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Theoretical and Empirical Essays on Labor Supply of the Elderly

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Für meine Eltern, Maria und Andreas.

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Abstract

To mitigate the adverse effects of the changing demographic environment, policy reforms of many countries aim at promoting longer working lives. Designing policy reforms requires a detailed understanding of the labor supply behavior of older workers. This thesis contains theoretical, empirical, and methodological essays related to the labor supply of the elderly.

Chapter 1 presents a new argument for the introduction of age dependent labor income taxes relying on age varying patterns of marginal social welfare weights. By contrast, the existing literature motivated age dependent taxes by age-varying properties of the earnings distribution and age-varying labor supply elasticities. I rationalize these age-varying weights in a two period framework with a transfer scheme at old age. Agents differ along two unobserved dimensions: Innate ability and preference for leisure. I adopt the normative view that the social planner fully compensates agents for low innate ability, but holds them responsible for their leisure preferences. This chapter points out an additional mechanism that has been neglected by the literature. In the analysis, average welfare weights of the working population decrease with age if low ability agents are over-proportionally represented in the inactive population at old age. In this case, I show that a tax reform increasing taxes for the working population at old age can be welfare improving.

Chapter 2 estimates the labor supply response when the spouse reaches full retirement age (FRA).[1] We exploit the age difference within couples and changes in pension legislation in Switzerland to identify the causal effect. In contrast to the majority of previous contributions, we estimate the effect not only on labor market participation (*extensive margin*), but also on working hours (*intensive margin*). We find that the labor force participation rate of women drops by approximately 3 percentage points in response to the spouse reaching full retirement age. We find no evidence that men adjust their labor force participation rate when their wives reach FRA. At the intensive margin, we find only small and non-significant effects for both men and women, although older workers use working hours to adjust their labor supply. We argue that the response can be explained by complementarity in leisure and liquidity effects.

Chapter 3 discusses identification of causal intensive margin effects.[2] The causal intensive margin effect is defined as the treatment effect on the outcome of individuals with a positive outcome irrespective of whether they are treated or not (always-takers or participants). A potential selection problem arises when conditioning on positive outcomes, even if treatment is randomly assigned. We propose to use difference-in-difference

[1]Chapter 2 is joint work with Elias Moor. Both authors contributed equally to this chapter.
[2]Chapter 3 is joint work with Elias Moor. Both authors contributed equally to this chapter.

methods - conditional on positive outcomes - to estimate causal intensive margin effects. We derive sufficient conditions under which the difference-in-difference methods identify the causal intensive margin effect in a setting with random treatment.

Chapter 4 studies the association between having a disability that limits activities of daily living (ADL) and the transition rates between *wage-employment*, *self-employment*, *unemployment insurance*, *disability insurance* and *inactivity*. The analysis focuses on older Swiss workers aged between 50 and the full retirement age (FRA). I use panel data from the Swiss Labor Force Survey matched with administrative social security records for the time period between 2003 and 2009. I find a strong association between reporting ADL and the transition rate from wage employment to the unemployment insurance, to the disability insurance, and to inactivity for both sexes. The analysis by socio-economic groups yields three main results. First, the association between reporting ADL and the transition rate from wage employment to the disability insurance is stronger for men than for women. Second, the association between reporting ADL and the transition rate from wage employment to the disability insurance is stronger for men in the age group from 58 to FRA than for men aged 50 to 57. Third, I find that the association between reporting ADL and the transition rate from wage employment to the disability insurance is stronger for men with obligatory education than for men with tertiary education. By contrast, the association between reporting ADL and the transition rate from wage employment to the disability insurance is stronger for women with tertiary education than for women with obligatory education.

Chapter 5 estimates the extent of the justification bias among older DI beneficiaries in Switzerland. A common concern with the use of self-reported health measures is that individuals misreport the extent of the physical and psychological impairment to rationalize their labor market or welfare receipt status. The extent to which individuals misreport is referred to as the *justification bias*. In chapter 5, I present evidence on the justification bias among older disability insurance beneficiaries in Switzerland using a new identification strategy. I exploit the feature that a first pillar disability pension is converted to an old age pension at full retirement age (FRA). For the analysis, I use survey data matched with social security registers for the time period between 2003 and 2009. For male DI beneficiaries, I find a large and significant drop in the share reporting a disability that limits them in activities of daily living when the FRA age is reached. I attribute this drop to the extent of the justification bias among male DI beneficiaries. For men, I find evidence that the effect is driven by DI beneficiaries from cantons with above average DI enrolment rates. By contrast, the effect for female DI beneficiaries is small and statistically insignificant.

Zusammenfassung

Reformen der Pensionssysteme in vielen Länder haben zum Ziel, den längeren Verbleib im Arbeitsmarkt für ältere Personen zu fördern. Die vorliegende Dissertation beinhaltet theoretische, empirische und methodische Aufsätze zum Arbeitsangebot älterer Menschen.

Kapitel 1 präsentiert ein neues Argument für die Einführung von altersabhängigen Einkommenssteuern. Das Argument fusst darauf, dass der Sozialplaner das Wohlergehen von Individuen mit einem gegebenen Einkommen altersabhängig beurteilt. Ich begründe die alterabhängigen Gewichte in einem Zwei-Perioden-Modell. Agenten haben die Möglichkeit, sich in Periode 2 frühpensionieren zu lassen. Die Agenten unterscheiden sich in zwei Dimensionen: Angeborene Fähigkeiten und Präferenzen für Freizeit. Ich nehme an, dass der soziale Planer die Agenten für Unterschiede in den angeborenen Eigenschaften kompensieren möchte, aber nicht für ihre Freizeitpräferenzen. In diesem einfachen Modell beurteilt der soziale Planer das Wohlergehen von Individuen mit gegebenen Einkommen altersabhängig. Ich zeige, dass eine Steuerreform, welche die Steuern in der zweiten Periode erhöht, die Wohlfahrt erhöhen kann.

Kapitel 2 schätzt die Veränderung des Arbeitsangebotes, wenn der Partner das ordentliche Rentenalter erreicht.[3] Wir nutzen Altersunterschiede von verheirateten Paaren und eine Reform des Frauenrentenalters um den Effekt zu identifizieren. Im Gegensatz zu bisherigen Studien schätzen wir nicht nur den Effekt auf die Arbeitmarktbeteiligung, sondern auch auf den Pensums Entscheid. Die Analyse zeigt, dass die Arbeitsmarktbeteiligung von Frauen um 3% sinkt, sobald der Ehemann das Rentenalter erreicht. Im Gegensatz dazu passen Männer ihr Arbeitsangebot nicht an, sobald die Ehefrau das Rentenalter erreicht. Wir argumentieren, dass der Effekt einerseits dadurch erklärt werden kann, dass ältere Paare zusammen verbrachte Freizeit mehr geniessen. Anderseits begründen wir die Anpassung des Arbeitsangebotes durch Liquiditätseffekte. Desweiteren zeigt die Analyse, dass weder Frauen noch Männer ihr Pensum anpassen, wenn der Partner das Rentenalter erreicht.

Kapitel 3 analysiert die Identifizierbarkeit des kausalen Mengenentscheidungseffektes einer politischen Massnahme mithilfe des Differenz-von-Differenzen Ansatzes.[4] Der kausale Mengenentscheidungseffekt ist definiert als kausaler Effekt einer politischen Massnahme auf die Mengenentscheidung von Individuen, welche unabhängig von der politischen Massnahme eine positive Menge aufweisen. Wir besprechen Differenz-von-Differenzen Methoden, wobei wir nur Individuen mit positivem Mengenentscheid in die Analyse einbeziehen. Wir leiten hinreichende Bedingungen her, mit welchen der Differenz-von-Differenzen Ansatz den kausalen Effekt auf die Mengentscheidung identifiziert.

[3]Kapitel 2 wurde in Zusammenarbeit mit Elias Moor verfasst.
[4]Kapitel 3 wurde in Zusammenarbeit mit Elias Moor verfasst.

