$ and therefore, they might increase their earnings.

A quasi-linear utility function, however, ignores the income effect induced by a policy change. In Appendix C I provide suggestive evidence that the induced income effect of the policy change in AISH is negligible. This simple framework illustrates that if induced incentives to work by a policy change are large enough to offset the associated adjustment costs, then a policy change can increase the labor supply.

[20]Individuals choose hours of work h for given wage w where earnings is $z = wh$.

3.2 Graphical evidence

Figure 4 plots the distribution of monthly earnings of DI recipients in AISH with no dependents two years before and two years after the policy change. The sample includes individuals 18 years and older with no dependents who have non-physical disabilities. The higher marginal tax rate on the earnings above a kink creates strong incentives for many individuals to locate their earnings right below the kink. Excess mass at a kink is known as "bunching." There is noticeable bunching at the exemption threshold every month before the policy change. There is, however, no noticeable bunching at the second kink.[21]

Figure 4 also shows that bunching at the exemption threshold gradually moves away toward the new exemption threshold after the policy change, but the bunching at the old exemption threshold does not completely disappear, even two years after the policy change. Figure 5 plots the distribution of monthly earnings for the pooled sample two years before and two years after the policy change.[22]

Bunching at the old exemption threshold is unlikely to be driven by higher marginal utility of leisure relative to working; since bunching at the old exemption threshold gradually fades away at months following the policy change. It is also unlikely to be driven by change in individuals' preferences to work. It also is unlikely to be due to lack of information on the policy change. Since those who bunch at the exemption threshold are the first to realize the changes in their pay check. Bunching at the old exemption threshold is then a suggestive evidence that DI recipients in AISH face adjustment costs when changing their labor supply. Findings of the several recent papers also suggest that individuals face adjustment costs when changing their behaviour in response to a policy change (see for instance, Chetty, 2009; Chetty, Friedman, Olsen and Pistaferri, 2011; Chetty, Guren, Manoli and Weber, 2012; Chetty, 2012; Chetty, Friedman and Saez, 2013; Kleven and Waseem, 2013). Utility loss associated with adjustment costs decreases the utility gain of changing labor supply and therefore some individuals might not change their labor supply.

[21]The second earning threshold increased to $1,500 from $1,000 at July 2008, three years prior to the policy change of interest at April 2012. There is also no bunching at the former kink at $1,000 (%50 and %100 marginal taxes respectively below and above the kink).

[22]Figure B.1 and B.2 plot the corresponding distributions of earnings for DI recipients with dependents. There is no noticeable bunching at none of the kinks before the policy change, neither at the kinks after the policy change. This could be caused by small sample size since, as shown in Table 1, less than ten percent of the whole sample have dependents. It also could be that DI recipients with dependents have another source of income (i.e. their partner's income) and might not be responsive to the incentives to work. For the rest of my empirical analysis on the adjustment costs, I use only DI recipients with no dependents. For evaluating the overall effects of the policy change in AISH in my DD analysis, I use both those with and with no dependents.

3.3 Heterogenous adjustment costs and elasticity of earnings

In this section, I present my model for estimating elasticity of earnings and heterogeneous adjustment costs that vary by individuals' ability to work. Individuals' ability is measured as their potential earnings if no tax had been imposed on them. I explore the policy change in AISH and use the amount of bunching at the exemption threshold before and after the policy change for my estimation.

Saez (2010) estimates an elasticity of earnings by exploring an assumed proportional relationship between elasticity of earnings and the amount of bunching at a kink.[23] Bunching at a kink conceptually increases by elasticity of earnings but also decreases by the size of adjustment costs. Gelber, Jones, Sacks and Song (2016) extend Saez (2010) to develop a novel framework to simultaneously estimate the elasticity of earnings and fixed adjustment costs. They explore a policy change in the Social Security Annual Earnings Test (AET) in the US. where the marginal tax rate above a kink is decreased. They assume that individuals face a fixed adjustment costs when they change their labor supply. They then use the amount of bunching at the kink before and after the policy change to estimate the elasticity of earnings with respect to net-of-tax ratio and the fixed adjustment costs.

Assuming that all individuals faces the same adjustment costs might be a fair assumption by Gelber et al. (2016), since their study sample is relatively more homogeneous (62-69 years old individuals). Allowing for heterogeneity in adjustment costs that vary by individuals' ability to work might be more plausible in the context of a DI program, specially for DI recipients with non-physical disabilities. Most of the non-physical disabilities are hard to verify and therefore those in a DI program might differ in the level of their ability to work and the adjustment costs they face when changing their labor supply. I extend Gelber et al. (2016) and estimate heterogeneous adjustment costs that vary by individuals' ability to work. Intuitively, observing more moments of bunching allows me to estimate more parameters than theirs. Better understanding of heterogeneous adjustment costs has important policy implications in designing policies to increase labor supply and targeting heterogeneous groups in DI programs. Some groups of DI recipients might be in need for more support to be able to work more while some others would not work regardless of the support provided for them.

3.3.1 Individual utility function

The utility function that has been used in most of the related literature (see for instance Saez, 2010; Chetty, Friedman, Olsen and Pistaferri, 2011; Gelber, Jones, Sacks and Song,

[23] I also estimate elasticity of earnings with no adjustment costs to compare with my estimates with heterogeneous adjustment costs. More details on the model with no adjustment costs is provides in Appendix B.1.

2016; Kleven and Waseem, 2013) is a quasi-linear, iso-elastic utility function:

$$u(C, z; \tau; \alpha) = C - \alpha^{-\frac{1}{e}} \frac{z^{(1+\frac{1}{e})}}{1+\frac{1}{e}} - \phi(\alpha)\mathbb{1}\{\text{change labor supply}\} \tag{3}$$

C and z are respectively represent consumption and earnings and τ denotes the non-linear tax on earnings. e denotes the elasticity of earnings with respect to net-of-tax ratio at a kink. α is a parameter of the utility function that reflects heterogeneous ability to work. $\mathbb{1}(.)$ denotes the indicator function. Individuals lose utility $\phi(\alpha)$ if they change their labor supply that varies by their ability to work α. The consumption is defined as $C = z - T(z)$ where $T(z)$ denotes the tax liability:

$$T(z) = \begin{cases} \tau_0 z & \text{if } 0 \leq z \leq z_1 \\ \tau_0 z_1 + \tau_1(z - z_1) & \text{if } z_1 < z \leq z_2 \\ \tau_0 z_1 + \tau_1(z_2 - z_1) + \tau_2(z - z_1 - z_2) & \text{if } z > z_2 \end{cases}$$

where $\tau_0 = 0, \tau_1 = 0.5$ and $\tau_2 = 1$ in AISH. For those with no dependents, the kinks before the policy change are $z_1 = \$400$, $z_2 = \$1,500$ and kinks after the policy change are $z_1 = \$800$ and $z_2 = \$1,500$.[24]

Individuals maximize their utility subject to consumption budget constraint. The corresponding first order condition implies that for an individual with ability α, the utility maximizing level of earnings and the corresponding utility with marginal tax τ on earnings respectively are:

$$\begin{aligned} z &= \alpha(1-\tau)^e \\ u(C, z; \tau; \alpha) &= \alpha \frac{(1-\tau)^{1+e}}{1+e} \end{aligned} \tag{4}$$

Setting $\tau = 0$ results in $z = \alpha$, individuals' potential earnings with no tax on earnings then measures individuals' ability to work.

This utility function rules out the income effects, I therefore disregard the monthly DI benefits from the model.[25] This utility function also ensures that the utility gain of relocating to a kink is increasing with the distance to the kink (See Theorem (1)). I follow previous work and assume that individuals' ability to work has a smooth distribution.[26] A smooth distribution of ability implies that distribution of earnings with a flat tax τ_0 on earnings is smooth and continuous. I also assume that the heterogeneity in earnings z stems only from heterogeneity in ability α.

[24]The corresponding kinks for individuals with dependents are \$975 and \$2,500 before the policy change and \$1,950 and \$2,500 after the policy change.

[25]I provide suggestive evidence in Appendix C that the induced income effects of the policy change in AISH is ignorable.

[26]See for instance Saez (2010); Chetty, Friedman, Olsen and Pistaferri (2011); Gelber, Jones, Sacks and Song (2016); Kleven and Waseem (2013).

3.3.2 The model

Assume that individuals face heterogeneous adjustment costs $\phi(\alpha)$ in the form of utility loss when they change their labor supply. The associated utility loss varies by individuals' ability α. A marginal bucher at a kink at z^* with initial earnings $z > z^*$ is indifferent between staying at z –where marginal tax on earnings is higher– or enduring adjustment cost and reducing their earnings to z^*, where marginal tax on earnings is lower. In the following, z_1^* and z_2^* denote respectively the old and the new exemption thresholds. Panel (a) of Figure 6 shows a marginal buncher with ability $\alpha^{m_1^0}$ at the kink at z_1^*. The initial earnings of a marginal buncher – if flat tax τ_0 would have been imposed on her – is $\underline{z}_1^0$ and she is indifferent between staying at $\underline{z}_1^0$ – where marginal tax on earnings is higher – or enduring utility loss $\phi(\alpha^{m_1^0})$ and decreasing her earnings to z_1^* where marginal tax on earnings is lower. The following equation (marginal buncher condition at z_1^*) implicitly defines $\underline{z}_1^0$:

$$u\left((1-\tau_0)z_1^*, z_1^*; \tau_1; \alpha^{m_1^0}\right) = u\left((1-\tau_0)z_1^* + (1-\tau_1)(\underline{z}_1^0 - z_1^*), \underline{z}_1^0; \tau_1; \alpha^{m_1^0}\right) + \phi(\alpha^{m_1^0}) \quad (5)$$

Suppose that individuals with initial earnings in range of $(z_1^*, z_1^* + \Delta z_1^*]$ would bunch at the kink at z_1^* if no adjustment costs is associated with changing earnings. When individuals face adjustment costs changing their earnings, Theorem (1) implies that those with initial earnings in range of $(\underline{z_1}^0, z_1^* + \Delta z_1^*]$ gain from relocating to z_1^*. This theorem imposes mild assumptions on individuals' utility function $u(.)$. A proof is presented in Appendix A.

Theorem 1. *Suppose utility loss $\phi > 0$ is associated with adjusting earnings when kink $z^* = (\tau_0, \tau_1)$ is introduced where $\tau_1 > \tau_0$ and $u(c, z; \tau; \alpha)$ is individuals' utility with $\frac{\partial u_c}{\partial \alpha} < 0$ (marginal utility of consumption decreases as ability increases). If for $z_2 > z_1$, $\frac{\partial (z_2 - z_1)}{\partial \alpha}$ increases at a rate that dominates $\frac{\partial u_c}{\partial \alpha} < 0$, then utility gain of relocation to z^* for initial earning level z_2 is higher than that at z_1.*

Suppose that $h(z)$ is the observed distribution of earnings when there is a kink at z_1^* and $h_0(z)$ is the counter-factual distribution of earnings if a flat tax τ_0 would have been imposed on all earnings. The amount of bunching at the kink at z_1^* then is the area under the counter-factual distribution of earnings in the bunching range (bunching equation):

$$B_1^0 = \int_{\underline{z}_1^0}^{z_1^* + \Delta z_1^*} h_0(\zeta) d(\zeta) \approx (z_1^* + \Delta z_1^{*0} - \underline{z}_1^0) h_0(z_1^*) \quad (6)$$

Figure 7 shows that the bunching range at the kink at z_1^* is smaller when individuals face adjustment costs. The bunching range in absence of adjustment costs would have been $i + ii + iii$ where it is $ii + iii$ if individuals face adjustment costs. Equation (5) and (6) together describe an equation of earnings elasticity e and parameters of the adjustment costs.

I construct similar marginal buncher and bunching equations for the bunching at the old and new exemption thresholds after the policy change. The policy change shifted forward the old exemption threshold at z_1^* to the new one at z_2^*. This is comparable to decreasing marginal taxes in a non-linear tax schedule on earnings. Those who bunch at the kink at z_1^* increase their earnings if their utility gain from relocation exceeds the utility loss associated with the adjustment costs. Panel (b) of Figure 6 shows a marginal buncher at the old exemption threshold after the policy change, with ability $\alpha^{m_1^1}$ and initial earnings $\underline{z}_1^1$ in range of $(\underline{z}_1^0, z_1^* + \Delta z_1^*]$. The marginal buncher is indifferent between continuing to bunch at the old exemption threshold at z_1^* or enduring utility loss $\phi(\alpha^{m_1^1})$ and changing her earnings to her optimal earnings $\underline{z}_1^{1\prime}$ with the new taxes. The following equation implicitly defines $\underline{z}_1^1$:

$$u\left((1-\tau_0)\underline{z}_1^{1\prime}, \underline{z}_1^{1\prime}; \tau_0; \alpha^{m_1^1}\right) = u\left((1-\tau_0)z_1^*, z_1^*; \tau_0; \alpha^{m_1^1}\right) + \phi(\alpha^{m_1^1}) \tag{7}$$

Under mild assumptions about the underlying utility function $u(.)$, Theorem (1) implies that individuals with higher initial earnings gain more from changing their earnings. Those with initial earnings in range of $(\underline{z}_1^0, \underline{z}_1^1]$ continue bunching at the former kink at z_1^*. Figure 7 shows that the amount of bunching at the former kink at z_1^* is:

$$B_1^1 = \int_{\underline{z}_1^0}^{\underline{z}_1^1} h_0(\zeta)d(\zeta) \simeq (\underline{z}_1^1 - \underline{z}_1^0)h_0(z_1^*) \tag{8}$$

Equation (7) and (8) together describe another equation of elasticity of earnings e and parameters of adjustment cost.

If no adjustment costs is associated with changing earnings, individuals with initial earnings in range of $(z_2^*, z_2^* + \Delta z_2^*]$ would bunch at the new exemption threshold at z_2^* after the policy change. Panel (c) of Figure 6 shows a marginal buncher at the kink at z_2^*. The initial earnings of a marginal buncher with ability α^{m_2} is $\underline{z}_2$ in range of $(z_2^*, z_2^* + \Delta z_2^*]$. After imposing an exemption threshold at z_1^*, a marginal buncher changes her earnings from $\underline{z}_2$ to her optimal earnings with marginal tax τ_1 at $\underline{z}_2{}'$ when the exemption threshold is increased to z_2^* from z_1^*. A marginal buncher is then indifferent between staying at $\underline{z}_2{}'$ with marginal tax τ_1 or enduring adjustment costs $\phi(\alpha^{m_2})$ and decreasing her earnings and bunch at the kink at z_2^*. The following equation implicitly defines $\underline{z}_2$:

$$u((1-\tau_0)z_2^*, z_2^*; \tau_1; \alpha^{m_2}) = u((1-\tau_0)\underline{z}_2{}', \underline{z}_2{}'; \tau_1; \alpha^{m_2}) + \phi(\alpha^{m_2}) \tag{9}$$

Theorem (1) implies that the gain of relocation to z_2^* is higher for those with higher initial earnings. Figure 7 shows that those with initial earnings in range of $(\underline{z}_2, z_2^* + \Delta z_2^*]$ would bunch at z_2^*. The amount of bunching at the kink at z_2^* then is:

$$B_2 = \int_{\underline{z}_2}^{z_2^*+\Delta z_2^*} h_0(\zeta)d\zeta \approx (z_2^* + \Delta z_2^* - \underline{z}_2)h_0(z_2^*) \tag{10}$$

Equation (9) and (10) together describe another equation of elasticity of earnings e and parameters of the adjustment costs. I generalize adjustment costs to include both a fixed costs element ϕ_1 and a variable costs element that vary by individuals' ability to work $\alpha\phi_2$ defined as $\phi(\alpha) = \phi_1 + \alpha\phi_2$.[27] I numerically solve the three equations obtained from each bunching moment to estimate the elasticity of earnings with respect to net-of-tax ration e and parameters of the adjustment costs ϕ_1 and ϕ_2.[28]

3.3.3 Measuring amount of bunching at a kink

The crucial underlying assumption for using the amount of bunching at a kink at z^* to estimate structural parameters of a utility function is that the distribution of earnings would be smooth and continuous if a flat tax would have been imposed on earnings. The marginal taxes on earnings below and above z^* are respectively τ_0 and τ_1 where $\tau_1 > \tau_0$. I follow previous work and assume that the ability of individuals is smoothly distributed. This assumption translates into a smooth distribution of earnings z with CDF $H(z)$ and PDF $h(z)$.[29] Suppose that $h(z)$ is the observed distribution of earnings with a kink at z^*. Assume also that $h_0(z)$ is the counter-factual distribution of earnings if flat tax τ_0 would have been imposed on earnings. Then using the utility function specified in (3):[30]

$$h(z) = \begin{cases} h_0(z) & \text{if } \alpha < \frac{z^*}{(1-\tau_0)^e}, z < z^* \\ (\frac{1-\tau_0}{1-\tau_1})^e h_0((\frac{1-\tau_0}{1-\tau_1})^e z) & \text{if } \alpha > \frac{z^*}{(1-\tau_1)^e}, z > z^* \end{cases}$$

When there is a kink at z^*, individuals with ability α in interval $[\frac{z^*}{(1-\tau_0)^e}, \frac{z^*}{(1-\tau_1)^e}]$ would bunch at a neighbourhood of z^*. The initial earnings range of bunchers at a kink at z^*, Δz^* is:

$$\Delta z^* = \left(\left(\frac{1-\tau_0}{1-\tau_1}\right)^e - 1\right) z^* \tag{11}$$

[27] Kleven (2016) provides a survey of recent works on bunching and suggests extending Gelber et al. (2016) with a similar generalization of adjustment costs.

[28] More details on empirical implementation of the model is provided in Appendix B.2.