Kapitel 4 analysiert den Zusammenhang zwischen Gesundheitsproblemen und den Übergangswahrscheinlichkeiten zwischen Lohnbeschäftigung, Selbständigkeit, Arbeitslosenversicherung, Invalidenversicherung, und Inaktivität. Die Analyse beschränkt sich auf Individuen im Alter zwischen 50 und dem offiziellen Rentenalter. Die Analyse basiert auf Paneldaten der Schweizerischen Arbeitskräfteerhebung für die Zeitperiode zwischen 2003 und 2009, welche mit Sozialversicherungsregisterdaten verknüpft worden ist. Die Analyse zeigt, dass es einen positiven Zusammenhang zwischen Gesundheitproblemen und der Übergangsrate von Lohnbeschäftigung zu der Arbeitslosenversicherung, der Invalidenversicherung, und Inaktivität gibt. Desweiteren zeigt die Analyse, dass der Zusammenhang zwischen der Übergangswahrscheinlichkeit von der Lohnbeschäftigung zur Invalidenversicherung stärker für Männer mit einer obligatorischen Ausbildung als für Männer mit einer tertiären Ausbildung ist. Im Gegensatz dazu ist der Zusammenhang zwischen der Übergangsrat von der Lohnbeschäftigung zur Invalidenversicherung schwächer für Frauen mit einer obligatorischen Ausbildung als für Frauen mit einer tertiären Ausbildung.

Kapitel 5 schätzt die Rechtfertigungsverzerrung von Invalidenrentenbezügern in der Schweiz. In vielen Analysen wird der selbstdeklarierte Gesundheitszustand genutzt, um den Effekt von Gesundheitsproblemen auf das Arbeitsangebot zu schätzen. Der selbstdeklarierte Gesundheitszustand hat das Problem, dass Umfrageteilnehmer Gesundheitsprobleme übertreiben, um ihren Arbeitsmarktstatus zu rechtfertigen. In diesem Kapitel schätze ich das Ausmass der Rechtfertigungsverzerrung mithilfe einer neuen Identifikationsstrategie. Ich nutze den Fakt, dass eine Invalidenrente beim Rentenalter in eine Altersrente umgewandelt wird, um den Effekt zu identifizieren. Ich analysiere, wie sich der selbstdeklarierte Gesundheitszustand von Invalidenrentenbezügern um das Rentenalter verändert. Ich finde Evidenz, dass männliche Invalidenrentenbezüger den selbstdeklarierten Gesundheitzustand nutzen, um ihren Arbeitsmarktstatus zu rechtfertigen. Weiter zeigt die Analyse, dass das Ausmass der Rechtfertigungsverzerrung von männlichen Invalidenrentenbezügern aus Kantonen mit hohen Invaliditätsberentungsquoten getrieben wird. Im Gegensatz zu den Männern finde ich bei Frauen nur schwache Evidenz für die Existenz einer Rechtfertigungsverzerrung.

Contents

Introduction

Declining fertility rates and longer lives imply that fewer workers have to cover the increasing costs of Social Security. There is much debate on which policy instrument to use to mitigate the adverse effects of the changing demographic environment. First, the government can increase taxes and social security contributions. The positive revenue effect, however, may be partially offset by a reduction in economic activity, depending on how individuals react to the increase. Second, the policy maker can reduce social security benefits. Third, many countries implemented reforms to promote longer working lives. Policy instruments to prolong working lives include, amongst others, the pension eligibility age, flexibility of the pension system, and the labor income tax code.

The pension eligibility age represents the most commonly used policy instrument to increase labor force participation rates of older workers. The benefits of an increase of pension eligibility age are twofold. The first is in an increase in contributions, the second is a reduction in benefits. In the time period between 2003 and 2016, 10 out of 30 OECD countries (2003) increased the normal pension eligibility age for men, and 15 out of 30 OECD countries (2003) increased the normal pension eligibility age for women (Duval, 2003; OECD, 2017a).[5] Policy reforms raising the pension eligibility age, however, often encounter strong public resistance. Social security, and in particular the pension eligibility age, are commonly referred by politicians as the third rail of politics: ”Touch it and you die”.[6]

Flexible retirement rules represent less controversial policy instruments to encourage longer working lives. Flexibility takes two forms. First, pension systems of various countries allow older workers to choose when to first draw an old age pension. In 2016, the majority of OECD countries have flexible pension rules in a sense that they allow for early or late withdrawal of old age pensions (OECD, 2017a, p. 93). Second, pension system of some countries allow older workers to gradually reduce their working hours and complement the reduction in earnings with a partial pension. At a later stage, workers retire fully and receive a full pension. Among the OECD countries, Australia, the Czech Republic, France and the Netherlands have partial retirement policies (OECD, 2017a, p.

[5] In 2003, 30 countries were members of OECD.

[6] This metaphor is attributed to Tip O’Neill, a former speaker of the house under Ronald Reagan (Lynch & Myrskylä, 2009).

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The labor income tax code represents an alternative policy instrument to increase labor supply of older workers. As shown by Saez (2001), optimal labor income tax rates can be expressed as a function of labor supply elasticities, social welfare weights and hazard rates of income. Therefore, the optimal taxation approach suggests that taxes ought to be age-dependent if either labor supply elasticities, marginal social welfare weights, or characteristics of the earnings distribution vary with age (Gervais & Erosa, 2002; Banks & Diamond, 2010; Weinzierl, 2011). Despite its potential, labor income tax codes of only few countries exhibit explicit age-dependencies.

An important determinant for the desirability of a reform is its impact on labor supply. Reforms that increased pension eligibility age have been very successful in terms of delaying retirement, see Blundell, French, and Tetlow (2016) for a summary on ex-post reform evaluations. For partial retirement policies, the empirical literature finds a positive effect on labor supply at the extensive margin (Graf, Hofer, & Winter-Ebmer, 2011; Wunsch, Lechner, & Huber, 2016). At the same time, existing evidence suggests that the effect of partial retirement policies on total hours worked is small or even negative (Graf et al., 2011; Börsch-Supan, Bucher-Koenen, Kutlu-Koc, & Goll, 2018).

The labor supply response of individuals affected by a pension reform and changes in pension claiming behavior do not fully capture the total effect of a pension reform on public finance. First, studies find that older couples coordinate their exit from the labor force, see e.g. Gustman and Steinmeier (2004) or Hospido and Zamarro (2014). As a result, changes in incentives can have spillover effects on labor supply of the spouse. Second, several studies indicate that pension reforms exhibit spillover effects on the unemployment insurance (Staubli & Zweimüller, 2013), as well as on the disability insurance (Duggan, Singleton, & Song, 2007).

The political debate on the desirability of pension reforms is often focused on its effect on fiscal revenue and expenditure. Much less attention has been directed to the effect of longer working lives on well-being. Arguably, an important determinant of well-being is health. There is a growing literature on the causal effect of retirement on health. Empirical evidence is mixed. Depending on country and health measure, the empirical literature finds positive (Coe & Zamarro, 2011; Eibich, 2015; Bloemen, Hochguertel, & Zweerink, 2017), as well as negative effects (Rohwedder & Willis, 2010; Behncke, 2012; Mazzonna & Peracchi, 2012) of retirement on health. Moreover, the desirability of pension reforms depends on its effect on inequality. Socio-economic inequality among older workers is high. According to OECD (2017b), income inequality is highest in the age group of individuals aged 55-59 and has been increasing in the last 50 years. Inequality in the population aged 65 and above is only slightly lower, but has been relatively stable for cohorts born between 1920 and 1940.

This thesis contains five chapters in which I theoretically and empirically study several aspects of the labor supply behavior of the elderly. In chapter 1, I theoretically study the design of optimal age-dependent labor income taxes. Existing studies make a case for age-dependent taxes based on age-varying properties of the earnings distribution and age-varying labor supply elasticities. By contrast, I provide a rationale for age dependent taxation based on age-varying marginal welfare weights. These weights reflect to what extent the social planner is willing to redistribute resources to a given group of individuals. I rationalize these age-varying welfare weights in a two period setting with a transfer scheme at old age.

Chapter 2 estimates the labor supply response when the spouse reaches full retirement age in Switzerland. Knowledge on the expected reaction of the spouse will provide information on spillover effects of future pension reforms. In contrast to the majority of previous contributions, we estimate the effect not only on labor market participation (*extensive margin*), but also on working hours (*intensive margin*).