[29] Assume CDF and PDF of α are respectively $F(\alpha)$ and $f(\alpha)$. Since $H(z) = \Pr(Z < z) = \Pr(\alpha(1-\tau)^e < z) = \Pr(\alpha < \dfrac{z}{(1-\tau)^e}) = F(\dfrac{z}{(1-\tau)^e})$. Therefore, $h(z) = H'(z) = \frac{1}{(1-\tau)^e} f(\frac{z}{(1-\tau)^e})$.

[30] For $\alpha < \frac{z^*}{(1-\tau_1)^e}$ and $z < z^*$ marginal tax on earnings after introducing kink z^* is still τ_0 and therefore $h(z) = h_0(z)$. Since for $\alpha > \frac{z^*}{(1-\tau_1)^e}$ and $z > z^*$, $H(z) = \Pr(\alpha(1-\tau_1)^e < z) = \Pr(\alpha < \frac{z}{(1-\tau_1)^e}) = F(\frac{z}{(1-\tau_1)^e})$, therefore $h(z) = H'(z) = \frac{1}{(1-\tau_1)^e} f(\frac{z}{(1-\tau_1)^e})$. Since $h_0(z) = \frac{1}{(1-\tau_0)^e} f(\frac{z}{(1-\tau_0)^e})$, then $h(z) = (\frac{1-\tau_0}{1-\tau_1})^e h_0((\frac{1-\tau_0}{1-\tau_1})^e z)$.

Amount of bunching at a kink at z^* is the difference between the observed and counter-factual distribution of earnings. I follow Chetty et al. (2011); Kleven and Waseem (2013); Gelber et al. (2016) to construct the counter-factual distribution of earnings using the observed distribution of earnings. I divide the observed monthly earnings into z_i bins with width δ and p_i is portion of individuals with earnings in range of $[z_i - \delta/2, z_i + \delta/2]$. I then fit a flexible polynomial of degree D to the observed distribution of earnings at a neighbourhood $Q = [Q^l, Q^u]$ of z^* by estimating the following regression:

$$p_i = \sum_{d=0}^{D} \beta_d (z_i - z^*)^d + \sum_{j=-l}^{l} \gamma_j \mathbb{1}\{z_i - z^* = \delta j\} + \epsilon_i \tag{12}$$

where $\mathbb{1}(.)$ is the indicator function denoting dummies for the bunching bins around the kink. Including dummies in the regression for the bins around the kink in range $[z^* - \delta l, z^* + \delta u]$ isolates the effects of the bunching bins on the estimated counter-factual distribution of earnings. l and u indicate the number of excluded bins respectively below and above the kink. These parameters are chosen by visual inspection of the observed distribution of earnings. The counter-factual distribution of earnings is then the fitted values from (12) where contribution of the bunching bins around the kink is excluded and is defined as:

$$\widehat{p_i} = \sum_{d=0}^{D} \widehat{\beta}_d (z_i - z^*)^d$$

An initial estimate of the amount of bunching at a kink at z^* is defined as:

$$\widehat{B}^0 = \delta \sum_{j=l}^{u} (p_j - \widehat{p_j}) = \delta \sum_{j=l}^{u} \widehat{\gamma}_j$$

However, the estimated bunching $\widehat{B}^0$ overestimates the true amount of bunching at a kink since it does not account for the fact that those who bunch at a kink would have located at points to the right of the threshold if flat tax τ_0 would have been imposed. Furthermore, when a kink is shifted forward, those who bunch at the new kink have moved from points to the left of the threshold. Therefore, the area under the estimated counter-factual distribution is not equal to the area under the observed empirical distribution (called integration constraint in Chetty et al., 2011). I use a technique proposed by Chetty et al. (2011) and shift the estimated counter-factual distribution to the right of z_1^* upward and to the left of z_2^* upward until the integration constraint holds. To do this, I estimate the following equations recursively (n is iteration counter) using the observed distributions of earnings respectively before and after the policy change:

$$
\begin{aligned}
p_i \cdot (1 + \mathbb{1}\{i > u_1\} \frac{\widehat{B_1}^{n-1}}{\sum_{q>u_1} p_q}) &= \sum_{d=0}^{D} \beta_d^n (z_i - z_1^*)^d + \sum_{j=l_1}^{u_1} \gamma_j^n \mathbb{1}\{z_i - z_1^* = \delta j\} + \epsilon_i \\
p_i \cdot (1 + \mathbb{1}\{i < l_2\} \frac{\widehat{B_2}^{n-1}}{\sum_{q<l_2} p_q}) &= \sum_{d=0}^{D} \beta_d^n (z_i - z_2^*)^d + \sum_{j=l_2}^{u_2} \gamma_j^n \mathbb{1}\{z_i - z_2^* = \delta j\} + \epsilon_i
\end{aligned}
\tag{13}
$$

where $\widehat{B_1}^{n-1}$ and $\widehat{B_2}^{n-1}$ are the estimated bunching respectively at z_1^* and z_2^*. The stopping criteria for the recursion is that the area under the estimated counter-factual distribution be equal to the area under the empirical one as $\sum_{i \in Q} p_i = \sum_{i \in Q} \widehat{p}_i$. The estimated amount of bunching at a kink at z^* at step n of the recursion then is:

$$
\widehat{B}^n = \delta \sum_{j=l}^{u} (p_j - \widehat{p}_j) = \delta \sum_{j=l}^{u} \widehat{\gamma_j}^n
$$

The estimated counter-factual distribution of earnings at a kink at z^* using (13) is $h_0(z)$ and is defined as:

$$
\begin{aligned}
h_0(z) &= \sum_{d=0}^{D} \widehat{\beta}_d (z - z^*)^d \\
h_0(z^*) &= \widehat{\beta_0}
\end{aligned}
\tag{14}
$$

where the amount of bunching at a kink at z^* which satisfies the integration constraint is:

$$
\widehat{B} = \delta \sum_{j=l}^{u} \widehat{\gamma_j} \tag{15}
$$

I normalize the estimated bunching $\widehat{B}$ by dividing it by the counter-factual mass at z^* bin from (14) to obtain a comparable measure of bunching within the kinks. The normalized bunching $\widehat{b}$ at the kink at z^* is defined as:

$$
\widehat{b} = \frac{\widehat{B}}{\delta h_0(z^*)} = \frac{\widehat{B}}{\delta \widehat{\beta_0}} \tag{16}
$$

3.4 Estimating elasticity of earnings and heterogeneous adjustment costs

3.4.1 Estimation assumptions

Estimating elasticity of earnings and adjustment costs using the amount of bunching at a kink relies on the assumption that if a flat tax would have been imposed on earnings – in absence of the kinks – the distribution of earnings would have been continuous and smooth. Another key parametric assumption is that the adjustment costs and elasticity of earnings are the same at all kinks, both before and after the policy change. I also assume that the induced income effects of the policy change is negligible and use a quasi-linear utility function.[31] I furthermore make one more simplifying assumption; I assume that the payroll tax on earnings of the DI recipients is zero. Annual earnings of almost all of the DI recipients falls in the lower bracket of the income tax schedule of the federal and provincial governments in Canada. Any individual who has earnings, however must pay for the Employment Insurance (EI) (about 2-5% in the lower bracket of the tax schedule). This is too small relative to the marginal tax rates below and above the exemption threshold and is unlikely to affect the estimates. However, I check robustness of my findings by including %5 payroll tax.

3.4.2 Inference

I estimate bootstrapped standard errors to make inference about the estimated parameters. I calculate standard errors using a parametric bootstrapping procedure described by Chetty et al. (2012). I draw 200 times with replacement from the estimated vector of errors ϵ_i from (13) to generate new earnings distributions. For each bootstrapped distribution then, I estimate the parameters of interest.[32] I define standard error of a parameter θ as the standard deviation of its bootstrapped distribution $S_{\widehat{\theta}}$. These standard errors reflect the misspecification of the fitted polynomial to the observed distribution of earnings rather than sampling error. To test whether an estimated parameter $\widehat{\theta}$ is significantly different than zero $H_0 : \theta \neq 0$, I construct test statistic $T = \frac{\widehat{\theta}}{S_{\widehat{\theta}}}$ for each bootstrapped distribution. The bootstrapped critical values at level α are the lower $\alpha/2$ and the upper $\alpha/2$ quantiles of the ordered bootstrapped test statistics. I then determine whether an estimate is significantly different from zero within a $100(1-\alpha)$ confidence interval if the corresponding t-statistic lies within the critical values at level α.

3.4.3 Estimation results

Study sample in the main estimates includes DI recipients in AISH with 18 years and older with no dependents who have non-physical disabilities, within two years of the policy change. To estimate the amount of bunching at each kink, I set the bin size $\delta = 10$ and fit a polynomial degree $D = 6$ where $l = u = 3$ bins at each sides of a kink are excluded.[33] Figure 9 shows the estimated normalized bunching at the exemption thresholds before and after the policy change respectively at Panel (a) Panel (b). The horizontal axis denotes the month relative to the policy change in AISH and the vertical

[31] In appendix C I provide suggestive evidence that the induced income effects of the policy change in AISH are negligible.

[32] I repeat the procedure explained in detail in Appendix B.2 for each bootstrapped distribution of earnings to estimate the parameters of the interest.

[33] I investigate robustness of the estimated amount of bunching to the selected parameters in Table B.2.

axis denotes the estimated normalized bunching at the corresponding exemption threshold using the method described in Section 3.3.3. Estimated bunching at the old exemption threshold is quite stable before the policy change. It gradually decreases during the months proceeding the policy change but it does not completely disappear. There is no bunching at location of the new exemption threshold before the policy change but it starts to gradually increase after the policy change. Gradual change in bunching and the fact that the estimated bunching at the old exemption threshold after the policy is still significant, suggests that individuals face adjustment costs when changing their labor supply.

The first row of Table 2 presents the estimated elasticity of earnings with respect to net-of-tax ratio at a kink and the heterogeneous adjustment costs that vary by individuals' ability to work. I use the data within two years of the policy change in AISH for this estimation. The estimated heterogeneous adjustment costs is $\phi = 20.69 - 0.02\alpha$ where α denotes individuals' ability to work. The estimated adjustment costs are higher for individuals with lower ability. Figure 10 plots the estimated adjustment costs as percentage of the potential earnings. The estimated adjustment costs vary from zero to 8 percent of the potential earnings. Table 2 also shows that the estimated elasticity of earnings with respect to net-of-tax ratio – accounting for heterogeneous adjustment cost – is 0.19.

Table 2 shows that the estimates do not change much using data within a year of the policy change nor including %5 payroll tax. This table also presents the estimated elasticity of earnings and heterogeneous adjustment costs broken down by age, gender, disability type and location of residence. The estimates are slightly higher for older, males and DI recipients living in metropolitan areas. Heterogeneity in estimated elasticity and adjustment costs within disability types however is striking. The estimates are considerably higher for those with Psychotic disabilities among the others. The estimated elasticity for DI recipients with psychotic disabilities is 0.50 and adjustment costs vary from zero to more than half of the potential earnings. The estimated elasticity for individuals with mental disabilities is 0.33 and adjustment costs vary from zero to more than one-third of their potential earnings. The estimates for DI recipients with neurological disabilities are quite similar to those estimated for the whole sample, elasticity of earnings at 0.15 and adjustment costs that vary from zero to 10 percent of the potential earnings.

Estimated elasticity of earnings with fixed adjustment costs (Gelber et al., 2016) is presented in Panel (a) of Table B.1 in Appendix B.[34] Estimated elasticity of earnings for

[34]Figure B.3 plots the estimated elasticity of earnings using the model of Saez (2010), assuming that individuals face no adjustment costs changing their labor supply. The horizontal axis denotes the relative month to the policy change and the vertical axis denotes the estimated elasticity of earnings with respect to net-of-tax ratio. Estimated elasticity of earnings at new exemption threshold increases gradually as the amount of bunching increases. More details on the models with fixed adjustment costs and a model with no adjustment costs are provided in Appendix B.

the whole sample is quite similar to the one estimated with heterogeneous adjustment costs (0.21 versus 0.19) and the fixed adjustment costs is about 4 percent of the average earnings. My estimated elasticity of earnings is similar in magnitude to Gelber et al. (2016) but estimated adjustment costs are much larger (%4 versus %0.5 of the average earnings). This table also shows the estimates broken down by age, sex, disability type and location of residence. Estimates are quite heterogeneous among disability types. Estimated elasticity of earnings and fixed adjustment costs for DI recipients with mental disabilities are the largest among the others and are respectively 0.54 and 16 percent of the average potential earnings.

Panel (b) of Table B.1 in Appendix B shows the estimated elasticity of earnings assuming that individuals do not face adjustment costs changing their labor supply (Saez, 2010). The estimated elasticity for the whole sample is 0.10, about half of the one estimated with heterogeneous adjustment costs. This table also shows the estimated elasticity of earnings broken down by age, gender, disability type and living location. Estimated elasticities for all the sub-samples are smaller than those estimated with heterogeneous adjustment costs.

My estimates show that there is considerable heterogeneity in adjustment costs among DI recipients. Individuals with higher potential earnings face lower adjustment costs when changing their labor supply. It could be that individuals with higher ability have a better chance for finding a job or stronger bargaining power in negotiating their wage or hours of work with a current employer. It also could be that they might need less support and workplace accommodation to work. The estimated heterogeneous adjustment costs are larger than the fixed ones. The estimated adjustment costs might seem quite small, but accounting for adjustment costs doubles the size of the estimated elasticity of earnings. For estimating adjustment costs, I use a sample of DI recipients who bunch at an exemption threshold. These individuals are relatively more flexible in changing their labor supply than the others. Evidence on existence of adjustment costs even for them magnifies the importance of the adjustment costs. Short term responses to incentives to work even to large incentives might be attenuated by adjustment costs. Furthermore, effectiveness policies that aim in increasing labor supply in DI programs would depend on size of the induced incentives to work versus size of adjustment costs that DI recipients face when changing their labor supply.

4 Labor supply responses to incentives to work

Estimates using the amount of bunching around an exemption threshold provide an incomplete picture of the effects of the policy change in AISH on labor supply; since the policy change also deceased the marginal tax rate on earnings far away from the exemption threshold. Furthermore, the policy change might also have extensive margin effects; some individuals might start working. Examining the overall effects of increase in incentives to work on labor supply in a DI program, however, is challenging. First, individuals' labor supply is endogenous since, selection process into a DI program strongly depends on having low labor supply. Second, adjustment costs attenuate the induced incentives to work by a policy change (Chetty, 2012). The policy change in AISH creates an opportunity to investigate the potential to induce greater labor supply when individuals face adjustment costs.

4.1 Identification strategy

I estimate the causal effects of the policy change on the labor supply using Difference-in-Differences (DD) design. I use DI recipients of the Ontario Disability Support Program (ODSP) – another provincial DI program in Canada – as the control group. The ODSP is an appropriate control group since its benefit scheme is similar to –but less generous than– AISH; and did not go under major policy changes during the period of my study. The first difference is over time, as the incentives to work increased in the AISH program after April 2012. The second difference is across provinces; there was a policy change in the AISH program in Alberta but not in the ODSP program in Ontario. The control group should capture the counter-factual labor market trends in the absence of the policy change. I implement a DD comparison by estimating a regression of the form:

$$y_{it} = \alpha + \beta(POST_t \times AISH_{it}) + \gamma AISH_{it} + X'_{it}\delta + \lambda_t + \epsilon_{it} \tag{17}$$

where i and t respectively denote individuals and monthly time. y_{it} denotes abor supply outcomes of interest which includes inflation adjusted earnings and labor force participation defined as a dummy that switches on for the positive earnings. $AISH_{it}$ is a dummy variable for the treatment group, DI recipients of AISH. This variable controls for program specific trends and is equal to one for those in the AISH program and zero otherwise. $POST_t$ is another dummy variable that turns on after the policy change. I also include a vector of time fixed effects λ_t to control for the changes in macroeconomics conditions. The vector X_{it} is a set of individual characteristics to control for any observable differences that might confound the analysis (sex, age, family structure, age entered to DI program at, disability type and location of residence). ϵ_{it} captures any unobserved factors affecting individuals' labor supply such as their ability or taste for work. The coefficient of interest is β which measures the effects of the policy change on labor supply of DI recipients in AISH relative to those in ODSP overt time.

To further explore impact of the policy change in AISH over time, I generalize (17) by replacing $POST_t \times AISH_{it}$ with a full set of treatment and quarterly time interaction terms and estimating a regression of the form:

$$y_{it} = \alpha + \sum_{t=-8}^{t=7} \beta_t (q_t \times AISH_{it}) + \gamma AISH_{it} + X'_{it}\delta + \lambda_t + \epsilon_{it} \tag{18}$$

where q_t is a dummy that is one in quarter t relative to the policy change and zero otherwise. The pre-policy change interaction terms provide pretreatment specification tests. The identification assumption is that there are no unobserved program specific change that first, are correlated with the policy change and second, are correlated with program specific changes in the outcome variable.

4.2 Results

4.2.1 Descriptive evidence

To graphically asses impact of the policy change in AISH on the labor supply, I plot trends in the inflation adjusted earnings and labor force participation among DI recipients in AISH and the ODSP in Figure 11, within two years of the policy change in AISH from April 2010 to March 2014. Panel (a) shows that earnings in the ODSP are fairly constant before and after the policy change. In the months following the policy change earnings of DI recipients of AISH however gradually begin to rise. Gradual increase in earnings provides an evidence that DI recipients face adjustment costs when changing their labor supply in intensive margins. A similar pattern also is observed in extensive margin of the labor supply –measured by labor force participation– in Panel (b). Labor force participation rates in the ODSP are quite low and fairly constant both before and after the policy change in AISH where participation rate slightly increases in AISH after the policy change. The policy change in AISH came to effect in April 2012, but it was publicly announced two months in advance in February 2012. Since individuals had little time to adjust their earnings or start to work, there is no observable evidence of anticipation effect in earnings neither in labor force participation.