In many cases, a decomposition of a binary treatment (e.g. policy intervention) into extensive and intensive margin effects is of special interest when studying economic outcomes with a corner solution at zero, i.e. when estimating the effect of partial retirement policies on labor supply. The estimation of intensive margin effect - defined as the effect on individuals with a positive outcome irrespective of whether they were affected by the policy or not - is complicated by the fact that the sample composition of individuals with positive outcomes is likely to change with the policy intervention. Chapter 3 presents a set of sufficient assumptions to identify the causal intensive margin effect using difference-in-difference methods on positive outcomes. The method presented in chapter 3 is applied in chapter 2 to study the effect of the spouse reaching FRA on hours worked. Moreover, optimal tax rates in chapter 1 depend on extensive and intensive labor supply elasticities. The method presented in chapter 3 represents one possible approach to estimate these elasticities.

Old age is associated with declining health and an increasing occurrence of disabilities. To assess the welfare implications of future pension or tax reforms, it is crucial to understand the labor market behavior of older workers with ill health. Chapter 4 studies the association between having a disability that limits activities of daily living and the transition rates between wage-employment, self-employment, unemployment insurance, disability insurance and inactivity for workers aged between 50 and the full retirement age in Switzerland. The analysis provides information to what extent older workers with ill health take up disability benefits, and if not, what alternative route to retirement they choose. The analysis in chapter 4 is related to the optimal tax design in chapter 1. The analysis of labor supply behavior of individuals with ill health provides relevant information to what extent the government may be willing to redistribute resources towards the inactive population.

The analysis in chapter 4 relies on a self-reported health measure. One problem associated with self-reported health measures is that survey respondents may exaggerate self-reported disability to rationalize their labor market status or welfare receipt. The extent to which individuals misreport is commonly referred to as the justification bias. In chapter 5, I estimate the extent of the justification bias among older disability beneficiaries using a new identification strategy. I exploit the feature that a first pillar disability pension is converted to an old age pension at full retirement age.

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Chapter 3 discusses identification and estimation of causal intensive margin effects by difference-in-difference methods in a setting with random treatment and a non-negative outcome.[8] The causal intensive margin effect is defined as the treatment effect on the outcome of individuals with a positive outcome irrespective of whether they are treated or not. This group is commonly referred to as always-takers or participants. We discuss difference-in-difference methods where we condition on positive outcomes. We derive sufficient conditions under which the difference-in-difference methods identify the causal

[7] Chapter 2 is joint work with Elias Moor. Both authors contributed equally to this chapter.

[8] Chapter 3 is joint work with Elias Moor. Both authors contributed equally to this chapter.

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Chapter 1

The Compensation Principle as a New Rationale for Age-Dependent Taxation

1.1 Introduction

In a seminal contribution, Saez (2001) showed that optimal tax rates can be expressed in terms of earnings distribution characteristics, labor supply elasticities and marginal social welfare weights. Consequently, an age varying structure of at least one of these three components creates a rationale for an age-dependent tax schedule. A first strand argued for age-dependent taxed based on age-varying hazard rates of income (Kremer, 2001; Gervais & Erosa, 2002; Weinzierl, 2011). The hazard rate of income is a function of the earnings distribution and represents a measure of distortion.[1] A second strand of the literature makes the case for age-dependent taxes based on age-varying labor supply elasticities (Laitner & Silverman, 2012; Alpert & Powell, 2014). Standard principles in public finance suggest that taxes should be low when labor supply elasticities are high. Therefore, the larger the labor supply elasticity at a given age is, the lower is the optimal tax rate at that given age.

Age-varying patterns of marginal social welfare weights and their potential impact on optimal taxes received much less attention in the literature. Marginal social welfare weights measure how society values consumption of an individual with given characteristics, such as income, health, or age. This chapter is an attempt to fill this gap by providing a theoretical setting with age-varying welfare weights. I rationalize these age-varying wel-

[1]The hazard rate at a given income level $\bar{z}$ is defined as the ratio between the fraction earning $\bar{z}$ and the fraction earning more than $\bar{z}$. The numerator represents the fraction whose labor supply is distorted when the marginal tax rate is increased at $\bar{z}$. The denominator represents the fraction of individuals who face an infra-marginal tax increase when the marginal tax rate is increased at $\bar{z}$, but whose labor supply does not get distorted by the marginal tax change at $\bar{z}$. Therefore, the higher the hazard rate is at $\bar{z}$, the larger the distortion of a marginal tax rate increase is at $\bar{z}$.

fare weights in a two period framework (young, old) with a transfer scheme at old age. Agents differ along two unobserved dimensions: Innate ability and taste for leisure. The government observes income, but not (perfectly) ability or taste for leisure. I adopt the normative view that the social planner fully compensates agents for differences in ability, but holds them responsible for their leisure preferences (compensation principle). The analysis proceeds in three steps. First, I compute optimal tax rates assuming there is no transfer scheme available for the inactive. Second, I study the effects of small tax reforms after a transfer scheme for inactive at old age has been introduced. Third, I compute optimal age-dependent tax rates, taking the existence of a transfer scheme for the inactive at old age as given.

The tax reform analysis yields two results. First, I find that a tax reform increasing taxes for the working population at old age can be welfare improving after the introduction of an transfer scheme at old age if low ability agents are over-proportionally represented in the inactive population at old age. Second, I find that a tax reform reducing tax rates for middle income workers at old age is welfare improving after the introduction of a transfer scheme at old age. Moreover, the analysis of the age-dependent optimum shows that the tax rate for low income workers at old age is increasing in the relative share of low ability agents in the inactive population.

I derive optimal tax rates using the tax perturbation approach (Piketty, 1997; Saez, 2001, 2002). With this approach, one does not solve the maximization problem of the social planner. Instead, optimal tax rates are derived by considering the welfare effects of small deviations from a given tax code. The primitives of the perturbation approach are labor supply elasticities, hazard rates of income, and marginal social welfare weights. To specify the marginal social welfare weights, I follow Saez and Stantcheva (2016) who introduced generalized marginal welfare weights. These generalized weights allow to capture a broad range of value judgements, including the compensation principle used in this chapter.

This chapter is directly connected to the literature on age-dependent taxation, see Banks and Diamond (2010) for a survey. This literature builds on the seminal contribution by Akerlof (1978) on the use of tags for optimal taxation. He shows that for taxation, the government should use observable characteristics such as age, if the observable characteristics are correlated with unobserved characteristics of interest (e.g. ability, effort type).

One of the central questions in the literature on age-dependent taxation is whether tax rates should increase or decrease with age. Recent contributions by Weinzierl (2011) and Laitner and Silverman (2012) find that an age-increasing tax schedule is welfare improving. The main mechanism driving the results in Weinzierl (2011) are age increasing hazard rates of income.[2] By contrast, the result in Laitner and Silverman (2012) is driven by age-increasing labor supply elasticities. This chapter points out an additional

[2]Note that Weinzierl (2011) only considered individuals aged between 25 and 55.

mechanism that has been neglected by the literature, and which may change the sign of optimal tax rates with respect to age. If low ability agents are over-proportionally represented in the inactive population at old age, the average marginal social welfare weight of the working population at old age is lower than the average marginal social welfare weight of the working population at young age. In the analysis, I show that an age increasing tax reform for the working population at old age can be welfare improving if welfare weights of the working population decrease with age and the decrease in welfare weights is sufficiently large to offset the extensive margin effect.

Moreover, this chapter is related to the literature studying the effect of preference heterogeneity on optimal taxation (Boadway et al., 2002; Philippe & Laroque, 2010; Fleurbaey, 2006; Lockwood & Weinzierl, 2015). In contrast to the seminal contribution in the optimal taxation literature by Mirrlees (1971), this literature considers the case where individuals not only differ in terms of ability, but also in their preferences for leisure. In this literature, ability differences stand for characteristics individuals cannot control and society views as fair to compensate for, i.e. health or social background. By contrast, preferences for leisure stands for characteristics the agent chooses (or controls). The fundamental problem of this literature is that the social planner cannot separate the leisure loving "epicurean" high ability types from the "hard working" low ability types.[3]

Following the terminology of Fleurbaey (1994), I adopt the normative view that the social planner follows the *compensation principle*.[4] It states that agents providing the same effort type should get compensated for ability differences. The *compensation principle* is closely related to the principle of equality of opportunity (Roemer, 1993, 1998). The concept of equality of opportunity is frequently used to measure the degree of intergenerational mobility (Roemer et al., 2003). Given family background, this literature measures effort as the position an individual takes in the earnings distribution. The equality of opportunity objective is maximized by minimizing differences between individuals with different family background providing the same effort (same position in earnings distribution).