4.2.2 Results

I present my main findings from estimating (17) in Table 3. The dependent variables are monthly inflation adjusted earnings and labor force participation (a dummy that switches on for positive earnings and zero otherwise). The effect of the policy change on earnings measures the intensive margins where the effect on labor force participation measures the extensive margins. The pre-period in the base specification is April 2010 to March 2012 and the post-period is April 2012 to March 2014.

The first column of Table 3 shows my main estimate of the effects on earnings from the policy change in AISH. The estimated effect is 12 percent increase in mean earnings of AISH benefit recipients ($30 per month). The second column shows the estimated effect after controlling for individual characteristics including sex, age, age entered to DI program at, family status, disability type and location of residence. The estimated effect is quite similar to the main estimate in the first column. The fourth and fifth columns of Table 3 show the estimated effects on extensive margins where the latter column shows the estimated effect after controlling for individual characteristics. The estimated effects are quite small at about one percentage point increase in the labor force participation in AISH.

Estimates using the full sample within the two years of the policy change might be contaminated since there has been a policy change in the ODSP at September 2013. The policy change implemented a monthly exemption threshold at $200 where the marginal tax on the earnings accumulated above the threshold is %50. The expected effects of this policy change is increase in the labor supply of DI recipients in the ODSP which might bias my estimates downward.[35] To account for possible contamination, I estimate the effects of the policy change using a shorter panel within one year and half of the policy change where the pre-period is November 2010-March 2012 and post-period is April 2012-September 2013. The estimated effects of the policy change using the shorter panel are presented in the third and sixth columns of Table 3 respectively on earnings and extensive margins. The estimated effects do not change much.

Estimates presented in Table 3 would be biased if the treatment and control groups have different labor supply trends before the policy change. I plot the estimated coefficients of the interaction terms in (18) in Figure 12. Panel (a) shows the effects on earnings and Panel (b) shows them for the extensive margins effects within two years of the policy change in AISH. Each point on the solid line indicates the estimated coefficient of the interaction between a dummy for quarter relative to the policy change and treatment variable $AISH$. The gray shades represent the corresponding 95 percent confidence intervals. In both panels, estimated coefficients vary closely around zero before the policy change. But the estimated coefficients for extensive margins in the early two quarters are slightly far from zero. This could be due to the delayed responses to the November 2008 policy change in AISH where the second kink was shifted forward. When facing an increase in work incentives, it might take longer for individual to find a job than increasing their hours of work if they are already employed. The estimated extensive margins effect using the shorter panel excluding the contaminated periods are almost the same as the one using the full sample as shown in Table 3. Estimated coefficients are significantly positive and gradually increase in quarters following the policy change.

[35]The estimates might also be contaminated by November 2008 policy change in AISH where the second kink is shifted forward to $1,500 from $1,000 for those with no dependents and to $2,500 from $2,000 for those with dependents.

I present estimated effects on labor supply for different sub-samples within two years of the policy change in Table 4. It is instructive to investigate effects of the policy change on those with no dependents and those with dependents separately since the earnings thresholds for those with dependents are higher than those for individuals with no dependents. Estimated effects from (17) are shown in the first panel of Table 4. The estimated increase in earnings and labor force participation of those with dependents is higher. The earnings and labor force participation of those with dependents increased respectively by 17.88 percent and 4.31 percentage points compared to the corresponding 12.77 percent and 0.62 percentage points increase for those with no dependents. There are also sizeable differences in the estimated effects of the policy change within the age groups. The second panel shows that the increase in earnings of younger individuals (18 to 34 years) is more than twice the size of that for the middle aged group (35 to 49 years) at 23 percent compared to 10 percent. The estimated effect on earnings of older individuals (50 years and older) is quite small decrease in earnings (about 2 percent). The extensive margin effect on older individuals is, however, relatively sizeable at 4.07 percentage points decrease compared to 4.21 percentage points increase for the younger ones and 0.79 percentage points decrease for the middle aged group. Estimated effects for males and females are almost the same in extensive margins but increase in earnings for males is slightly higher at 14 percent compared to 11 percent for females.

Individuals' health condition plays an important role in determination process for DI benefits. Panel (D) of Table 4 shows the estimated effects of the policy change broken down by types of disabilities. I divide individuals to three sub-groups based on the ICD-9 codes. Increases in earnings of those with psychotic and neurological disabilities are quite similar and relatively higher than that for individuals with mental disabilities at 15 and 12 compared to 7 percent. Extensive margin response of individuals with Psychotic disabilities is more pronounced than the others at 1.46 percentage point increase compared to 0.07 and 0.05 percentage point reductions, not even significant at conventional levels. The last panel shows the estimates broken down by the location of residence; metropolitan and non-metropolitan area. Increase in earnings in both locations are almost the same at about 13 percent. Extensive margin effects however for those who live in metropolitan areas is 1.83 percentage point increase in labor force participation, but there is no significant effect on those residing in non-metropolitan areas. This finding might be caused by more employment opportunities in metropolitan areas compared to non-metropolitan areas.

Individuals who did not work before the policy change are unlikely to be affected by the induced substitution effects of the policy change since their budget constraints before and after the policy change are parallel as shown in Figure 1. In Appendix C, I provide suggestive evidence that the induced income effects of the policy change in AISH are negligible. One plausible explanation for why they might start working after the policy change –while they are receiving more benefits– is that they might have been facing adjustment costs and the extra benefits covers up adjustment costs they might face.

Gelber et al. (2016) in a setting where individuals are not compensated for adjustment costs that they might be facing, show that existence of Annual Earnings Test (AET) in the US. results into lower employment rate among the affected older individuals. My findings highlights the role of adjustment costs in extensive margin responses to work incentives. The overall increase in labor supply in AISH from the policy change highlights the interaction between induced incentives to work and adjustment costs. Incentives to work must be large enough to offset the adjustment costs to increase the labor supply in a DI program.

4.2.3 Robustness analysis

To analysis robustness of my findings from DD design, I further estimate the effects from the policy change in AISH on labor supply of benefit recipients in a Regression Discontinuity Design (RDD). I exploit the policy change in AISH at April 2012 (cut-off date) using the date as assignment variable. Intuitively, I compare labor supply right after the policy change (treatment group) to that right before the policy change (control group). This approach sheds light on concern that the control and treatment group in my DD analysis might be quite different. I provide more details on my RDD estimates in Appendix **??**. Figure **??** shows the discontinuity in inflation adjusted monthly earnings and labor force participation at the date of the policy change in AISH within one year window. Table **??** presents the estimated effects from the RDD framework within a six months window. The estimated effect is 9 percent increase in earnings and no significant effect on extensive margins. These estimates are smaller that those from DD design using the data within two years of the policy change. There might be delayed responses to the policy change since individuals face adjustment costs. Figure **??** plots the estimated effects using different bandwidths. This figure shows that the estimated effects are quite robust to the selected bandwidths. There are concerns that the estimated effects from RDD design however might be contaminated by the seasonality effects. To shed light on this concern, I estimated the effects from placebo policy changes in Table **??**. All the estimates are either negative or insignificant. This finding suggest that either there is no seasonality effect or if there is, it causes decrease in labor supply. In either case, it is unlikely that my findings presented in Table **??** be contaminated by seasonality effects and at least my estimates would be a lower bond on the true effects of the policy change in AISH on earnings and extensive margins.

4.3 Elasticity of labor force non-participation

My estimates show that the policy change in AISH caused increase in labor supply both in extensive and intensive margins. In this section, I adopt the approach of Kostol and Mogstad (2014) to the policy change in AISH to estimate the implied elasticity of labor force non-participation to Participation Tax Rate (PTR). Kostol and Mogstad estimate elasticity of labor force non-participation to PTR form work incentives induced by a policy change in a Norwegian DI program where the marginal taxes on earnings above a threshold is decreased. The elasticity ϵ is defined as:

$$\epsilon = \frac{\Delta(1 - LFP)/(1 - LFP_{before})}{\Delta PTR/PTR_{before}} \tag{19}$$

where $1 - LFP$ denotes labor force non-participation. LFP is defined as below:

$$LFP = \begin{cases} 0 & \text{if } earnings \leq z_1^* \\ 1 & \text{if } earnings > z_1^* \end{cases} \tag{20}$$

where z_1^* denotes the exemption threshold before the policy change (\$400 for those with no dependents and \$975 for those with dependents). There is no marginal tax on earnings below z_1^* but the marginal tax on earnings above z_1^* is 50%. That is, earnings below z_1^* are fully exempted but benefits phase out at a rate of \$1 for every \$2 earnings accumulated above z_1^*. The PTR captures the behavioural responses and I define it as follows for earnings level w respectively before and after the policy change where the exemption threshold at z_1^* is shifted forward to z_2^*:

$$PTR_w^{before} = \begin{cases} 0 & \text{if } w \leq z_1^* \\ 1 - \frac{I_0^{before} - I_w}{w} & \text{if } w > z_1^* \end{cases} \tag{21}$$

$$PTR_w^{after} = \begin{cases} 0 & \text{if } w \leq z_2^* \\ 1 - \frac{I_0^{after} - I_w}{w} & \text{if } w > z_2^* \end{cases}$$

I_0^{before} and I_0^{after} denote the mean total income (net earnings and benefits) of individuals who do not participate in the labor force respectively before and after the policy change. I_w is the total income with earnings w. ΔPTR denotes changes in PTR before and after the policy change.

I use aggregated data to empirically implement this model. To aggregate the data, I divide observed monthly earnings into $[w - \delta/2, w + \delta/2]$ bins with width δ (I set $\delta = \$10$). ΔPTR is the mean of differences in PTR in each bin weighted by p_w^{before}, the portion of the individuals in each bin before the policy change:

$$\Delta PTR = \mathbb{E}_w[(PTR_w^{after} - PTR_w^{after})p_w^{before}] \tag{22}$$

This specification for estimating elasticity of non-participation respect to PTR ignores the income effects, but the estimated elasticity could be interpreted as effect of the policy change. In Appendix C, I provide suggestive evidences that there income effects of the policy change on labor supply is negligible.

4.3.1 Descriptive evidences and results

Figure 13 plots PRT by earnings before and after the policy change for individuals with no dependents in Panel (a) and for those with dependents in Panel (b). PTR is zero for exempted earnings but it increases afterwards. For any earnings levels, PTR is lower after the policy change than that before the policy change. Figure 13 also plots smoothed density of earnings before and after the policy change. The figure suggests that lower PTR is associated with higher density of earnings.

Table 5 presents the estimated elasticity of labor force non-participation respect to PTR using the aggregate data two years before and two years after the policy change in AISH. Standard errors are estimated using a non-parametric bootstrap. I obtain 200 samples of the observed earnings with replacement. For each bootstrapped sample, I then estimate the elasticities. Standard error of a parameter is the standard deviation of its bootstrapped distribution. The first column shows the estimates for individuals with no dependents. The estimated elasticity of non-participation respect to PTR is 0.114; ten percent reduction in PTR decreases labor force non-participation by 11.4 percent. The second column shows the estimates for individuals with dependents. The estimated elasticity is 0.033, a ten percent decrease in PTR decreases labor force non-participation by 3.3 percent. This estimate is quite smaller than that for individuals with no dependents. My estimates are in line with estimates of Kostol and Mogstad (2014) where their estimates are about 0.119 to 0.186.

4.4 Fiscal effects

In this section, I discuss fiscal effects of the policy change in AISH for the government and the related policy implications. Table 6 shows fiscal effects of the policy change in AISH in years before and after the policy change. Tax revenue includes all the taxed DI benefits in addition to a 5% payroll tax on earnings. All the Monterey values are inflation adjusted based on 2012 dollar. There is an increase in DI benefits reflecting the new entries into the program. The substantial increase in expenses in DI benefits in the years after the policy change relative to those before the policy change is associated with the increase in the maximum DI benefits after the policy change. The annual cost of increase in maximum DI benefits is about fifty million dollars. Expense of DI benefits is offset by the tax revenue. Tax revenues in the years after the policy change do not fall much, despite the higher exemption thresholds. In fact, tax revenue two years after the policy change is about one million dollar higher than that one year after the policy change. This finding suggest that the policy change has resulted in a significant increase in DI recipients' earnings. The estimated effect suggests that the DI recipients who increased their labor supply, worked an additional 3 to 5 hours per month.

5 Policy implications and conclusions

Do disabled individuals face adjustment costs when changing their labor supply in response to a policy change? Many countries have recently implemented – or are considering – policies to increase work incentives in their DI programs. While these policies provide work incentives, findings on their effectiveness are mixed. In this paper, I provide evidence that the mixed findings on the effects of work incentives induced by a policy changes on labor supply in DI programs could be explained by adjustment costs.

I use a policy change in a Canadian DI program and estimate the size of heterogeneous adjustment costs that vary by individuals' ability to work. I use change in bunching at the earnings exemption threshold induced by the policy change for my empirical analysis. I extend the model for estimating elasticity of earnings and fixed adjustment costs by allowing for heterogeneous adjustment costs that vary by individuals ability to work. Individuals' ability to work is measured as their potential earnings – earnings if no tax would have been imposed on them. The estimated adjustment costs are higher for individuals with lower ability; varying from zero to 8 percent of their potential earnings. The estimated elasticity of earnings with respect to tax rates – accounting for heterogeneous adjustment costs – is 0.2 which is double the size of the one estimated with no adjustment costs. The overall effect of the policy change on labor supply estimated using a DD design is 12 percent increase in average earnings and one percentage point increase in labor force participation. The overall increase in labor supply in AISH from the policy change highlights the interaction between induced incentives to work and adjustment costs. Incentives to work must be large enough to offset the adjustment costs to increase the labor supply in a DI program. The adjustment costs are estimated for a sub-sample of individuals who bunch at the exemption threshold and are relatively more flexible in changing their labor supply. The evidence on existence of adjustment costs for the bunchers suggests that the adjustment costs might be even larger and my estimates are a lower bound on adjustment costs that DI recipients face when changing their labor supply.

My paper has two main caveats. First, I estimate a fixed elasticity of earnings while allowing the adjustment costs to vary by individuals' ability. I also use a static framework where it seems labor supply decisions are dynamic. For my future research, I will extend the model to a dynamic model with heterogeneous elasticity and adjustment costs. Potentially, the observed mass above the second threshold in the program could be used as another moment of bunching to estimate more parameters. Second, adjustment costs in my model is like a black box where not much is known about its nature. It could be related to supply side or demand side of the labor force (i.e. firms). Better understanding of its nature is required to implement policy interventions to increase labor supply in DI programs. This would need data sources on both sides of the market.

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Tables

Table 1: Summary statistics

	AISH		ODSP	
	Before	After	Before	After
Labor market statistics				
Positive earnings (%)	48.1	48.4	9.9	9.4
Mean monthly earnings (2012$)	255	285	50	55
	(420)	(470)	(235)	(245)
Mean monthly net benefits (2012$)	1,160	1,530	1,020	1,015
	(120)	(150)	(470)	(460)
Number of new DI awards	1,215	636	8,440	9,965
Background characteristics				
Male (%)	55.3	55.4	53.4	53.9
Mean age (years)	38.5	39.8	43.0	42.9
	(12.5)	(12.8)	(12.6)	(12.9)
Mean age DI awarded at	28.8	29.1	33.2	33.1
	(11.1)	(11.4)	(11.8)	(11.9)
Has no dependent	91.3	90.8	82.1	82.2
Type of disability				
-Psychotic (%)	42.1	42.1	42.6	43.5
-Neurological (%)	50.1	51.0	36.3	36.4
-Mental (%)	7.3	6.9	21.1	20.2
Live in metropolitan area (%)	49.5	48.9	29.1	29.0
Mean number of individuals	8,940	9,890	142,970	160,775
Total number of observations	214,595	237,285	3,431,300	3,385,615

Notes: This table provides summary statistics of AISH and ODSP data. "Before" refers to the period before the policy change in AISH from April 2010 to March 2012 and "After" denotes the period after the policy change from April 2012 to March 2014. Mean earnings and benefits are adjusted for inflation and are rounded to the closest five according to the confidentiality guidelines of the Statistics Canada. Standard deviation of the continuous variables are in the pantheists.

Table 2: Estimted elasticity of earnings and heterogeneous adjustment costs

	Bunching at kink at \$400 before policy change b_1^0	Earnings response at kink at \$400 before policy change Δz_1^*	Bunching at \$400 after policy change b_1^1	Bunching at kink at\$800 after policy change b_2	Earnings response at \$800 kink after policy change Δz_2^*	Elasticity e	Adjustment costs ϕ_1	ϕ_2
A. Full sample								
Within two years	2.920***	56.900***	1.950***	1.880***	113.800***	0.192***	20.693***	-0.024***
	(0.227)	(5.250)	(0.107)	(0.389)	(10.501)	(0.017)	(1.197)	(0.002)
Within one year and half	2.790***	63.41***	2.120***	1.820***	126.83***	0.180***	20.247***	-0.023***
	(0.202)	(11.17)	(0.124)	(0.423)	(22.34)	(0.014)	(0.989)	(0.002)
Adding 5%	2.920***	54.623***	1.950***	1.880***	109.245***	0.171***	19.526***	-0.022***
payroll taxes	(0.227)	(4.951)	(0.107)	(0.389)	(9.903)	(0.015)	(1.086)	(0.001)
B. Age								
18-34	2.660***	53.078***	1.630***	2.580***	106.156***	0.180***	19.658***	-0.023***
	(0.175)	(5.175)	(0.101)	(0.377)	(10.349)	(0.016)	(1.767)	(0.003)
35-49	2.680***	54.179***	1.550***	2.820***	108.357***	0.183***	20.033***	-0.024***
	(0.217)	(8.897)	(0.122)	(0.653)	(17.793)	(0.028)	(4.537)	(0.070)
> 50	3.600***	67.821***	2.770***	-0.320	135.642***	0.226***	24.406*	-0.026
	(0.705)	(19.226)	(0.239)	(0.264)	(38.452)	(0.059)	(10.190)	(0.118)
C. Gender								
Male	3.510***	69.146***	2.160***	1.040***	138.292***	0.230***	23.656***	-0.026***
	(0.377)	(16.177)	(0.146)	(0.334)	(32.353)	(0.050)	(7.612)	(0.006)
Female	2.210***	43.040***	1.680***	3.280***	86.079***	0.147***	18.746***	-0.024
	(0.144)	(5.816)	(0.087)	(0.490)	(11.632)	(0.019)	(2.736)	(0.119)
D. Disability type								
Psychotic	4.630	165.685***	1.620***	1.930***	331.369***	0.500***	62.727	-0.057
	(3.771)	(57.228)	(0.147)	(0.347)	(114.457)	(0.146)	(54.727)	(0.171)
Neurological	2.330***	43.836***	2.050***	1.770***	87.673***	0.150***	18.132***	-0.021***
	(0.159)	(3.076)	(0.112)	(0.447)	(6.152)	(0.010)	(0.925)	(0.002)
Mental	4.300***	102.772**	2.100***	2.770***	205.544**	0.330**	36.510**	-0.038
	(0.630)	(46.754)	(0.174)	(0.350)	(93.507)	(0.134)	(21.761)	(0.070)
E. Living location								
Metropolitan area	4.290***	81.041	3.180***	3.360***	162.081***	0.266***	30.339***	-0.034
	(0.962)	(24.731)	(0.216)	(49.461)	(0.457)	(0.074)	(10.022)	(0.118)
Other	1.650***	34.145**	0.880***	0.420***	68.289**	0.118**	11.713*	-0.014**
	(0.136)	(15.007)	(0.103)	(0.334)	(30.014)	(0.050)	(8.054)	(0.007)

Note: This table presents the estimated elasticity of earnings with respect to net-of-tax ratios assuming that utility loss is associated with adjusting earnings that varies by individuals ability from the model specified in Section 3.3.2. The bootstrapped standard errors are in the parenthesis. $*p < 0.10, **p < 0.05, ***p < 0.01$

Table 3: Estimated effect of policy change on earnings and extensive margins

	Earnings ($)			Extensive margin (%)		
	(1)	(2)	(3)	(4)	(5)	(6)
AISH × Post	29.98***	31.02***	29.87***	0.79***	0.79***	0.78***
	(1.34)	(1.34)	(1.53)	(0.15)	(0.15)	(0.17)
AISH	202.09***	197.89***	195.57***	38.22***	38.16***	37.66***
	(0.92)	(0.92)	(1.05)	(0.11)	(0.11)	(0.12)
Sample	Full	Full	Short	Full	Full	Short
Individual co-variates	No	Yes	Yes	No	Yes	Yes
Mean in AISH before policy change	252.47 (420.40)	250.18 (420.65)	250.89 (421.03)	48.12	48.12	47.60
R-Sq.	0.04	0.04	0.04	0.08	0.10	0.10
Num. of. Obs.	7,741,795	7,741,795	5,810,529	7,741,795	7,741,795	5,810,529

Notes: This table shows the estimated effects of the policy change in AISH from a Difference-in-Difference framework using (17). The full sample includes individuals with non-physical disabilities within two years of the policy change (April 2010-March 2014). The short panel covers a period of one year and half within the policy change (October 2010-September 2013). Included individual co-variates are sex, age, age DI awarded at, family structure, disability type and living location. The earnings are CPI adjusted. The dependent variable for the extensive margins is a dummy that switches on for positive earnings. Robust standard errors are in the parenthesis.
$*p < 0.10, **p < 0.05, ***p < 0.01$

Table 4: Heterogeneity in effect of policy change on earnings and extensive margins

	Earnings ($)		Extensive margin (%)		
	AISH × Post	Mean	AISH × Post	Mean	Num. of. Obs.
A. Family structure					
No dependent	31.81***	249.06	0.62***	49.87	6,400,493
	(1.37)	(404.04)	(0.16)		
With dependent(s)	42.39***	237.11	4.31***	29.76	1,341,302
	(5.37)	(498.67)	(0.47)		
B. Age					
18-34	57.29***	249.38	4.21***	45.27	2,323,720
	(2.19)	(425.70)	(0.23)		
35-49	25.82***	262.85	-0.79***	50.80	2,660,571
	(2.39)	(420.75)	(0.26)		
> 50	-4.11*	224.29	-4.07***	49.63	2,757,504
	(2.33)	(375.49)	(0.30)		
C. Gender					
Male	37.79***	263.09	0.80***	49.02	4,162,168
	(1.88)	(428.66)	(0.20)		
Female	24.82***	229.36	0.79***	47.00	3,579,627
	(1.89)	(392.29)	(0.22)		
D. Type of disability					
Psychotic	32.65***	216.60	1.46***	39.22	3,329,884
	(2.02)	(403.23)	(0.23)		
Neurological	32.28***	272.41	-0.07	55.40	2,878,196
	(1.91)	(418.40)	(0.21)		
Mental	19.72***	260.00	-0.50	48.86	1,533,715
	(5.03)	(420.88)	(0.56)		
E. Living location					
Metropolitan area	34.34***	261.63	1.83***	46.82	2,338,947
	(1.97)	(428.07)	(0.21)		
Other	31.40***	234.69	-0.18	49.39	5,402,848
	(1.81)	(397.81)	(0.21)		

Notes: This table shows the estimated effects of the policy change in AISH from a Difference-in-Difference framework using (17) broken down by different sub samples. The sample includes individuals with non-physical disabilities within two years of the policy change (April 2010-March 2014). Include individual co-variates are sex, age, age DI awarded at, family structure, disability type and living location. The earnings are CPI adjusted. The dependent variable for the extensive margins is a dummy that switches on for positive earnings. Robust standard errors are in the parenthesis.
$*p < 0.10, **p < 0.05, ***p < 0.01$

Table 5: Estimated elasticity of non-participation respect to Participation Tax Rate (PTR) in AISH

	No dependent	With dependent(s)
$\Delta(1-LFP)$	-0.035	-0.030
	(0.001)	(0.003)
$(1-LFP_{before})$	0.747	0.879
	(0.001)	(0.002)
ΔPTR	-0.190	-0.204
	(0.001)	(0.002)
PTR_{before}	0.480	0.205
	(0.007)	(0.004)
$Elasticity(\epsilon)$	0.114***	0.033***
	(0.004)	(0.003)
Num. of Obs.	411,373	40,507

Note: This table shows the estimated elasticity of labor force non-participation respect to Participation Tax Rate (PTR) defined in (21) in Section 4.3. The sample includes individuals with non-physical debilitates within two years of the policy change in AISH. The bootstrapped standard deviations are in the parenthesis.
$*p < 0.10, **p < 0.05, ***p < 0.01$

Table 6: Annual fiscal effects of the policy change in AISH

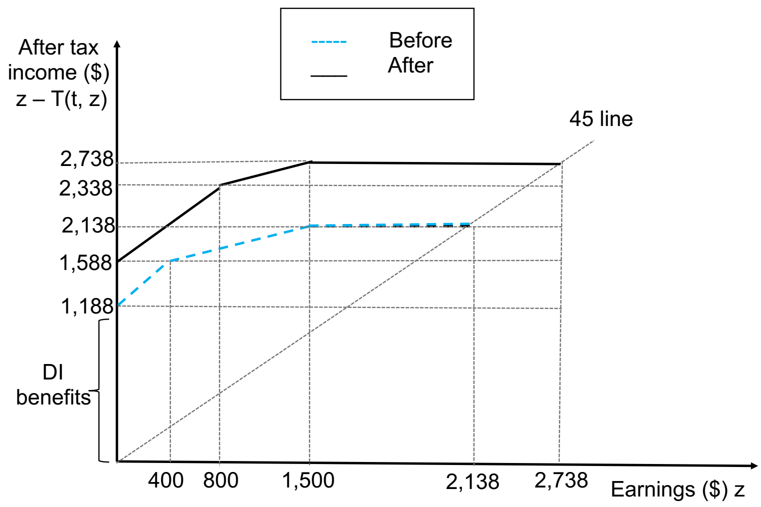
	Before			After	
	2009	2010	2011	2012	2013
DI benefits (million$)	118.3	126.9	132.6	184.8	187.5
Tax revenue (million$)	7.1	7.1	8.0	6.1	6.9
Net expenses (million$)	111.2	119.8	124.6	178.7	180.6

Note: This table shows the annual fiscal effects of the policy change in AISH. Each fiscal year is April-March. The tax revenue includes the claw backed benefits and a 5% payroll tax on the earnings. All monetary values are in 2012$.

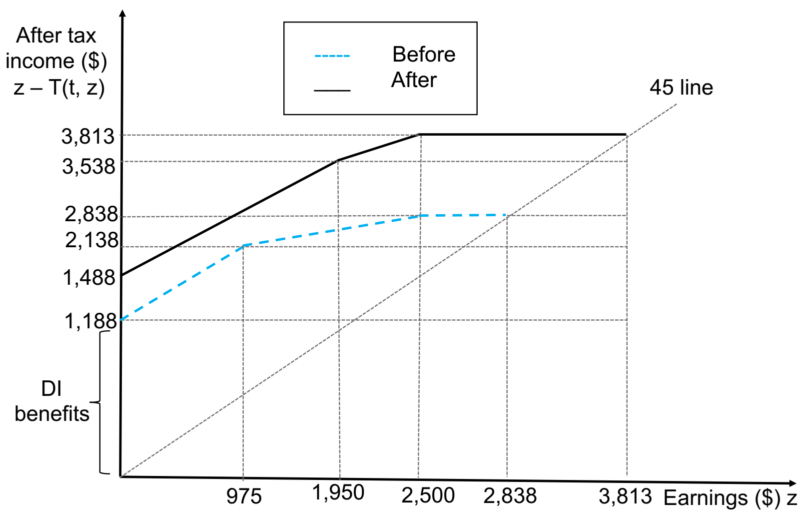
Figures

Figure 1: Budget constarints of benefit recipients of AISH

(a) No dependents

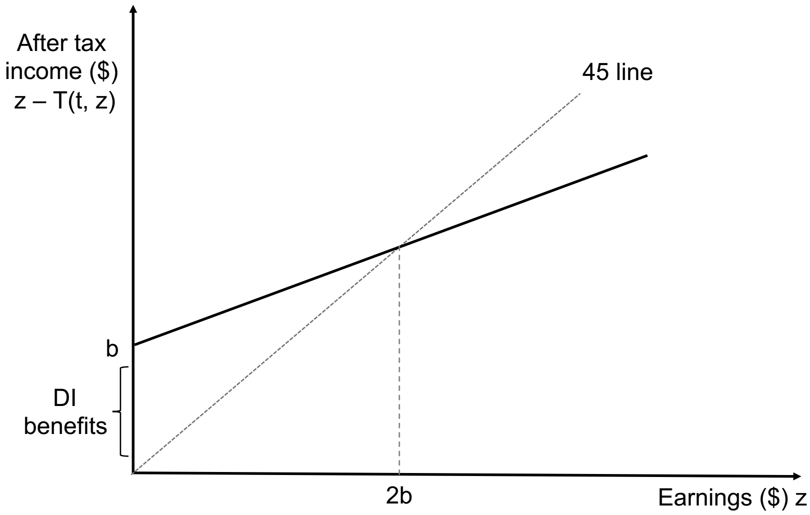


(b) With dependents



Note: This figure shows the budget constraint of DI recipients of AISH before and after the policy change. Panel (a) shows the budget constraints for those with no dependents and panel (b) shows them for those with dependents. Horizontal axes represents earnings and vertical axes is total income (DI benefits and net earnings). Earnings above the exemption threshold up to the second threshold reduce DI benefits at a rate of $1 for every $2. DI recipients lose DI benefits $1 for every $1 of earnings above the second threshold.

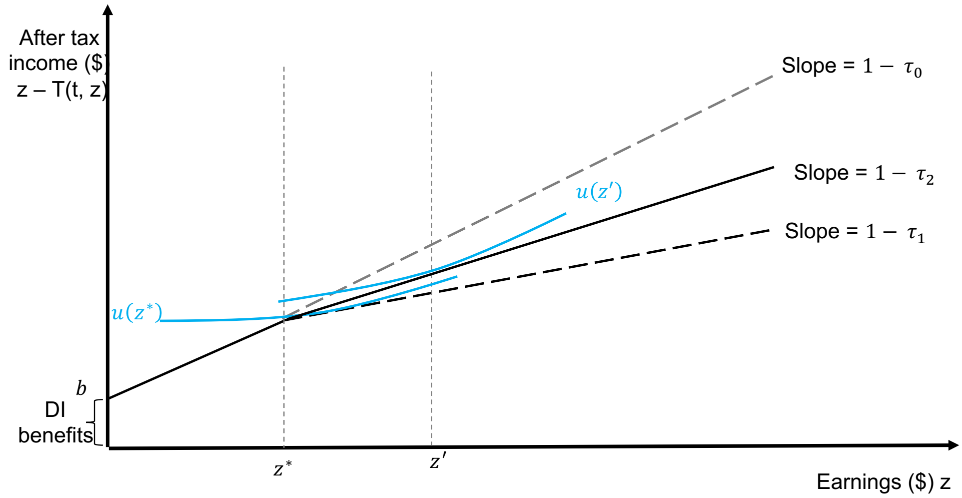
Figure 2: Budget constraint of benefit recipinets of ODSP



Note: This figure shows the budget constraint of DI recipients of ODSP. Horizontal axes represents monthly earnings and the vertical axes represents the total monthly income (DI benefits and net earnings). b denotes the monthly DI benefits that depends on the family size that vary from $1,086 to $1,999. DI recipients lose $1 for every $2 of earnings.

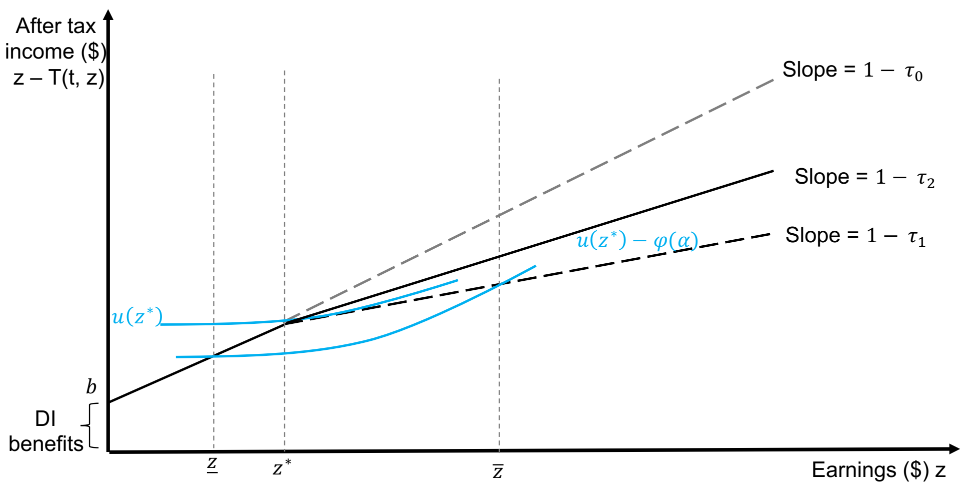
Figure 3: Earnings responses and adjustment costs

(a) No adjustment costs



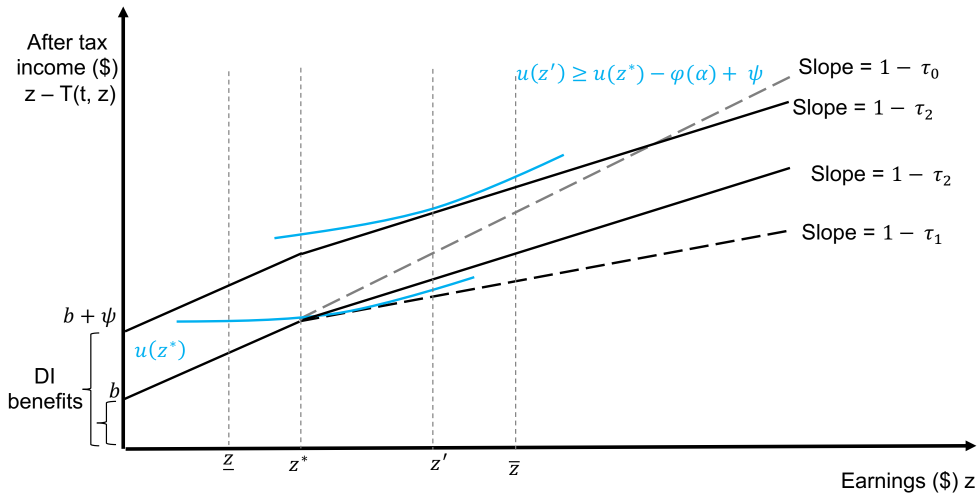
Note: This figure illustrates change in earnings around a kink at z^* where marginal tax rate below and above the kink are respectively τ_0 and τ_1 where $\tau_0 < \tau_1$. Assume that individuals do not face any adjustment costs when they change their earnings. When marginal tax rate above the kink is decreased to τ_2 where $\tau_2 < \tau_1$, then an individual with initial earnings z^* would increase their earnings to z' to get higher utility.

(b) With adjustment costs



Note: This figure illustrates change in earnings around a kink at z^* where marginal tax rate below and above the kink are respectively τ_0 and τ_1 where $\tau_0 < \tau_1$. Assume that individuals face adjustment cost $\phi(\alpha) > 0$ that varies by individuals' ability α. When marginal tax rate above the kink is decreased to τ_2, then individuals with earnings in range of $[\underline{z}, \bar{z}]$ will not change their earnings, since the their utility gain is not as large as adjustment costs they face. $\underline{z}$ and $\bar{z}$ are defined in Equation (1).