The remainder of this chapter is organized as follows. Selected stylized facts on labor supply of older workers are presented in section 1.2. Section 1.3 provides an overview of age dependencies in tax codes of selected countries. Section 1.4 introduces the two period framework with discrete choice. In section 1.5, I analyse the optimal tax schedule. The last section concludes.

[3]Epicureanism represents a school of thought based on contributions from the ancient Greek philosopher Epicurus. It has the notion that humans should lead a simple and modest life, and avoid any bodily pain.

[4]In the literature on fair income taxation, there is a trade off between the *compensation principle* and the *responsibility principle*, see Fleurbaey and Maniquet (2011) for a summary. The *responsibility principle* states that agents having the same innate ability should not be treated differently by social planner.

1.2 Stylized facts on labor supply of the elderly

There are two aspects of labor supply among the elderly that are of importance for the upcoming analysis. First, *characteristics of early retirees* are an important determinant to what extent the social planner may want to redistribute resources to individuals retiring early. Second, *labor supply elasticities at the extensive and intensive margin* determine how tax revenue is affected by a change in the tax rates.

Characteristics of early retirees

Among older workers in OECD countries, there are large differences across highest educational attainment in labor market participation rates. According to a report from the OECD, average OECD labor force participation rates (2015) in the age group from 55-64 amounted to 44% for older workers with a low education and to 72% for workers with high education (OECD, 2017b, p. 34). Furthermore, OECD (2017a) showed that low educated individuals at older ages face a higher risk of being in ill health or having a disability. Bad health is associated with lower wages and lower labor force participation rates (OECD, 2017b).

Life expectancy differences across socio-economic groups are large. According to OECD (2017a), the average gap in life expectancy at age 65 in OECD countries between low and high educated individuals amounted to 7.5 years for men (2011) and to 4.6 years for women (2011). Income related disparities in life expectancy are even larger. For the United states, Chetty et al. (2016) found that individuals from the richest 1% have an around 14 years (men) and around 10 years (women) higher life expectancy than individuals from the poorest 1%.

As in most of the economic literature, the decision to retire early in this chapter is driven by preferences for leisure, ability, and financial incentives. By contrast, evidence suggest that the retirement decision is not only a labor supply issue, but that also employer behavior matters. Analysing a reform in Finland that improved incentives for employers to keep older workers, Hakola and Uusitalo (2005) find that the prevalence of early retirement decreased. Moreover, Dorn and Sousa-Poza (2010) find in a cross-country analysis that early retirement pension provision increases the probability of getting pushed to retirement by the employer.

Labor supply elasticities of older workers

The most prevalent retirement pattern is an abrupt transition from full time work to inactivity, see Blundell, French, and Tetlow (2016) for a summary on evidence from various countries. Therefore, the bulk of previous research has studied the effect of tax and pension reforms on the participation decision (*extensive margin*). Analysing a reform in Sweden that reduced taxes for older worker, Laun (2017) finds a participation elasticity with respect to the net tax rate of 0.22, where she uses the same extensive elasticity definition as Saez (2002).[5] In a meta-analysis on labor supply responses to pension benefits, Chetty et al. (2012) find an average extensive margin elasticity of 0.26. There is scarce evidence on intensive margin labor supply elasticities of older workers. Engelhardt and Kumar (2014) summarize evidence on estimated intensive margin elasticities of the abolishment of the earnings test.[6] They find that compensated intensive margin elasticities range between 0.05 and 0.12. Moreover, there is some evidence on intertemporal labor supply responses from the abolishment of the Social Security earnings test in the United States. Friedberg and Webb (2009) find that the abolishment of the earnings test not only increased labor supply of workers aged 65-69, but also affected labor supply of individuals below 65.

1.3 Age dependencies in tax codes for older workers

In the following, I describe age dependencies in tax codes for older workers for selected developed countries. I make a distinction between explicit and implicit age dependencies in the tax code.

Explicit age-dependent tax schedule

Few countries have explicit age-dependent labor income taxes in their tax codes. One example for age targeted tax policies are earned income tax credits. In 2007, Sweden introduced an age-dependent, non refundable earned income tax credit. The earned income tax credit increases discontinuously at age 65. The age-dependent earned income tax credit creates age-decreasing *marginal* tax rates and age-decreasing *average* tax rates, see Laun (2017). In the United States, eligibility for earned income tax credits ends at age 65 (Alpert & Powell, 2014). For low income workers, this feature of the tax code creates age increasing *marginal* tax rates and age increasing *average* tax rates.[7]

Implicit age-dependent tax schedule

Implicit age-dependent labor income taxes are widespread. Old age pensions are by their very nature age-dependent. In many countries, the pension system creates an implicit age-dependency. After reaching pension eligibility, most of the developed countries offer the possibility to combine earnings with pension withdrawal. Several countries, however, have an earnings test which limits the extent to which pension withdrawal and earnings can be combined. One country with such a system is Australia. Older workers in Australia are entitled to a means tested age pension when reaching pension eligibility age. The

[5]Note that in this paper, the same elasticity definition as in Saez (2002) is used.

[6]The Seniors Citizens Freedom to Work Act of 2000 removed the earnings test for workers age 65 to 69.

[7]In addition to earned income tax credits, several countries such as Switzerland and United States, allow for higher deductions once pension eligibility age is reached (OECD, 2017a).

means tested pension is not reduced up to yearly earnings of AUD 10'730 for a single pensioner without additional income (OECD, 2017a). Earnings above this threshold reduce the pension. This creates an implicit age-increasing schedule for *marginal* and *average* tax rates for low income workers.
Moreover, the marginal increase of future pension entitlements when contributing may change with age. For instance, Switzerland has a system where labor income after reaching pension eligibility age is still subject to a payroll tax.[8] In contrast to contributions before pension eligibility age, however, no additional first pillar pension entitlements are gained when contributing. Therefore, implicit *average* tax rates are age-increasing. Moreover, implicit *marginal* tax rates for individuals with yearly earnings below CHF 84'600 are age-increasing. This can be explained by the redistributive nature of the first pillar old age insurance in Switzerland. Before the pension eligibility age, additional earnings of an individual with yearly earnings of less than CHF 84'600 increase future pension entitlements. By contrast, an additionally earned CHF for individuals with earnings above CHF 84'600 does not increase pension entitlements. Additionally, the earnings-related public pension depends in many countries on a limited number of years with the highest earnings, which creates an implicit age-dependency in labor income taxes. Countries with such a system in 2017 are France (25 highest years of earnings) or the United States (35 highest years of earnings).