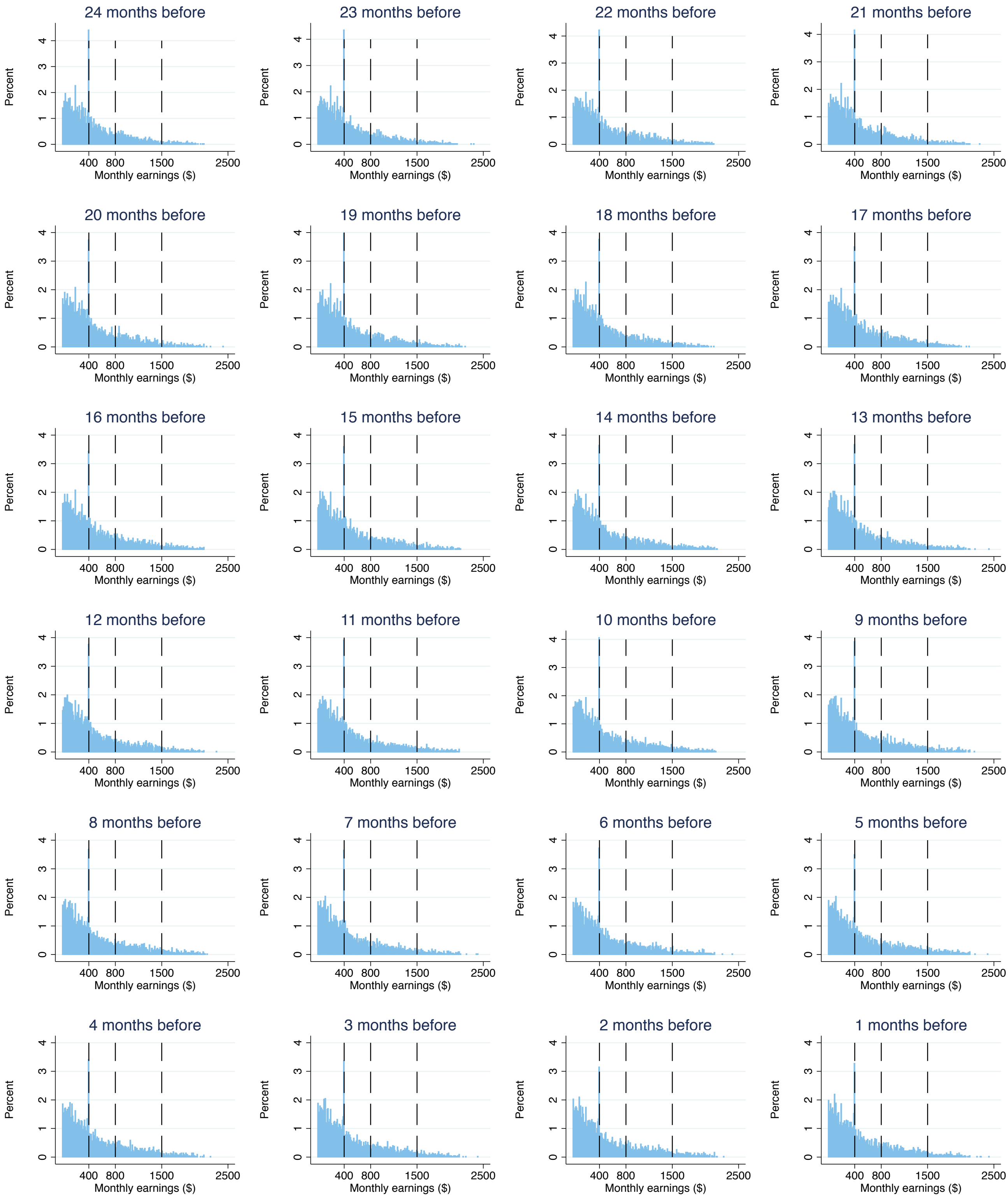
(c) With adjustment costs and lump-sum transfer



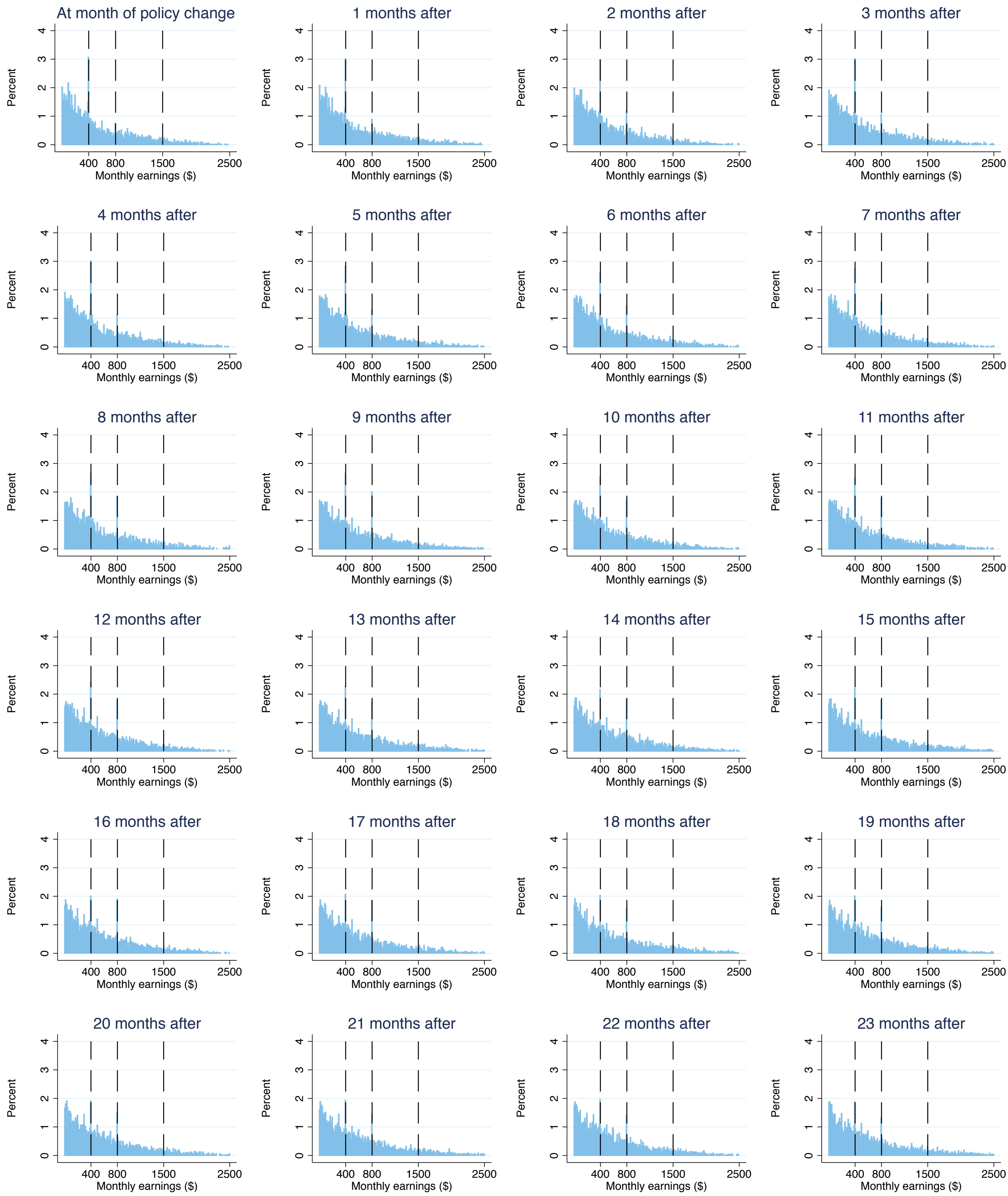
Note: This figure illustrates change in earnings around a kink at z^* where marginal tax rate below and above the kink are respectively τ_0 and τ_1 where $\tau_0 < \tau_1$. Assume that individuals face adjustment cost $\phi(\alpha) > 0$ that varies by individuals' ability α. Suppose that marginal tax rate above the kink is decreased to τ_2 and individuals receive a lump-sum transfer of amount $\psi > 0$. Then individuals with earnings in range of $[\underline{z}, \bar{z}]$ might change their earnings if their utility gain is larger than adjustment costs net of the lump-sum transfer they receive. $\underline{z}$ and $\bar{z}$ are defined in Equation (1).

Figure 4: Distribution of monthly earnings of DI recipients in AISH with no dependents by relative month to the policy change

(a) Before policy change



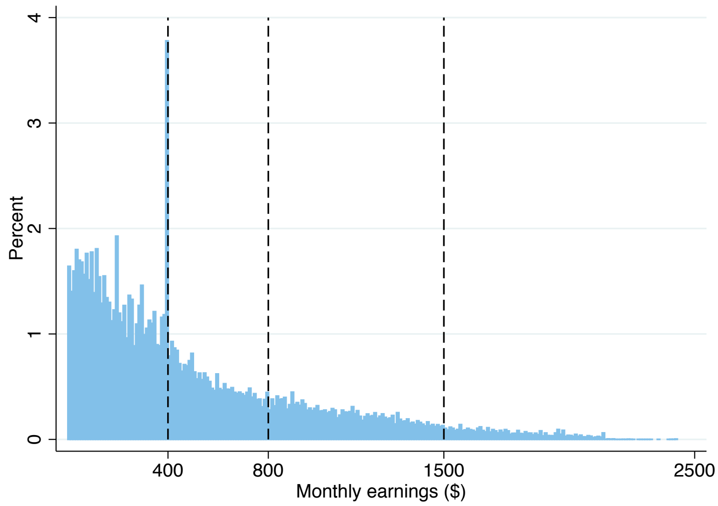
(b) After policy change



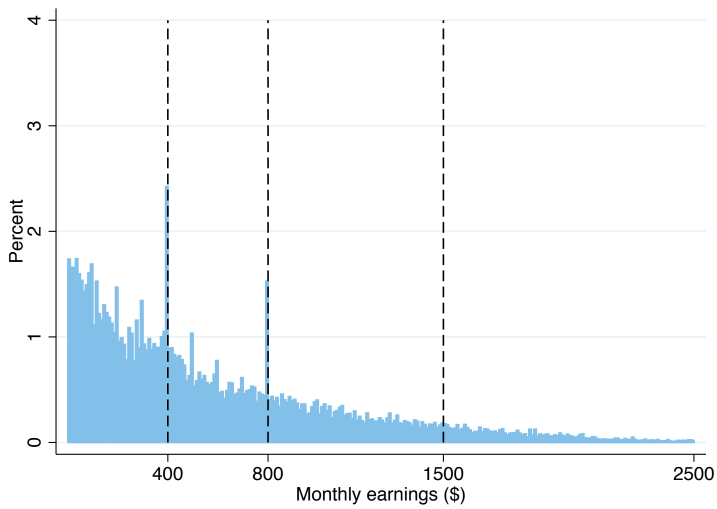
Note: This figure plots the distribution of monthly earnings of DI recipients in AISH within \$10 bins. The sample includes individuals 18-64 years old with no dependents who have non-physical disabilities. Panel (a) and Panel (b) show the distributions respectively two years before and two years after the policy change. There is bunching at the exemption threshold every month before the policy change. The bunching moves away to the new exemption threshold after the policy change but still some individuals continue bunching at the old exemption threshold. There is no noticeable bunching at the second kink before, neither after the policy change.

Figure 5: Distribution of monthly earnings of DI recipinets in AISH with no dependents

(a) Before policy change



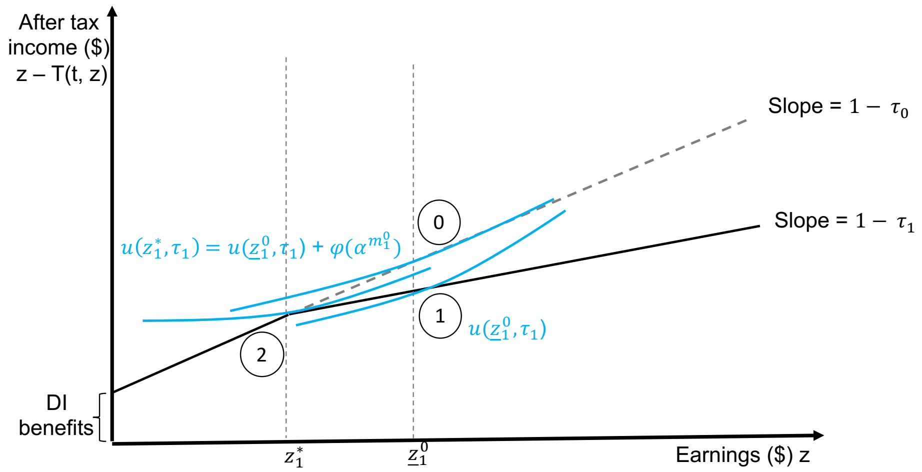
(b) After policy change



Note: This figure shows the distribution of monthly earnings of DI recipients in AISH within \$10 bins. The sample includes individuals 18-64 years old with no dependents who have non-physical disabilities. Panel (a) and (b) show the distribution of earnings for the pooled sample respectively two years before and after the policy change. There is a noticeable bunching at the exemption threshold before the policy change. The bunching moves away to the new exemption threshold after the policy change. Some individuals however continue bunching at the old exemption threshold after the policy change. There is no visually noticeable bunching at the second kink before, neither after the policy change.

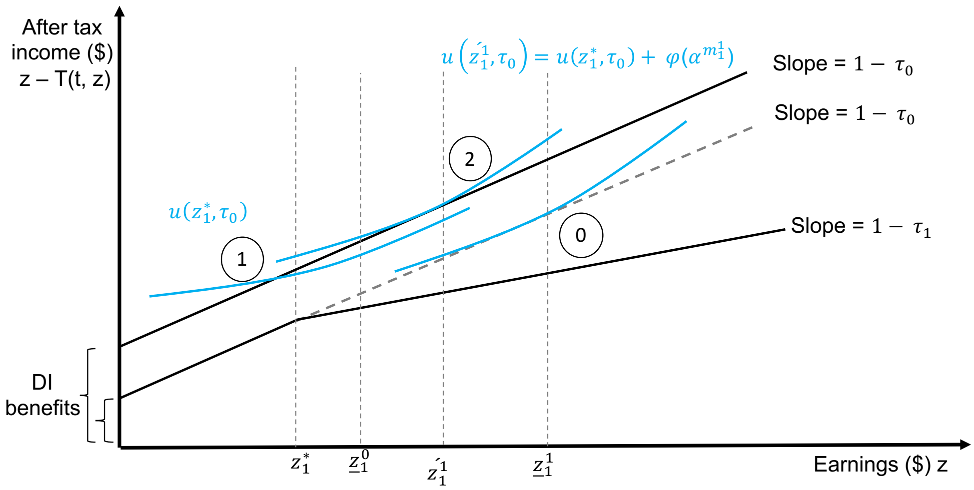
Figure 6: Change in bunching at an exemption threshould induced by a policy change

(a) Introducing an exemption threshould



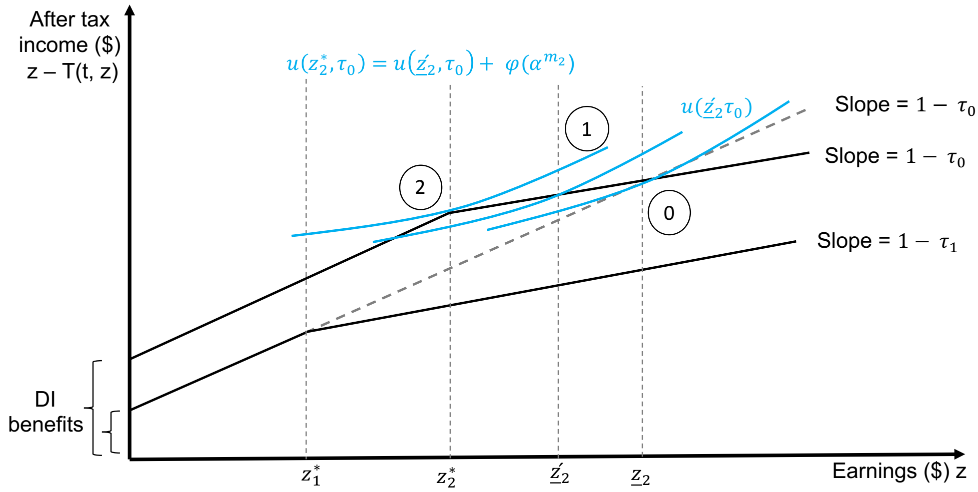
Note: This figure illustrates the earnings adjustment of a marginal buncher at the exemption threshold at z_1^* with ability $\alpha^{m_1^0}$ and initial earnings $\underline{z}_1^0$ when utility loss $\phi(\alpha^{m_1^0})$ is associated with changing labor supply. A marginal buncher is indifferent between staying at $\underline{z}_1^0$ with marginal tax τ_1 or enduring utility loss $\phi(\alpha^{m_1^0})$ and moving to z_1^* with marginal tax τ_0.