1.4 Setup

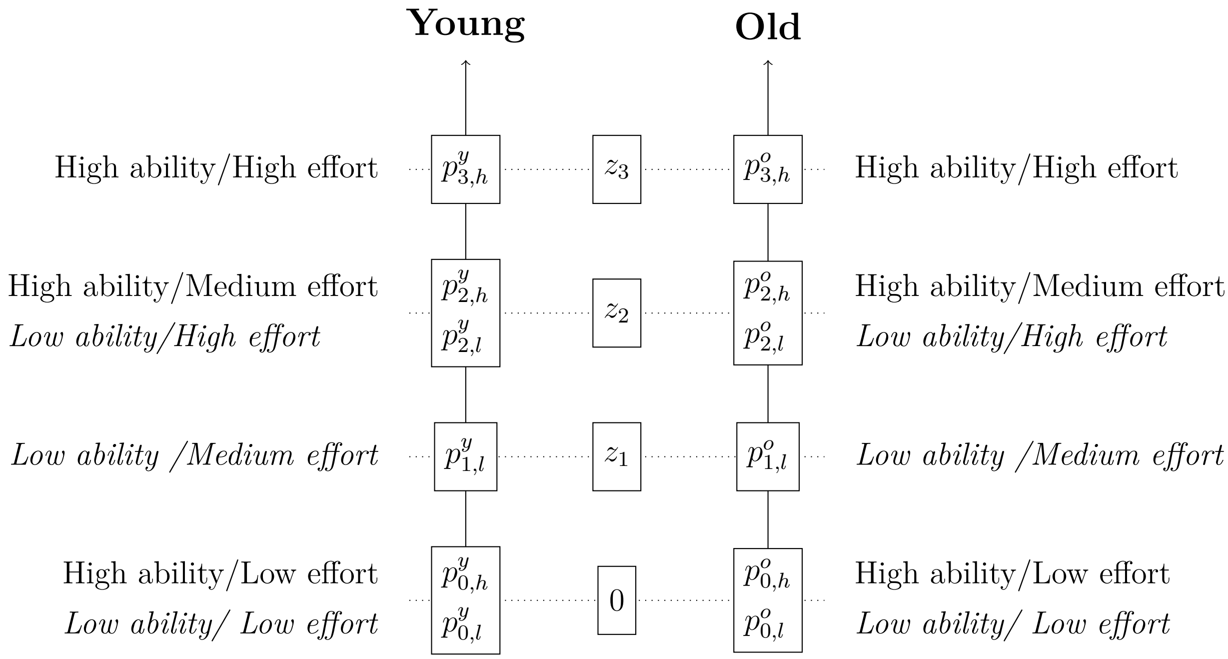
I compute tax rates using the perturbation approach. The primitives of this approach are generalized social marginal welfare weights, labor supply elasticities at extensive and intensive margin, and hazard rates of income, see Saez (2001, 2002) and Saez and Stantcheva (2016).

1.4.1 Setup with Discrete Choice

Agents in the model live for two periods, denoted by superscript $t \in \{y, o\}$. I normalize the total population to one. At any point in time, half of the population is at young age, and half is at old age. Individuals are heterogeneous with respect to ability and effort. Ability is indexed with $n \in \{l, h\}$. A fraction of p_h agents is endowed with high ability, and a fraction p_l with low ability correspondingly. Ability is time independent. Individuals can either provide *low effort*, *middle effort*, or *high effort*. The effort choice depends on the tax code in place.

[8] 8.4% with an allowance of CHF 16'800 in 2018. There is no ceiling for social security contributions.

Figure 1.1: Discrete choice setting



I follow closely Saez (2002) and consider a discrete choice model with three levels of earnings $z_j > 0$ for $j \in \{1, 2, 3\}$ in both periods, where $z_3 > z_2 > z_1 > 0$. Moreover, agents in both periods can decide to be inactive. At the intensive margin, I assume that each individual is restricted to choose between earnings level z_j and its neighbouring earnings level z_{j+1}. In particular, I assume that high ability providing high effort earn z_3, and high ability agents providing middle effort earn z_2. Low ability individuals providing high effort earn z_2, and low ability agents providing middle effort earn z_1. Low and high ability individuals providing low effort choose zero earnings. The fraction with ability type n at age t choosing z_j is denoted by $p^t_{j,n}$.[9] The discrete choice setting is illustrated in figure 1.1. Taxes at age t and income level z_j are denoted by T^t_j. The earnings net of income taxes for an individual earnings z_j at age t are given by $c^t_j = z_j - T^t_j$. Note that earnings net of income taxes have to be increasing in earnings, hence $c_3 > c_2 > c_1 > c_0$.[10] The key feature of the following analysis is that the government only observes income, but neither observes the ability nor effort type of agents. The government sets a net tax T^t_j at each earnings level z_j, where $T^t_j > 0$ denotes a tax and $T^t_j < 0$ a benefit. The budget constraint of the government takes the form

$$\sum_j p^y_j T^y_j + \sum_j p^o_j T^o_j \geq G,$$

[9]In the following, I drop the ability superscript when I do not condition on the ability type, i.e. $p^t_2 = p^t_{2,l} + p^t_{2,h}$.

[10]Otherwise, none of the high ability agents would provide high effort.

where G represents non-redistributive public expenditure. If the government is restricted to age independent taxes, then $T_j^y = T_j^o$. I do not consider history-dependent taxes. Therefore, I assume that the government cannot condition tax liability on earnings in previous periods.

1.4.2 Behavioral Elasticities

To simplify the analysis, I rule out income effects on labor supply. Therefore, agents do not change labor supply if tax rates are raised at the same rate at all income levels. Moreover, I abstract from intertemporal labor supply responses. Therefore, the choice of effort at time t only depends on the tax code at time t.

I assume that the share of high ability agents providing high effort $p_{3,h}^t$ depends only on T_3^t and T_2^t (and not on T_0^t). Analogously, the share of low ability agents providing high effort $p_{2,l}^t$ depends only on T_2^t and T_1^t (and not on T_0^t). Similar to Saez (2002), I define the (substitution) elasticities at the intensive margin as follows:

Definition 1.1 *The labor supply elasticities at the intensive margin ξ_n^t for agents with ability n and age t are given by*

$$\xi_l^t \equiv \frac{\delta p_{2,l}^t}{\delta(T_2^t - T_1^t)} \frac{c_2^t - c_1^t}{p_{2,l}^t}, \tag{1.1}$$

$$\xi_h^t \equiv \frac{\delta p_{3,h}^t}{\delta(T_3^t - T_2^t)} \frac{c_3^t - c_2^t}{p_{3,h}^t}, \tag{1.2}$$

where $c_3^t = z_3 - T_3^t$, $c_2^t = z_2 - T_2^t$ and $c_1^t = z_1^t - T_1^t$.

The choice at the extensive margin depends on the consumption difference between providing middle and low effort.

Definition 1.2 *The labor supply elasticities at the extensive elasticities η_n^t for agents with ability n and age t are given by*

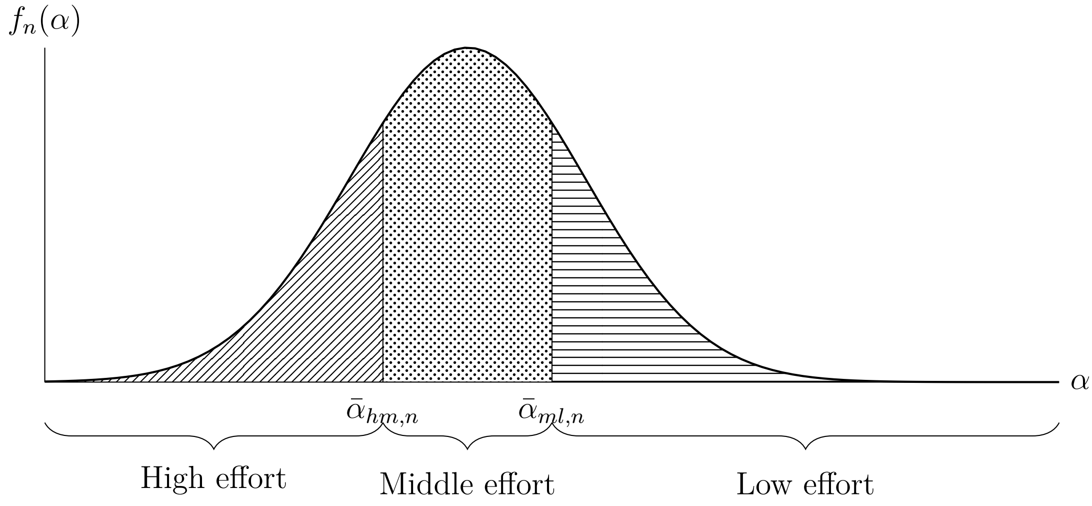
$$\eta_l^t \equiv \frac{\delta p_{1,l}^t}{\delta(T_1^t - T_0^t)} \frac{c_1^t - c_0^t}{p_{1,l}^t} \tag{1.3}$$

$$\eta_h^t \equiv \frac{\delta p_{2,h}^t}{\delta(T_2^t - T_0^t)} \frac{c_2^t - c_0^t}{p_{2,h}^t} \tag{1.4}$$

where $c_2^t = z_2 - T_2^t$, $c_1^t = z_1 - T_1^t$ and $c_0^t = -T_0^t$.