(b) Increase in exemption threshould: bunching at the old exemption threshould



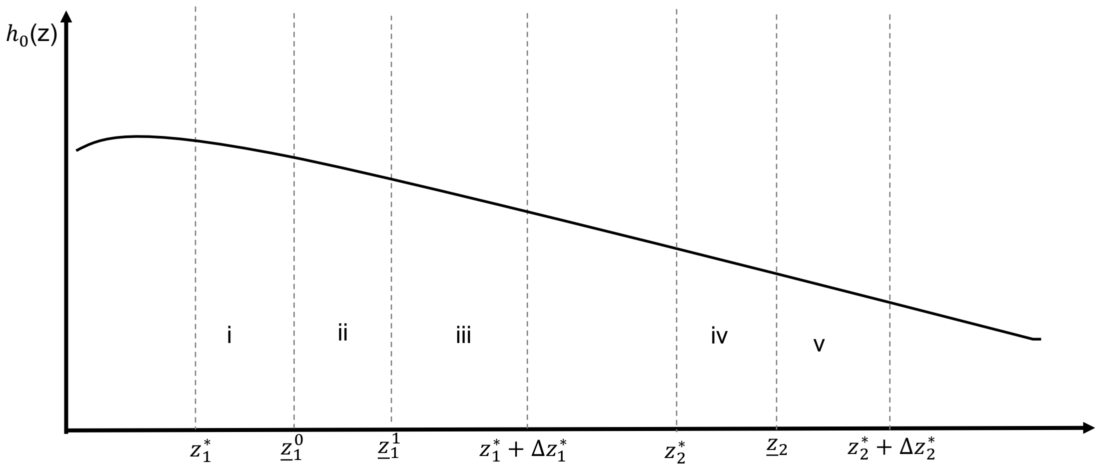
Note: This figure illustrate the earnings adjustment of a marginal buncher at the old exemption threshold at z_1^* after the policy change with ability $\alpha^{m_1^1}$ and initial earnings $\underline{z}_1^1$ when utility loss $\phi(\alpha^{m_1^1})$ is associated with changing the labor supply. After introducing an exemption threshold at z_1^*, she bunches at the exemption threshold. When the exemption threshold is increased, a marginal buncher at the old exemption threshold is indifferent between staying at z_1^* with marginal tax τ_0 or enduring utility loss $\phi(\alpha^{m_1^1})$ and changing her earnings to the optimal one at $z_1^{1\prime}$.

(c) Increase in exemption threshould: bunching at the new exemption threshold



Note: This figure illustrates the earnings adjustment of a marginal buncher at the new exemption threshold at z_2^* with ability α^{m_2} and initial earnings $\underline{z}_2$ when utility loss $\phi(\alpha^{m_2})$ is associated with changing labor supply. After introducing an exemption threshold at z_1^*, she decreases her earnings to $\underline{z}_2{}'$. When the exemption threshold is increased to z_2^*, a marginal buncher is indifferent between staying at $\underline{z}_2{}'$ with marginal tax τ_1 and enduring utility loss $\phi(\alpha^{m_2})$ and bunching at z_2^*.

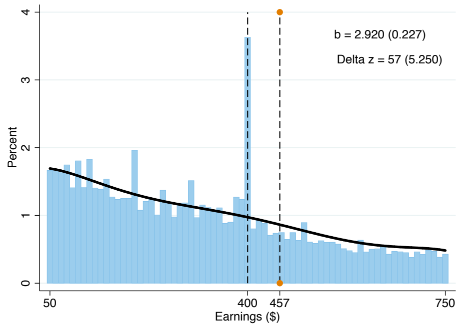
Figure 7: Counter-factual earnings with a flat tax



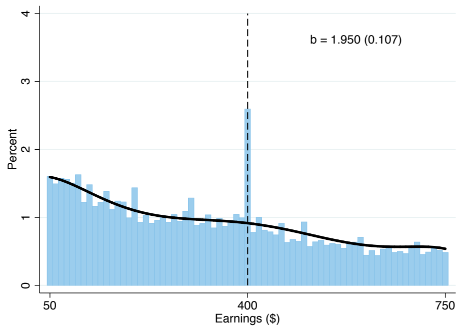
Note: This figure plots the counter-factual distribution of earnings, the distribution if a flat tax τ_0 is imposed on earnings. The amount of bunching at the exemption threshold before the policy change at z_1^* is the area $i + ii + iii$ if individuals face no adjustment costs changing their labor supply. The amount of bunching is however is smaller if individuals face adjustment costs where it is the area $ii + iii$. The area i is the amount of bunching at the old exemption threshold after the policy change. Similarly, the area $iv + v$ and v are the amount of bunching at the new exemption threshold at z_2^* respectively with and without adjustment costs.

Figure 8: Fitted polynomials to distribution of earnings at exemption threshoulds

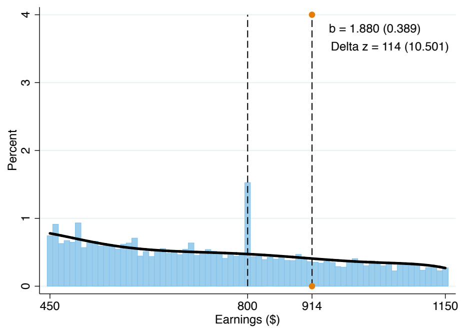
(a) At the exemption threshould before the policy change



(b) At the old exemption threshould after the policy change



(c) At the new exemption threshould after the policy change

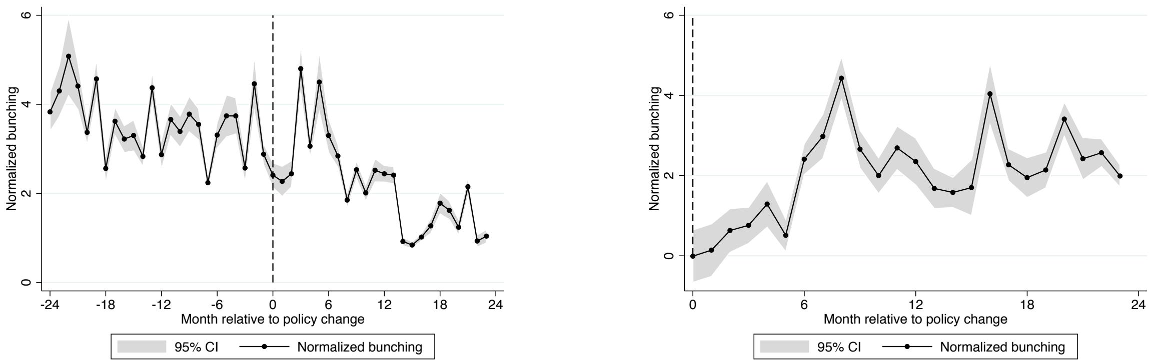


Note: This figure shows the fitted flexible polynomials to the observed distribution of earnings of DI recipients of AISH around the exemption thresholds. The corresponding regression is specified in (13). The estimation parameters are $D = 6$, $\delta = 10$ and $l = u = 3$. The sample includes 18-64 years old individuals with no dependents who have non-physical disabilities within two years of the policy change in AISH. Panel (a) and (b) show the fitted polynomials at the old exemption threshold at \$400 respectively before and after the policy change. Panel (c) shows the fitted polynomial at the new exemption threshold at \$800 after the policy change. The amount of normalized bunchings are estimated using (16).

Figure 9: Normalized bunching at the exemption threshould

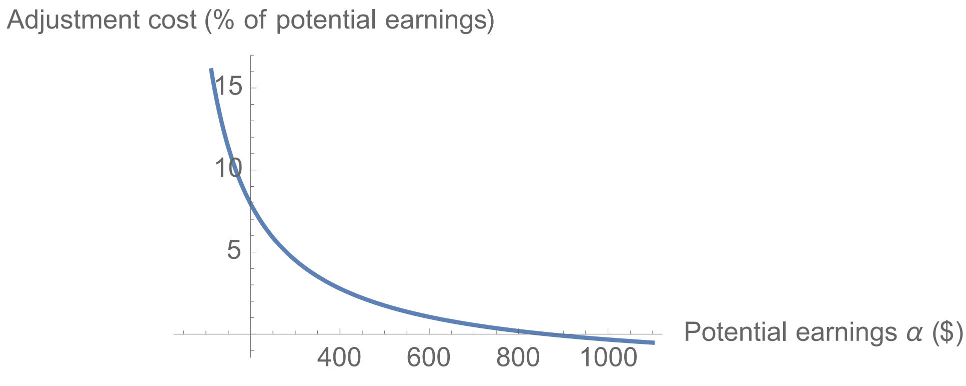
(a) At the old exemption threshould

(b) At the new exemption threshould



Note: This figure shows the amount of normalized bunching at the exemption thresholds estimated using the method presented in Section 3.3.3. The sample includes 18-64 years old DI recipients with no dependents who have non-physical disabilities. The parameters used for the estimation are $\delta = 10$, $D = 6$ and $l = u = 3$. Bunching at the old exemption threshold decreases after the policy change but it does not disappear after the policy change. Bunching at the new exemption threshold gradually increases after the policy change. The 95% Confidence Intervals (CI) using bootstrapped standard errors are shown in gray shades.

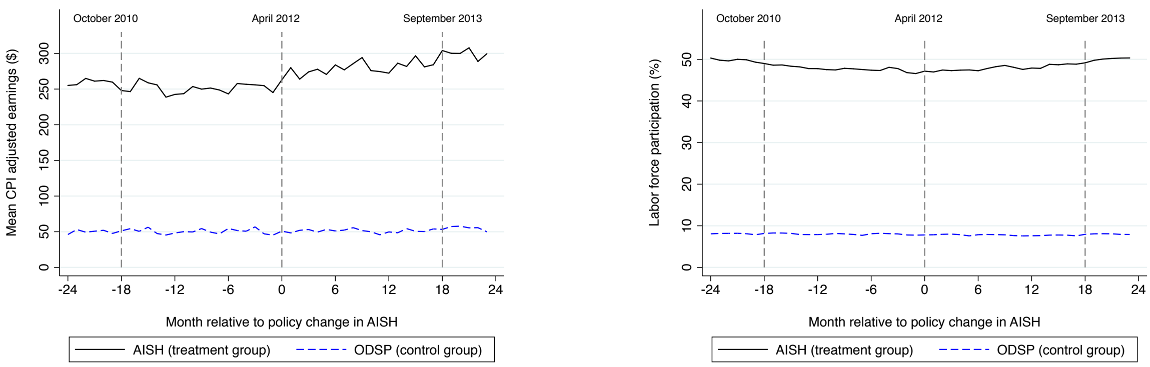
Figure 10: The estimated heterogeneous adjustment costs



Note: This figures plots the estimated heterogeneous adjustment costs as percentage of the potential earnings using the model specified in Section 3.3.2. The estimated heterogenous adjustment costs as shown in Table 2 is $\phi = \frac{20.69}{\alpha} - 0.024$ where α denotes individuals' potential earnings (ability). The sample includes 18-64 years old DI recipients in AISH with no dependents who have non-physical disabilities, within two years of the policy change in AISH.

Figure 11: Trends in earnings and labor force participation before and after April 2012 policy change in AISH

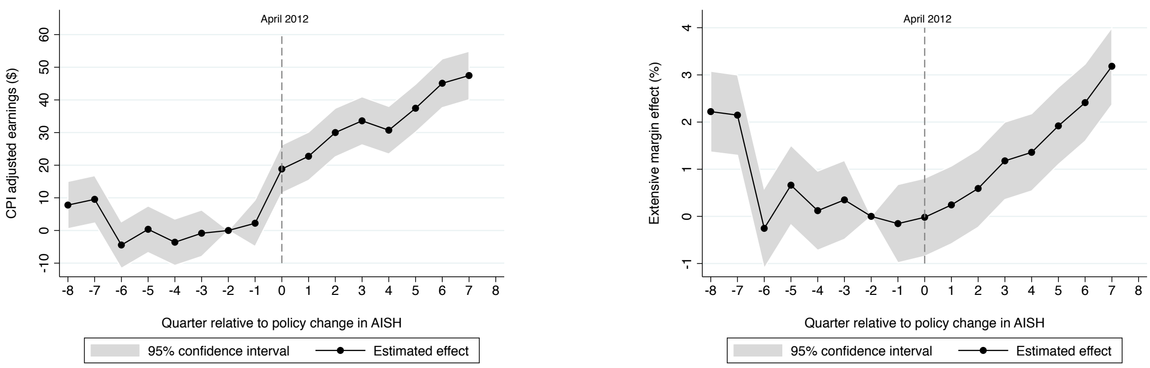
(a) Earnings (b) Labor force participation



Notes: This figure plots the mean monthly earnings and labor force participation rate in the AISH and ODSP respectively in Panel (a) and Panel (b). Labor force participation is defined as a dummy that turns on for positive earnings. The sample includes those with non-physical debilitates. The x-axis shows the month relative to the policy change in AISH at April 2012.

Figure 12: Coefficients of the interaction quarter×AISH in Equation (18)

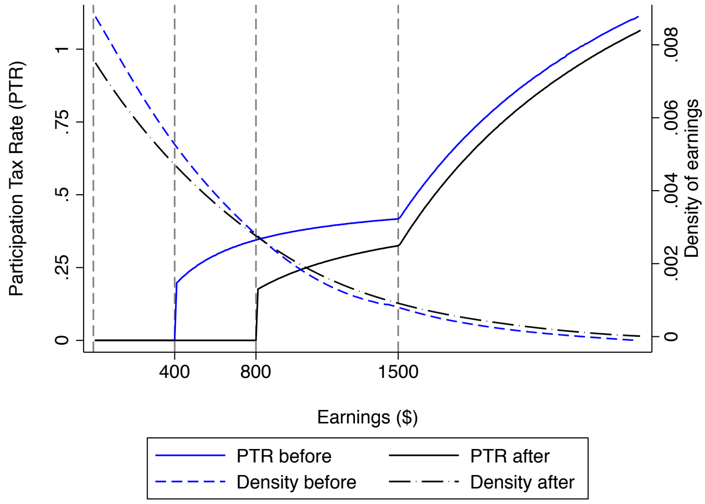
(a) Earnings (b) Extensive margins effects



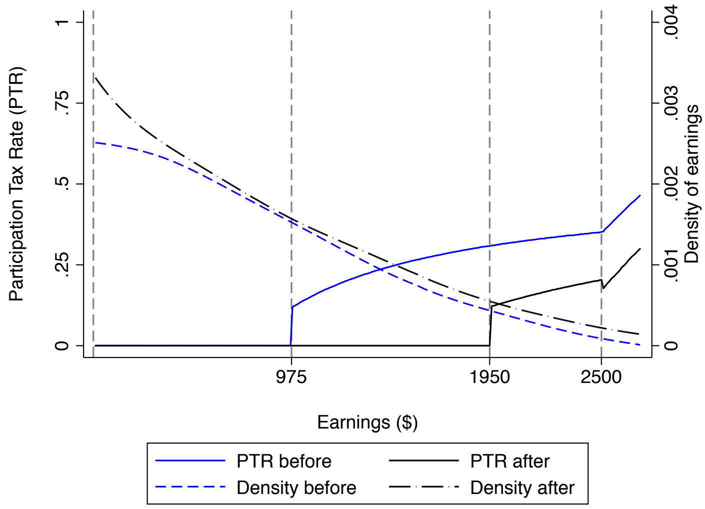
Notes: This figure plots the estimated time trends (β_t) from (18). For extensive margins effects the dependent variable is a dummy which switches on for the positive earnings. The individual characteristics sex, age, age DI awarded at, disability conditions, dummies for whether they live in a metropolitan area and dummies whether they have dependents are included in the model. The sample includes those with non-physical disabilities within two years of the policy change in AISH. The gray area indicated the 95% confidence intervals.

Figure 13: Participation tax rates and smoothed density of earnings

(a) No dependents



(b) With dependents



Note: This figure shows the Participation Tax Rate (PTR) by earnings levels, before and after the policy change in AISH. It also plots the smoothed density of earnings before and after the policy change. Panel (a) and Panel (b) correspond to those respectively with no dependents and with dependents.

Appendix: For On-line Publication

A Proof of Theorem (1)

Theorem 1: Suppose utility loss $\phi > 0$ is associated with adjusting earnings when kink $z^* = (\tau_0, \tau_1)$ is introduced where $\tau_1 > \tau_0$ and $u(c, z; \tau; \alpha)$ is individual's utility with $\dfrac{\partial u_c}{\partial \alpha} < 0$ (marginal utility of consumption decreases as ability increases). If for $z_2 > z_1$, $\dfrac{\partial(z_2 - z_1)}{\partial \alpha}$ increases at a rate that dominates $\dfrac{\partial u_c}{\partial \alpha} < 0$, then utility gain of relocation for initial earning level z_2 is higher than that at z_1.

Proof. The utility gain from relocating to kink z^* from z_k for $k \in \{1, 2\}$ is $\Delta u_k = u((1 - \tau_0)z^*, z^*; \alpha) - u((1-\tau_0)z^* + (1-\tau_1)(z_k - z^*), z_k; \tau_0; \alpha)$. Differences in utility gains from relocating to z^* is:

$$\begin{aligned}\Delta u &= \Delta u_2 - \Delta u_1 \\ &= u((1 - \tau_0)z^* + (1 - \tau_1)(z_2 - z^*), z_2; \tau_1; \alpha) \\ &\quad - u((1 - \tau_0)z^* + (1 - \tau_1)(z_1 - z^*), z_1; \tau_1; \alpha)\end{aligned}$$

Using a first order approximation:

$$\begin{aligned}\Delta u &\simeq [(1 - \tau_1)u_c + u_z]z_2 - [(1 - \tau_1)u_c + u_z]z_1 \\ &\simeq (z_2 - z_1)[(1 - \tau_1)u_c + u_z]\end{aligned}$$

The differences in the gain of relocation to a kink at z^* from $z_2 > z_1$ depends on the marginal utility of consumption u_c and working u_z. Therefore changes in the differences of relocation to a kink by ability is:

$$\frac{\partial \Delta u}{\partial \alpha} = (z_2 - z_1)\left((1 - \tau_1)\frac{\partial u_c}{\partial \alpha} + \frac{\partial u_z}{\partial \alpha}\right)$$

Since marginal utility of consumption decreases as ability increases ($\frac{\partial u_c}{\partial \alpha} < 0$), then $\frac{\partial \Delta u}{\partial \alpha} > 0$ only if $\frac{\partial u_z}{\partial \alpha}$ increases at a rate that dominates. □

Assuming that $\frac{\partial u_z}{\partial \alpha} > 0$ dominates $\frac{\partial u_c}{\partial \alpha} < 0$, then this theorem implies that gain of relocation to a kink is higher for those with higher initial earnings (ability).

B Adjustment costs

B.1 The model with no adjustment costs

The proceeding model for estimating elasticity of earnings using the amount of bunching at a kink is well known and described in Saez (2010). Assume that initially flat tax τ_0 is imposed on earnings. Suppose now that a higher marginal tax τ_1 on earnings above z^* is imposed, introducing a kink in the tax schedule at z^*. With no adjustment costs for changing labor supply, individuals choose their utility maximizing earnings. A smooth distribution of individuals' ability to work implies that those who would locate in the range $(z^*, z^* + \Delta z^*]$ in absence of the kink would bunch in a neighbourhood of z^*. Δz^* is the earnings response range to the kink at z^*.

Suppose that $h(z)$ is the observed distribution of earnings – with a kink at z^* – and $h_0(z)$ is the counter-factual distribution of earnings, if flat tax τ_0 would have been imposed on earnings. The amount of bunching at the kink at z^* is then the area under the counter-factual density of earnings within the bunching interval and is defined as:

$$B = \int_{z^*}^{z^*+\Delta z^*} h_0(\zeta)d\zeta \simeq \Delta z^* h_0(z^*) \tag{B.1}$$

The elasticity of earnings with respect to net-of-tax ratio at kink $z^* = (\tau_0, \tau_1)$ as specified by Saez (2010) is:

$$e = \frac{\Delta z^*/z^*}{(\tau_1 - \tau_0)/(1-\tau_0)} \tag{B.2}$$

where $\Delta z^* = B/h_0(z^*)$.

B.2 Empirical implementation

The model with no adjustment costs: I use the observed distributions of earnings before the policy change to estimate the counter-factual distribution of earnings at the kink at z_1^* by estimating the regressions specified in (13). I then estimate the normalized bunching at the kinks from (15). I back up Δz_1^* from (B.1) by feeding in the estimated B and $h_0(z_1^*)$. Substituting Δz^* in (B.2) results into the elasticity of earnings with respect to net-of-tax at the kink at z_1^* defined as:

$$\widehat{e} = \frac{\ln(1 + \frac{\widehat{\delta b_k}}{z_k^*})}{\ln(\frac{1-\tau_0}{1-\tau_1})} \tag{B.3}$$

The model with fixed adjustment costs: Assume that individuals with initial earnings in the range $(\underline{z}_1^0, z_1^* + \Delta z_1^*]$ would bunch at the kink at $z_1^* = (\tau_0, \tau_1)$. $\underline{z}_1^0$ is the utility maximizing earnings level of a marginal buncher at the kink at z_1^* with ability $\alpha^{m_1^0}$, if flat tax τ_0 would have been imposed on the earnings. A marginal buncher at the kink at z_1^* is indifferent between staying at $\underline{z}_1^0$ where marginal taxes on the earnings are higher or enduring utility loss $\phi > 0$ and bunching at the kink at z_1^*. Using the utility function specified in (3) and the utility maximizing level of earnings from (4):

$$\alpha^{m_1^0} = \frac{\underline{z}_1^0}{(1-\tau_0)^e}$$

Feeding this in (5) using the specified utility function in (3) results in an equation which implicitly defines $\underline{z}_1^0$ as a function of the elasticity of earnings e and utility loss ϕ associated with adjusting earnings:

$$(1-\tau_1)(\underline{z}_1^0 - z_1^*) - \frac{1-\tau_0}{1+\frac{1}{e}}\left(\underline{z}_1^0 - {z_1^*}^{1+\frac{1}{e}}\,{\underline{z}_1^0}^{-\frac{1}{e}}\right) + \phi = 0 \tag{B.4}$$

I use the observed distributions of earnings at a neighbourhood of the kink at z_1^* before the policy and estimate the first regression specified in (13). Panel (a) of Figure 8 plots the fitted degree six polynomial where three bins around the kink are excluded ($D = 6, l = u = 3$). I compute b_1^0, the normalized bunching at z_1^* before the policy change from (16) using the fitted polynomial. Feeding Δz_1^* from (11) and the estimated b_1^0 in (6) results in:

$$\underline{z}_1^0 = \left(\frac{1-\tau_0}{1-\tau_1}\right)^e z_1^* - \delta \widehat{b_1^0} \tag{B.5}$$

Together (B.4) and (B.5) describe an equation of e and ϕ.

I then use the residual bunching at the former kink at z_1^* to construct another equation of e and ϕ and together estimate the parameters of interest. Assume that individuals with initial earnings in the range $(\underline{z}_1^0, \underline{z}_1^1]$ would bunch at the former kink at z_1^*. $\underline{z}_1^1$ is the initial earnings of a marginal buncher at z_1^* with ability $\alpha^{m_1^1}$. A marginal buncher is indifferent between bunching at z_1^* or enduring utility loss ϕ and relocating to their utility maximizing level of earnings at $\underline{z}_1^{1\prime}$. Similar to the case before the policy change:

$$\alpha^{m_1^1} = \frac{\underline{z}_1^1}{(1-\tau_0)^e}$$

Feeding this into (7) using the utility function specified in (3) results into:

$$(1-\tau_0)\left(z_1^* - \frac{1}{1+\frac{1}{e}}{\underline{z}_1^1}^{1-\frac{1}{e}}{z_1^*}^{1+\frac{1}{e}} - \frac{\underline{z}_1^1}{1+e}\right) + \phi = 0 \tag{B.6}$$

I use the observed distribution of earnings at a neighbourhood of z_1^* after the policy change to estimate the first regression specified in (13). Panel (b) of Figure 8 shows the fitted polynomial with parameters set as $l = u = 3$ and $D = 6$. Feeding b_1^1, the estimated normalized bunching at the former kink at z_1^* using (16), into (8) results into:

$$\underline{z}_1^1 = \underline{z}_1^0 + \delta \widehat{b_1^1} \tag{B.7}$$

Together (B.6) and (B.7) describe another equation of e and ϕ. This together with (B.4) and (B.5) estimate the elasticity of earnings e and the fixed adjustment costs ϕ.

The model with heterogeneous adjustment costs: Suppose that after the policy change, individuals with initial earnings in the range $(\underline{z}_2, z_2^* + \Delta z_2^*]$ would bunch at the kink at $z_2^* = (\tau_0, \tau_1)$ where $\underline{z}_2 > z_2^*$. $\underline{z}_2$ is the initial earnings of a marginal buncher at z_2^* with ability α^{m_2} who after the policy change is indifferent between staying at their optimal level of earnings before the policy change at $\underline{z}_2'$ or enduring utility loss ϕ and bunching at z_2^*. Since $\underline{z}_2$ is the utility maximizing earnings of a marginal buncher when flat tax τ_0 is imposed, then using the utility function specified in (3) and the utility maximizing level of earnings from (4):

$$\alpha^{m_2} = \frac{\underline{z}_2}{(1-\tau_1)^e}$$

Feeding this into (9) using the utility function specified in (3) results into an equation which implicitly defines $\underline{z}_2$ as a function of elasticity of earnings e and the utility loss ϕ associated with adjusting earnings:

$$(1-\tau_1)\left(\frac{\underline{z}_2}{1+e}\left(\frac{1-\tau_1}{1-\tau_0}\right)^e - z_2^*\right) + \frac{1-\tau_0}{1+\frac{1}{e}}\left(\underline{z}_2^{-\frac{1}{e}} z_2^{*1+\frac{1}{e}}\right) + \phi = 0 \tag{B.8}$$

I use the observed distribution of earnings at a neighbourhood of the kink at z_2^* after the policy change and estimate the second regression specified in (13). Panel (c) of Figure 8 shows the fitted polynomial with parameters set as $l = u = 3$ and $D = 6$. Feeding $\widehat{b}_2$, the estimated normalized bunching at the kink at z_2^* after the policy change from (16), and Δz_2^* from (11) into (10) results in:

$$\underline{z}_2 = \left(\frac{1-\tau_0}{1-\tau_1}\right)^e z_2^* - \delta\widehat{b_2} \tag{B.9}$$

Together (B.8) and (B.9) define another equation of e and ϕ. I assume a linear adjustment costs as $\phi = \phi_1 + \alpha\phi_2$ that vary by individuals' ability α. I then numerically solve the three equations specified earlier simultaneously to estimate e, ϕ_1 and ϕ_2.

B.3 Tables

Table B.1: Estimated elasticity of earnings and adjustment costs

(a) Fixed adjustment costs (Gelber et al., 2016)

	Bunching at kink at \$400 before policy change b_1^0	Earnings response at kink at \$400 before policy change Δz_1^{*0}	Bunching at \$400 after policy change b_1^1	Elasticity e	Adjustment costs ϕ
A. Full sample					
Within two years	2.920***	62.605***	1.950***	0.210***	11.933***
	(0.227)	(6.028)	(0.107)	(0.019)	(0.972)
Within one year and half	2.790***	58.975***	2.120***	0.198***	11.733***
	(0.202)	(5.009)	(0.124)	(0.016)	(0.744)
Adding 5%	2.920***	59.481***	1.950***	0.186***	11.119***
payroll taxes	(0.227)	(5.373)	(0.107)	(0.016)	(0.777)
B. Age					
18-34	2.660***	57.295	1.630***	0.193***	10.642***
	(0.175)	(9.160)	(0.101)	(0.029)	(2.202)
35-49	2.680***	58.203***	1.550***	0.196***	10.657***
	(0.217)	(13.112)	(0.122)	(0.041)	(3.142)
> 50	3.600***	77.854***	2.770***	0.257***	15.639***
	(0.7.5)	(18.100)	(0.239)	(0.055)	(4.288)
C. Gender					
Male	3.510***	77.040***	2.160***	0.254***	14.410***
	(0.377)	(18.436)	(0.146)	(0.056)	(4.450)
Female	2.210***	46.063***	1.680***	0.157***	9.139***
	(0.144)	(3.371)	(0.087)	(0.011)	(0.470)
D. Disability type					
Psychotic	4.630	53.160	1.620***	0.182	3.317
	(3.771)	(35.160)	(0.147)	(0.112)	(14.756)
Neurological	2.330***	48.441***	2.050***	0.165***	10.224***
	(0.159)	(3.443)	(0.112)	(0.011)	(0.496)
Mental	4.300***	184.393***	2.100***	0.547***	39.403***
	(0.630)	(49.252)	(0.174)	(0.122)	(11.420)
E. Living location					
Metropolitan area	4.290***	95.123***	3.180***	0.308***	18.954***
	(0.962)	(18.123)	(0.216)	(0.053)	(3.242)
Other	1.650***	32.933***	0.880***	0.114***	5.647***
	(0.136)	(4.176)	(0.103)	(0.014)	(1.350)

Note: This table presents the estimated elasticity of earnings with respect to net-of-tax ratios assuming that fixed loss is associated with adjusting earnings, using the model specified in (Gelber et al., 2016). The bootstrapped standard errors are in the parenthesis.
$*p < 0.10, **p < 0.05, ***p < 0.01$

(b) No adjustment costs (Saez, 2010)

	Bunching b	Earnings response Δz^*	Elasticity e
A. Full sample			
Within two years	2.920***	29.000***	0.100***
	(0.227)	(2.274)	(0.008)
Within one year and half	2.790***	28.000***	0.100***
	(0.202)	(2.019)	(0.007)
Adding 5%	2.920***	29.000***	0.090***
payroll taxes	(0.227)	(2.274)	(0.007)
B. Age			
18-34	2.660***	27.000***	0.090***
	(0.175)	(1.748)	(0.006)
35-49	2.680***	27.000***	0.090***
	(0.217)	(2.171)	(0.007)
> 50	3.600***	36.000***	0.120***
	(0.705)	(7.048)	(0.023)
C. Gender			
Male	3.510***	35.000***	0.120***
	(0.377)	(3.770)	(0.013)
Female	2.210***	22.000***	0.080***
	(0.144)	(1.439)	(0.005)
D. Disability type			
Psychotic	34.630	46.000	0.16
	(3.771)	(36.708)	(0.241)
Neurological	2.330***	23.000***	0.080***
	(0.159)	(1.593)	(0.005)
Mental	4.300***	43.000***	0.150***
	(0.630)	(6.300)	(0.021)
E. Living location			
Metropolitan area	4.290***	43.000***	0.110***
	(0.962)	(9.616)	(0.007)
Other	1.650***	16.000***	0.060***
	(0.136)	(1.361)	(0.005)

Note: This table presents the estimated elasticity of earnings with respect to net-of-tax ratios assuming that no utility loss associated with adjusting earnings using the model specified in Section B.1. The bootstrapped standard errors are in the parenthesis.
$*p < 0.10, **p < 0.05, ***p < 0.01$

Table B.2: Robustness of the estimted amount of bunching at the kinks with respect to the selected parameters

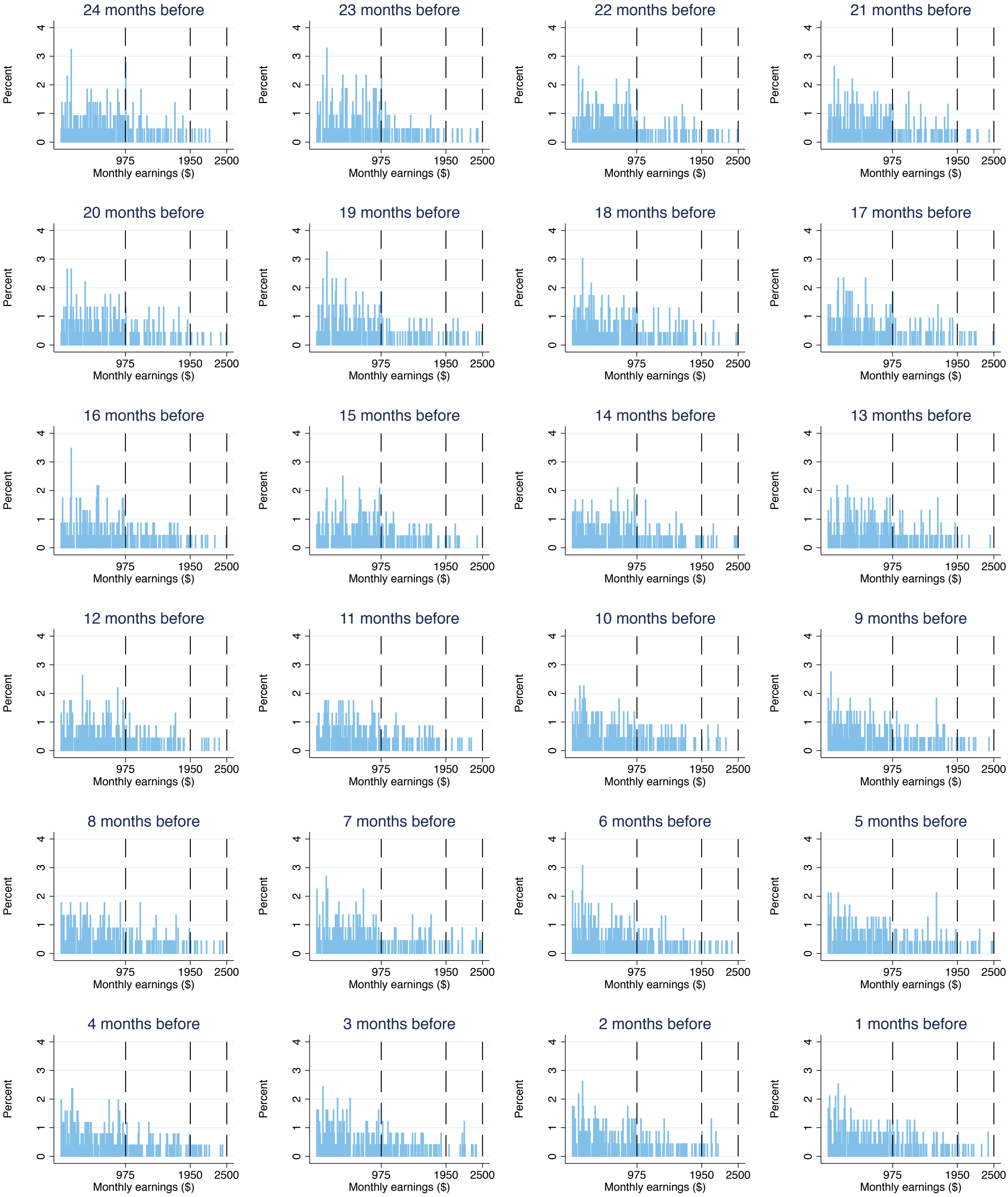
Bin size ($) δ	Degree of polynomial D	Number of excluded bins at each side l	Bunching at kink at $400 before policy change b_1^0	Bunching at kink at $400 after policy change b_1^1	Bunching at kink at $800 after policy change b_2
			Panel A: Baseline estimate		
10	6	3	2.920***	1.950***	1.880***
			(0.227)	(0.107)	(0.389)
			Panel B: Robustness to bin size		
5	6	6	3.460***	1.430***	0.730***
			(0.353)	(0.172)	(0.197)
15	6	2	1.020***	0.640***	0.310***
			(0.065)	(0.059)	(0.073)
			Panel C: Robustness to degree		
10	5	3	2.030***	1.400***	0.650*
			(0.131)	(0.113)	(0.408)
10	7	3	1.650***	0.880***	0.420*
			(0.115)	(0.092)	(0.327)
			Panel D: Robustness to excluded bins		
10	6	2	1.860***	1.170***	0.750***
			(0.126)	(0.108)	(0.304)
10	6	4	0.760***	0.710***	-0.060
			(0.086)	(0.098)	(0.214)