For tractability, I impose some additional structure on the behavioral elasticities. If the tax schedule is age independent, I assume that labor supply elasticities (extensive and intensive), and the fractions providing high, middle and low effort are the same at young

Figure 1.2: Illustration leisure preferences



and old age. Moreover, I assume that the fraction of low and high ability agents choosing inactivity (or zero earnings) is zero if $T_0^t = 0$.

Formal Model

Behavioral elasticities at intensive and extensive margin represent the primitives of the model. This behavioral elasticities can be rationalized by the following setting. Consider an economy populated by a a continuum of individuals indexed by i. Population size is normalized to one. Agent i maximizes life time utility

$$u_i(z_i^y, z_i^o; w_i, \alpha_i) = z_i^y - T^y(z_i^y) - \alpha_i \cdot v\left(\frac{z_i^y}{w_i}\right) + z_i^o - T^o(z_i^o) - \alpha_i \cdot v\left(\frac{z_i^o}{w_i}\right), \tag{1.5}$$

by choosing earnings z_i^y and z_i^o. Disutility of work is denoted by $v(z/w)$ is a convex function with respect to z/w. Low ability choose earnings $z_i^y, z_i^o \in \{0, z_1, z_2\}$, and high ability types choose earnings level $z_i^y, z_i^o \in \{0, z_2, z_3\}$. Preference for leisure is denoted by α_i and assumed to be age independent. The parameter α of agents with ability type n is distributed according to the continuous density function $f_n(\alpha)$, which is strictly positive on the support $[\underline{\alpha}_n, \overline{\alpha}_n]$. The continuity of $f_n(\alpha)$ ensures that labor supply reactions to small tax changes are smooth, see also Saez (2002).

For a given tax schedule, let $\alpha_{hm,n}$ denote the value for which an agent with ability type n is indifferent between providing high or middle effort. Analogously, let $\alpha_{ml,n}$ denote the value for which an agent with ability type n is indifferent between providing middle or low effort. Throughout the analysis, I assume that $\underline{\alpha}_n < \alpha_{hm,n} < \overline{\alpha}_n$ and $\alpha_{hm,n} < \alpha_{ml,n}$. That implies that for both ability types, a strictly positive fraction provides middle effort and a strictly positive fraction provides high effort. Moreover, I assume that for $T_0 = 0$, $\alpha_{ml,n} > \overline{\alpha}_n$. This implies that the fraction of low and high ability agents providing low effort is zero if there is no transfer scheme available for the inactive.

1.4.3 Generalized Social Welfare Weights

The individual marginal social welfare weights measure how society values redistributing an additional unit of consumption to a given agent. To compute these weights, the standard approach in the literature is to assume the existence of a social welfare function. However, a social welfare approach which solely depends on individual utilities fails to coincide with intuitive norms of justice when there is heterogeneity in preferences, see e.g. Fleurbaey and Maniquet (2015).

To cope with this problem, one approach is to be agnostic about the welfare weights and to conduct a sensitivity analysis using a set of different weights, see e.g. Saez (2002). However, optimal tax rates depend substantially upon these welfare weights. Hence, a sensitivity analysis does not provide sufficient information for policy recommendations.

A different approach has been taken by Saez and Stantcheva (2016). Instead of deriving the marginal social welfare weights from social welfare functions, they directly specify the marginal social welfare weights as the primitives of the model. This allows to include a broad range of justice concept into the marginal social welfare weights, including the compensation principle used in this chapter. Following Saez and Stantcheva (2016), I define the individual marginal social welfare weights as follows:

Definition 1.3 ***Individual social welfare weight:*** *The individual marginal social welfare weight of an individual with age t, ability n, and earning z_j is defined as $g^t_{j,n}$.*

Note that the individual social welfare weights are only determined up to a multiplicative constant. The social planner observes age and income, but does not (perfectly) observe effort and ability. Hence, weights have to aggregated at each age t and income level z_j. Following Saez and Stantcheva (2016), I aggregate the welfare weights at age t and income level z_j as follows:

Definition 1.4 ***Average social welfare weights:*** *The average marginal social welfare weight for individuals earning z_j at age t, denoted by $\bar{g}^t_j$, is defined as*

$$\bar{g}^t_j \equiv \frac{p^t_{j,l} g^t_{j,l} + p^t_{j,h} g^t_{j,h}}{p^t_{j,l} + p^t_{j,h}} \left[\frac{1}{\sum_t \sum_j \left(p^t_{j,l} g^t_{j,l} + p^t_{j,h} g^t_{j,h} \right)} \right] \tag{1.6}$$

where $j \in \{0, 1, 2, 3\}$ and $t \in \{y, o\}$.

By definition 1.4, we have $\sum_n \sum_j p^t_{j,n} \bar{g}^t_{j,n} = 1$. Since half of the population is at young age and half at old age, we additionally have $\sum_j p^y_{j,n} \bar{g}^y_{j,n} = 1/2$, and $\sum_j p^o_{j,n} \bar{g}^o_{j,n} = 1/2$.[11]

The interpretation of $\bar{g}(z_j)$ is as follows. The social planner is indifferent between having $\bar{g}^t_j$ more dollars of public funds and giving one more dollar to the agents earning z_j at

[11] This implies that $\sum_j p^y_{j,n}(1 - \bar{g}^y_{j,n}) = 0$, and $\sum_j p^o_{j,n}(1 - \bar{g}^o_{j,n}) = 0$.

age t. Hence, the higher g_j^t, the more the government values consumption of individuals earning z_j at age t.

Compensation Principle

Following the terminology of Fleurbaey (1994), I adopt the normative view that the social planner follows the *compensation principle*.[12] It states that agents having the same effort type or the same preferences for leisure should get compensated for ability differences. Ability differences stand for characteristics individuals cannot control and society views as fair to compensate for. In the example with early retirement, that may include characteristics such as disability, care obligations, or social background. By contrast, preferences for leisure stand for characteristics the agent chooses (or controls). Translated to the setting of this paper, the compensation principle states that the difference in income after taxes within effort groups should minimized.

In the framework presented in this chapter, consumption within effort groups cannot be equalized. In a second best optimum where the government only observes earnings and age, consumption of the low ability type is always inferior to the amount consumed by high ability agents.[13] Otherwise, none of the high ability agents would provide high effort. This implies that low ability agents always receive full weight. Following Saez and Stantcheva (2016), the individual social welfare weights are $g_{j,l}^t = 1$ for low ability agents, and $g_{j,h}^t = 0$ for high ability agents. The structure of these individual welfare weights implies that the social planner has no concern for inequalities in earnings net of income taxes between effort groups.

Aggregating the welfare weights at each earnings level using definition 1.4 yields

$$\bar{g}_3^t = 0, \tag{1.7}$$

$$\bar{g}_2^t = \frac{p_{2,l}^t}{p_{2,l}^t + p_{2,h}^t} \frac{1}{p_l}, \tag{1.8}$$

$$\bar{g}_1^t = \frac{1}{p_l}, \tag{1.9}$$

$$\bar{g}_0^t = \frac{p_{0,l}^t}{p_{0,l}^t + p_{0,h}^t} \frac{1}{p_l}. \tag{1.10}$$

Average social welfare weights at a given earnings level depend on the composition of individuals at the corresponding level. Therefore, average welfare weights at a given earnings level change with age if the relative share of high and low ability agents at the

[12] In the literature on fair income taxation, there is a trade off between the *compensation principle* and the *responsibility principle*, see Fleurbaey and Maniquet (2011) for a summary. The *responsibility principle* states that agents having the same innate ability should not be treated differently by social planner.

[13] Consumption for the inactive at old age is equalized for low and high ability agents. Life time consumption, however, is lower for low ability agents who choose inactivity at old age, which rationalizes these individual marginal social welfare weights.

corresponding level changes.

1.5 Optimal tax analysis

The optimal tax analysis proceeds in three steps. First, I compute optimal tax rates assuming there is no transfer scheme available for the inactive. Second, I study the effects of small tax reforms after a transfer scheme for the old has been introduced. Third, I compute optimal age-dependent tax rates, taking the existence of a transfer scheme at old age as given.

1.5.1 Optimal age independent taxes without transfer scheme at old age

In a first step, I assume that there is no transfer system in place, therefore $T_0^y = 0$ and $T_0^o = 0$. As described in the previous section, I assume that everyone participates in the labor market when $T_0^t = 0$.

I derive optimal age independent tax rates using the perturbation methodology following Saez (2002). The perturbation method applied in this chapter represents a first order approach.[14] Therefore, the resulting optima are by nature local.

Proposition 1 *The optimal age independent tax schedule, T_j for $j = \{0, 1, 2, 3\}$, is associated with tax rates*

$$\frac{T_3 - T_2}{c_3 - c_2} = \frac{(1 - \bar{g}_3^y)p_3^y + (1 - \bar{g}_3^o)p_3^o}{p_{3,h}^y \xi_h^y + p_{3,h}^o \xi_h^o}, \tag{1.11}$$

$$\frac{T_2 - T_1}{c_2 - c_1} = \frac{(1 - \bar{g}_3^y)p_3^y + (1 - \bar{g}_3^o)p_3^o + (1 - \bar{g}_2^y)p_2^y + (1 - \bar{g}_2^o)p_2^o}{p_{2,l}^y \xi_l^y + p_{2,l}^o \xi_l^o}, \tag{1.12}$$

where for $t \in \{y, o\}$, we have $\bar{g}_1^t = \frac{1}{p_l}$, $\bar{g}_2^t = \frac{p_{2,l}^t}{(p_{2,l}^t + p_{2,h}^t)} \frac{1}{p_l}$, and $\bar{g}_3^t = 0$.

Proof *(Heuristic)* Suppose taxes T_2 and T_3 are increased marginally by dT. There are three effects. First, tax income increases mechanically by $dM = [p_2^y + p_3^y + p_2^o + p_3^o]\, dT$. Second, the mechanical welfare effect amounts to $dW = [\bar{g}_2^y p_2^y + \bar{g}_3^y p_3^y + \bar{g}_2^o p_2^o + \bar{g}_3^o p_3^o]\, dT$. Third, the behavioral response amounts to $dS = -\left[\xi_l^y p_{2,l}^y \frac{T_2 - T_1}{c_2 - c_1} + \xi_l^o p_{2,l}^o \frac{T_2 - T_1}{c_2 - c_1}\right] dT$.[15] At the optimum, the sum of the three effects is zero. This yields the optimality condition in equation (1.12). Analogously, the optimality condition in equation (1.11) can be derived by considering a perturbation of T_3 by dT. □

[14] See Saez and Stantcheva (2016) for a discussion on second order conditions.

[15] Note that the behavioral response has no first order effect on welfare, see also Saez and Stantcheva (2016).

By assumption, the share earning z_3 is the same at young and old age under an age independent tax schedule. Assuming that the fraction providing high effort $p^t_{3,h}$ is the same at young and old age under an age independent tax schedule, equation (1.11) can be rewritten as

$$\frac{T_3 - T_2}{c_3 - c_2} = \frac{1}{\xi^y_h} = \frac{1}{\xi^o_h}. \tag{1.13}$$

High income individuals at young and old age are taxed at the rate, at which tax revenue is maximized, which is commonly referred to as the Laffer rate. This result can be explained by the fact that the social planner in this setting only values low ability agents. Since there are no low ability agents in the highest income class, the social planner maximizes tax revenue by imposing the Laffer rate.

Again, the share of individuals earning z_1, z_2, and z_3 are the same at young and at old age under an age independent tax schedule, since I assume that the parameter for leisure preference is the same at young and old age. Moreover, using $\sum_{j=0}^{3}(1-\bar{g}^t_j)p^t_j = 0$ from definition 1.4, equation (1.12) can be rewritten as

$$\frac{T_2 - T_1}{c_2 - c_1} = \frac{(\bar{g}^y_1 - 1)p^y_1 + (\bar{g}^o_1 - 1)p^o_1}{p^y_{2,l}\xi^y_l + p^o_{2,l}\xi^o_l}. \tag{1.14}$$

The tax rate for middle income workers is positive, since $\bar{g}^t_1 = \frac{1}{p_l} > 1$.

1.5.2 Tax reform after introduction of transfer scheme at old age

In a next step, I assume that a transfer system for non-working individuals at old age is introduced. Benefits for the old with no labor income amount to $b > 0$. Therefore, the tax for individuals with no labor income at old age amounts to $T^o_0 = -b$. I assume that a strictly positive mass of low and high ability individuals chooses inactivity after the transfer scheme at old age is introduced, meaning that $p^o_{0,l} > 0$ and $p^o_{0,h} > 0$. I assume that the government budget is balanced by a non-distortive lump sum tax. Since $p^o_{2,l}$, $p^o_{3,h}$, ξ^o_l, and ξ^o_h do not depend on T^o_0 by assumption, these quantities remain unaffected by the introduction of the transfer scheme at old age.

In the following, I study the welfare effects of marginal tax reforms starting from the age independent tax schedule derived in section 1.5.1. In contrast to the optimal tax approach, the tax reform approach does not require knowledge on elasticities at the optimum, but elasticities at the current tax level. Following Saez and Stantcheva (2016), I consider a tax reform to be desirable if its first order effect on welfare is positive.

Tax level for working population at old age

In a first step, I study how welfare changes when taxes are marginally increased for individuals participating in the labor market at old age (individuals choosing z_1, z_2, and z_3).

Proposition 2 *Starting from an optimal age independent tax schedule, a tax reform increasing taxes for the working population at old age can be welfare improving after the introduction of transfer scheme at old age if low ability agents are over-proportionally represented in the inactive population at old age.*

Proof *(Heuristic)* Consider a tax reform where T_1^o, T_2^o, and T_3^o are increased marginally by dT. There are three effects. First, tax revenue increases mechanically by $dM = (p_1^o + p_2^o + p_3^o)dT$. Second, welfare of working individuals at old age mechanically decreases by $dW = -(\bar{g}_1^o p_1^o + \bar{g}_2^o p_2^o + \bar{g}_3^o p_3^o)dT$. Third, the behavioral reaction at the extensive margin amounts to $dS = -\left[\eta_l^o p_{1,l}^o \frac{T_1^o - T_0^o}{c_1^o - c_0^o} + \eta_h^o p_{2,h}^o \frac{T_2^o - T_0^o}{c_2^o - c_0^o}\right]$. Summing up the three effects yields

$$dV = \underbrace{[p_0^o(\bar{g}_0^o - 1)]}_{dW+dM} - \underbrace{\left[\eta_l^o p_{1,l}^o \frac{T_1^o - T_0^o}{c_1^o - c_0^o} + \eta_h^o p_{2,h}^o \frac{T_2^o - T_0^o}{c_2^o - c_0^o}\right]}_{dS}, \tag{1.15}$$

where I used $\sum_{j=0}^{3}(1 - \bar{g}_j^o)p_j^o = 0$ from definition 1.4. Again, using definition 1.4, we have $\bar{g}_0^o = \frac{p_{0,l}^o}{p_0^o}\frac{1}{p_l}$. Therefore, the sum of welfare and mechanical effect ($dW + dM$) is positive if $p_{0,l}^o > p_l p_0^o$, in which case $\bar{g}_0^o > 1$. □

A tax reform is desirable if the term in equation (1.15) is positive. The condition $p_{0,l}^o > p_l p_0^o$ is equivalent to the statement that there are more low ability in the inactive population than in the total population. As shown in the previous section, tax rates are positive under the optimal age independent tax schedule. Hence, the elasticity effect represented by the second term in equation (1.15) is positive. Therefore, the sign of the welfare effect of a tax reform increasing tax rates at old age depends on the relative size of the first term in equation (1.15) versus the second term in equation (1.15), if low ability individuals are over-proportionally represented in the inactive population. By contrast, an age increasing tax reform decreases welfare for sure if low ability individuals are under-proportionally represented in the inactive population. In this case, the first term in equation (1.15) is negative.