Note: This table presents the estimated amount of normalized bunching at the kinks with respect to the selected parameters using (13), (15) and (16). The selected parameters include bin size, degree of the fitted polynomial and the number of excludes bins around a kink. Since changing the bin size also changes the number of excluded bins, therefore number of the excluded bins are changes accordingly. The bootstrapped standard errors are in the parenthesis.
$*p < 0.10, **p < 0.05, ***p < 0.01$

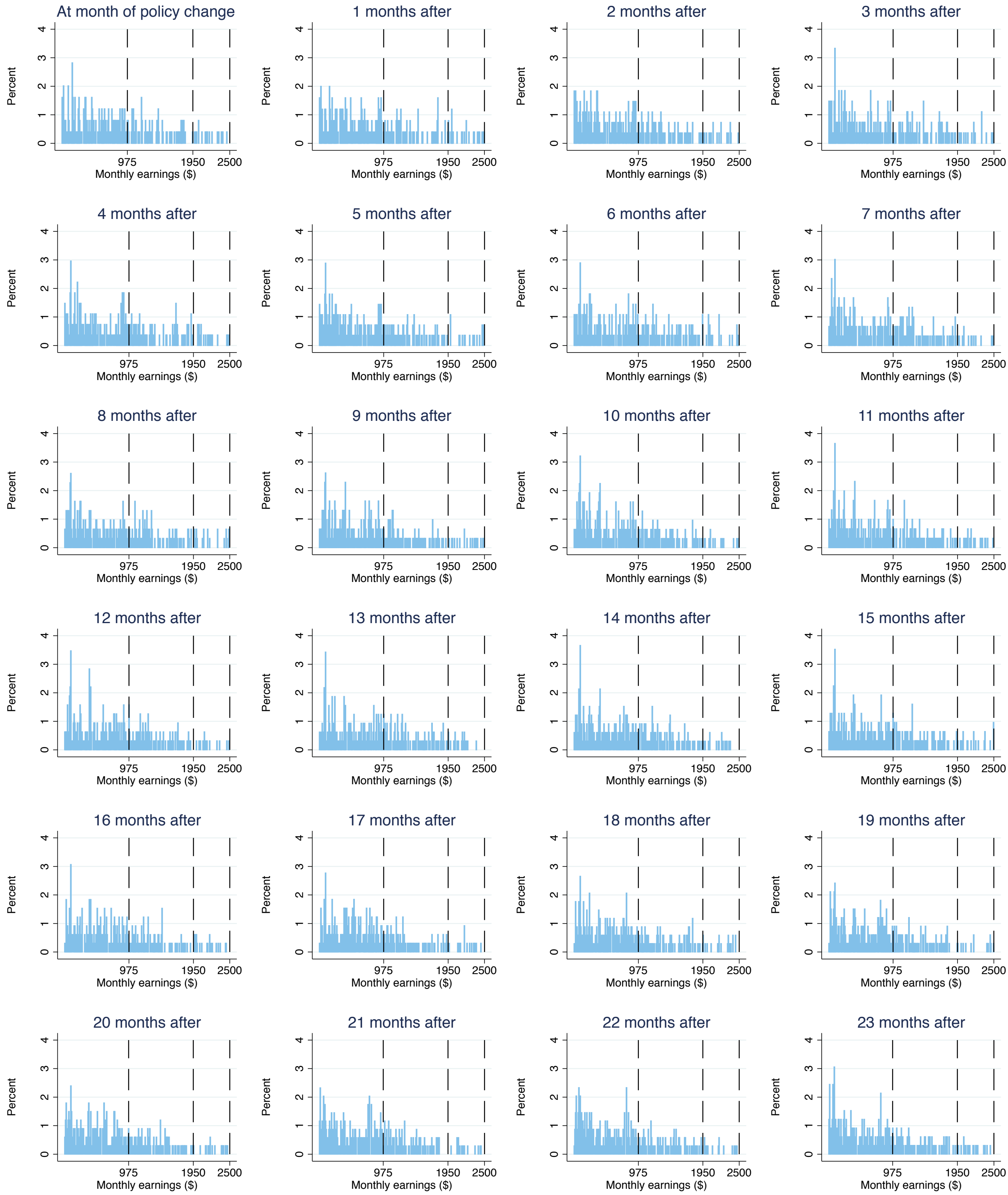
B.4 Figures

Figure B.1: Distribution of monthly earnings of AISH benefit recipients with dependents by relative month to the policy change

(a) Before policy change



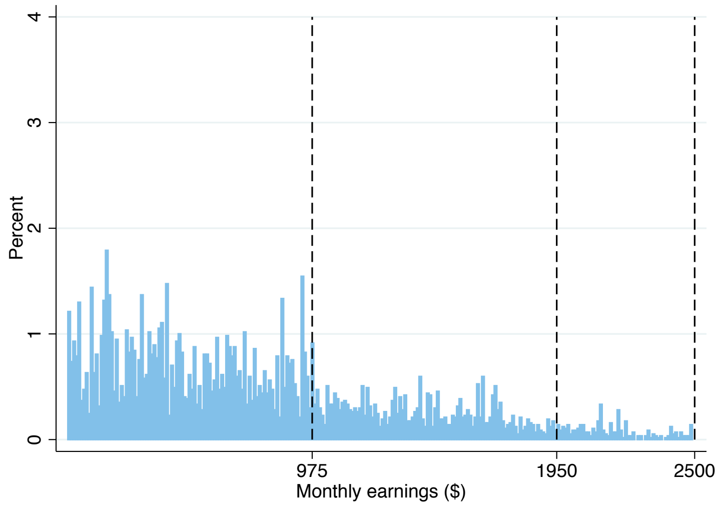
(b) After policy change



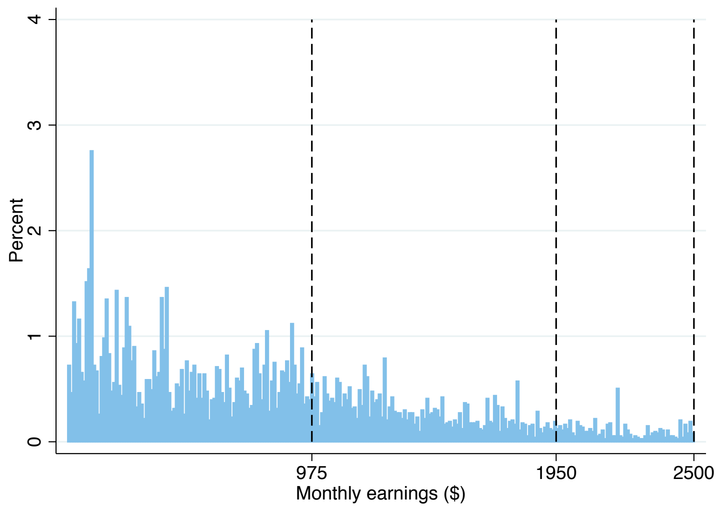
Note: This figure plots the distribution of monthly earnings of DI recipients in AISH within $10 bins. The sample includes individuals 18-64 years old with dependents who have non-physical disabilities. Panel (a) and Panel (b) show the distributions respectively two years before and two years after the policy change. There is no noticeable bunching at any of the kinks before, neither after the policy change.

Figure B.2: Distribution of monthly earnings of DI recipinets in AISH with dependents

(a) Before policy change



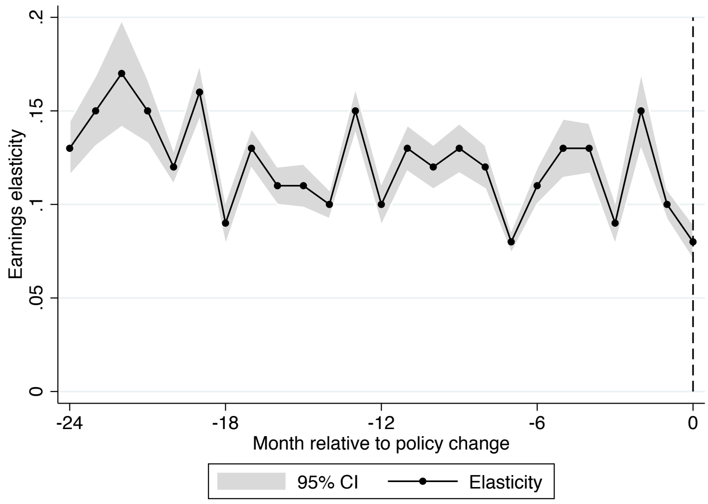
(b) After policy change



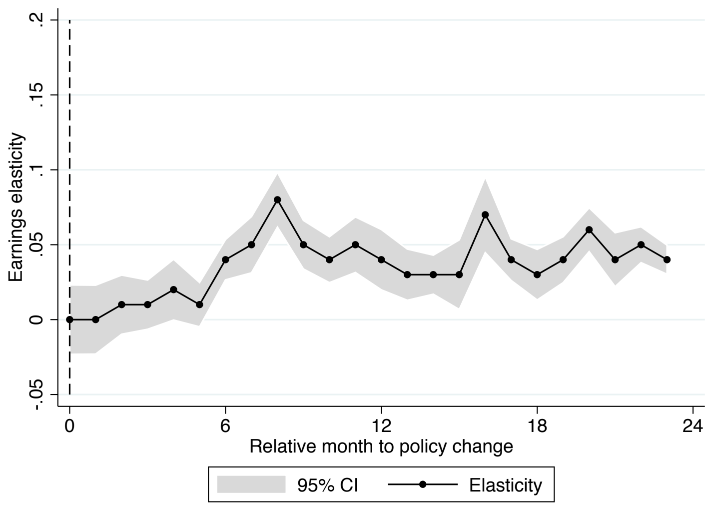
Note: This figure shows the distribution of monthly earnings of DI recipients in AISH within \$10 bins. The sample includes individuals 18-64 years old with dependents who have non-physical disabilities. Panel (a) and (b) show the distribution of earnings for the pooled sample respectively two years before and after the policy change. There is no noticeable bunching at any of the kinks before, neither after the policy change.

Figure B.3: Estimated elasticity of earnings with no adjustment costs (Saez, 2010)

(a) At the old exemption threshould



(b) At the new exemption threshould



Note: This figure shows the estimated elasticity of earnings with respect to net-of-tax ratios at the exemption thresholds before and after the policy change using (Saez, 2010) method described in Appendix B.1. The sample includes 18-64 years old DI recipients with no dependents who have non-physical disabilities. The parameters used for the estimation are $\delta = 10$, $D = 6$ and $l = u = 3$. The estimated elasticity at the old exemption threshold gradually decreases while it increases at the new exemption threshold. The 95% Confidence Intervals (CI) using bootstrapped standard errors are shown in gray shades.

C Income effect of policy change in AISH

The April 2012 policy change in AISH consists of two pieces; first, doubling earnings exemption threshold; second, 35% increase in maximum monthly DI benefits. While this policy change might induce both income and substitution effects, I assume that the induced income effect are negligible and I use a quasi-linear utility function specified in (3) for estimating elasticity of earnings and heterogeneous adjustment costs. In this section I provide suggestive evidence that the induced income effect of the policy change are negligible and this is a plausible assumption.

Panel (a) of Figure 1 shows the budget constraints of DI recipients in AISH with no dependents. Theoretically, individuals with monthly earnings between zero and \$400 and those with monthly earnings above \$800 before the policy change are only exposed to income effect (pieces with parallel budget constraints). Similarly Panel (b) shows that those with monthly earnings between zero and \$950 and above \$1,950 before the policy change are only exposed to income effect. I use sample of individuals who are expected to be exposed only to income effect, to estimate induced income effect of the policy change in AISH in Difference-in-Difference (DD) framework using corresponding sub samples of benefit recipients of ODSP as control group. My estimates of elasticity of earnings and adjustment costs presented in Table 2 suggest that those with earnings within \$100 of the thresholds would respond to the policy change. I restrict my samples to within \$100 of each threshold to make sure that my finding are not contaminated by any other confounding factor.

C.1 Descriptive evidences and findings

Figure C.1 plots the trends in mean CPI adjusted earnings of AISH and ODSP benefit recipients for different samples that are exposed to income effect. Panel (a) and (b) show the trends for samples of individuals with no dependents whose monthly earnings is in the range $(0, \$300]$ respectively six months and one year prior to the policy change. Panel (c) and (d) show the trends for samples of individuals with no dependents whose monthly earnings in above \$900 respectively six months and one year prior to the policy change. Finally, Panel (e) shows the trends for those with dependents whose earnings six months prior to the policy change is in the range $(0, \$850]$. The sub sample of individuals with family whose earnings one year prior to the policy change is in the range $(0, \$850]$ is quite small. These figures all visually suggest that for each sub sample trends in earnings in AISH is quite similar to that in ODSP prior to the policy change.

Table C.1 presents the estimated effects of the policy change for each sub sample described above using the corresponding sub sample from ODSP as control group using (17). Most of the estimated effects are negative and insignificant. The estimated positive effects are either insignificant or very small. Each of these sub samples are more likely to be effected by income effect induced by the policy change and are less likely to be effected by the induced substitution effects of the policy change. Therefore, the estimated effects provide suggestive evidence on the induced income effect of the policy change.

C.2 Tables

Table C.1: Estimated income effect of the policy change

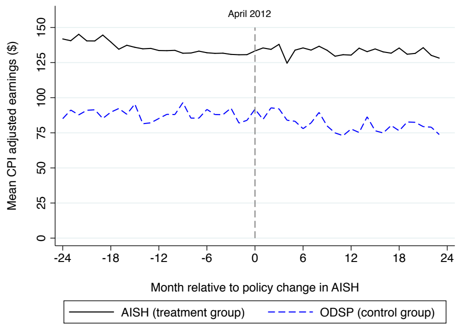
	No dependent				With dependent(s)
	(1)	(2)	(3)	(4)	(5)
AISH × Post	-1.61	4.74***	-4.99	18.97	-4.76
	(1.23)	(1.22)	(12.48)	(10.40)	(11.12)
AISH	44.66***	37.36***	-133.79***	-81.01***	2.21
	(0.81)	(0.83)	(8.23)	(7.19)	(6.67)
Sample	$0 < earnings \leq 300$	$0 < earnings \leq 300$	$earnings \geq 900$	$earnings \geq 900$	$0 < earnings \leq 850$
	12 months	6 months	12 months	6 months	6 months
Individual co-variates	Yes	Yes	Yes	Yes	Yes
Mean in AISH	138.76	135.59	1,248.98	1,140.49	307.25
before policy change	(103.65)	(118.55)	(421.28)	(492.57)	(348.25)
R-Sq.	0.06	0.04	0.07	0.07	0.01
Num. of. Obs.	213,642	268,394	29,361	52,104	55,667

Notes: This table shows the estimated effects from Difference-in-Difference framework using (17) for samples of individuals who are likely to get exposed only to income effect of the policy change in AISH. The sample in each columns includes those whose earnings x months before the policy change always have been $y_1 < earnings \leq y_2$. Each sample covers two years within the policy change. Included individual co-variates are sex, age, age DI awarded at, disability type and living location. Robust standard deviations are in the parenthesis.
$*p < 0.10, **p < 0.05, ***p < 0.01$

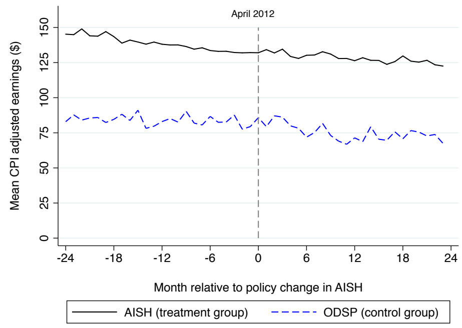
C.3 Figures

Figure C.1: Trends in earnings before and after April 2012 policy change in AISH for those facing only income effect

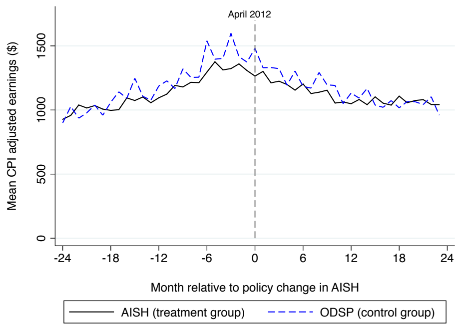
(a) No dependents and earnings in range $(0, \$300]$ six months before the policy change



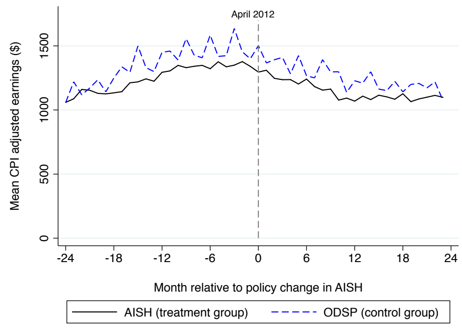
(b) No dependents and earnings in range $(0, \$300]$ one year before the policy change



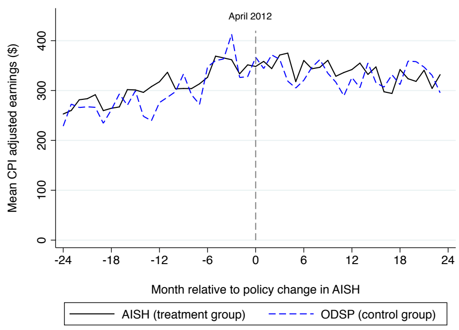
(c) No dependents and earnings over \$900 six months before the policy change



(d) No dependents and earnings over \$900 one year before the policy change



(e) With dependents and earnings in the range $(0, \$850]$ six months before the policy change



Note: This figure shows trends in earnings before and after the policy change in AISH at April 2012 for AISH and ODSP benefit recipients who are only exposed to income effect of the policy change. The sample includes those with non-physical disabilities within two years of the policy change. The sample is further specified in the title of each panel.