The result can be explained by the fact that the average welfare weight of the working population (individuals earning z_1, z_2, and z_3) decreases with age if low ability are over-proportionally represented in the inactive population at old age. The welfare gains from the tax increase for workers at old age stem from the objective of the social planner to redistribute resources from high to low ability agents. An age increasing tax schedule allows the social planner to better tax high ability agents and to redistribute resources towards the low ability agents.

Progressivity for middle income earners at old age

In addition to the level of taxes, the social planner may change progressivity. I study how decreasing tax rates for middle income individuals (individuals earning z_2) at old age changes welfare. Note that reducing marginal tax rates for middle income individuals simultaneously reduces average tax rates for high income individuals.

Proposition 3 *Starting from an optimal age independent tax schedule, a tax reform reducing tax rates for middle income workers at old age is welfare improving after the introduction of a transfer scheme for the inactive at old age.*

Proof *(Heuristic)* Suppose taxes T_2^o and T_3^o are decreased marginally by dT. There are three effects. First, tax income decreases mechanically by $dM = -[p_2^o + p_3^o]dT$. Second, welfare of working individuals in the second period increases by $dW = [\bar{g}_2^o p_2^o + \bar{g}_3^o p_3^o]\, dT$. Third, the behavioral reaction at the extensive margin for high ability agents and at the intensive margin for low ability agents amounts to $dS = \left[\eta_h^o p_{2,h}^o \frac{T_2^o - T_0^o}{c_2^o - c_0^o}\right] dT + \left[\xi_l^o p_{2,l}^o \frac{T_2^o - T_1^o}{c_2^o - c_1^o}\right] dT$. Summing up these three effects yields

$$dV = \underbrace{\left[\left((\bar{g}_2^o - 1)p_2^o - p_3^o\right) + \xi_l^o p_{2,l}^o \frac{T_2^o - T_1^o}{c_2^o - c_1^o}\right]}_{>0} + \underbrace{\left[\eta_h^o p_{2,h}^o \frac{T_2^o - T_0^o}{c_2^o - c_0^o}\right]}_{>0}. \qquad (1.16)$$

The first term in equation (1.16) represents the optimality condition for marginal tax rate of low income earners in the absence of transfer scheme at old age, see (1.12). The term $(\bar{g}_2^o - 1)p_2^o$ increases as $p_{2,h}^o$ decreases.[16] Since by assumption, $p_{3,h}^o, \xi_l^o$ and $p_{2,l}^o$ remain unaffected by the introduction of the transfer scheme at old age, the first term in equation (1.16) is positive. □

The intuition for the result from proposition 3 is as follows. The tax revenue effect when reducing tax rates for workers at old age earning z_2 and z_3 amounts to $dM = -[p_2^o + p_3^o]dT$. By contrast, the tax revenue effect when reducing tax for workers at young earning z_2 and z_3 amounts to $dM = -[p_2^y + p_3^y]dT$. Since by assumption, $p_2^o < p_2^y$ and $p_3^y = p_3^o$, it is less costly in terms of tax revenue for the social planner to reduce tax rates at old than at young age. The mechanical welfare effect of reducing tax rates at z_2 and z_3 amounts to $dW = \bar{g}_2^y p_2^y = \frac{p_{2,l}^y}{p_l}$ at young age, and to $dW = \bar{g}_2^y p_2^y = \frac{p_{2,l}^o}{p_l}$ at old age, where I used definition 1.4. Since by assumption, $p_{2,l}^y = p_{2,l}^o$, the welfare gain of redistributing

[16]Note that $(\bar{g}_2^o - 1)p_2^o = \frac{p_{2,l}^o}{p_l} - (p_{2,l}^o + p_{2,h}^o)$.

dT to individuals earning z_2 and z_3 is the same at young and at old age. Moreover, the intensive elasticity effect, $dS = \left[\xi_l^o p_{2,l}^o \frac{T_2^o - T_1^o}{c_2^o - c_1^o}\right]$, remains unchanged by assumption. To sum up, benefits of redistributing dT to agents earning z_2 and z_3 at young and old age are the same, and costs are lower. Therefore, welfare increases when reducing tax rates for middle income workers at old age (individuals earning z_2). Broadly speaking, the age-dependent tax schedule allows the social planner to support the "hard working" low ability agents.

In addition to the redistributive effect, decreasing marginal tax rates for middle income earners has a positive extensive margin effect, represented by the second term in equation (1.16). The extensive margin effect amplifies the welfare gains from the introduction of age dependency in the labor income tax schedule.

1.5.3 Optimal age-dependent taxes with transfer scheme at old age

I compute optimal tax rates at young and old age, taking the existence of a pension system at old age as given, $T_0^o = -b$, where $b > 0$.

Proposition 4 *The optimal age-dependent tax schedule at young age is associated with tax rates*

$$\frac{T_3^y - T_2^y}{c_3^y - c_2^y} = \frac{1 - \bar{g}_3^y}{\xi_h^y} \tag{1.17}$$

$$\frac{T_2^y - T_1^y}{c_2^y - c_1^y} = \frac{(1 - \bar{g}_2^y)p_2^y + (1 - \bar{g}_3^y)p_3^y}{\xi_l^y p_{2,l}^y} \tag{1.18}$$

where $\bar{g}_1^y = \frac{1}{p_l}$, $\bar{g}_2^y = \frac{p_{2,l}^y}{p_2^y}\frac{1}{p_l}$, *and* $\bar{g}_3^y = 0$.

The optimal age-dependent tax schedule at old age is associated with tax rates

$$\frac{T_3^o - T_2^o}{c_3^o - c_2^o} = \frac{(1 - \bar{g}_3^o)}{\xi_h^o} \tag{1.19}$$

$$\frac{T_2^o - T_1^o}{c_2^o - c_1^o} = \frac{(1 - \bar{g}_2^o)p_2^o + (1 - \bar{g}_3^o)p_3^o - \eta_h^o p_{2,h}^o \frac{T_2^o - T_0^o}{c_2^o - c_0^o}}{\xi_l^o p_{2,l}^o} \tag{1.20}$$

$$\frac{T_1^o - T_0^o}{c_1^o - c_0^o} = \frac{(\bar{g}_0^o - 1)p_0^o - \eta_h^o p_{2,h}^o \frac{T_2^o - T_0^o}{c_2^o - c_0^o}}{\eta_l^o p_{1,l}^o} \tag{1.21}$$

where $\bar{g}_0^o = \frac{p_{0,l}^o}{p_0^o}\frac{1}{p_l}$, $\bar{g}_1^o = \frac{1}{p_l}$, $\bar{g}_2^o = \frac{p_{2,l}^o}{p_2^o}\frac{1}{p_l}$, *and* $\bar{g}_3^o = 0$.

Proof *(Heuristic)* Suppose taxes T_2^y and T_3^y are increased marginally by dT. There are three effects. First, tax income increases mechanically by $dM = [p_2^y + p_3^y]dT$. Second, the mechanical welfare effect of individuals earning z_2 and z_3 amounts to $dW = -\left[\bar{g}_2^y p_2^y + \bar{g}_3^y p_3^y\right] dT$. Third, the behavioral reaction at the intensive margin amounts to $dS = -\left[\xi_l^y p_{2,l}^y \frac{T_2^y - T_1^y}{c_2^y - c_1^y}\right] dT$. Summing up these three effects yields the optimality condition in equation (1.18). Analogously, the optimality condition in equation (1.17) can be derived by considering a marginal increase of T_3^y by dT. The optimality condition in equation (1.19) can be derived by changing T_3^y marginally by dT. The optimality condition in equation (1.20) can be derived by changing T_2^o and T_3^o marginally by dT. The optimality condition in equation (1.21) can be obtained by considering a marginal increase of T_1^o, T_2^o, and T_3^o by dT. □

Since $\bar{g}_3^t = 0$, the young and the old earning z_3 in the age-dependent optimum are taxed at the Laffer rate, see equation (1.17) and equation (1.19). The optimality condition for tax rate for middle income workers when being young, $T_2^y - T_2^y/(c_2^y - c_1^y)$, can be rewritten as $\frac{T_2^y - T_1^y}{c_2^y - c_1^y} = \frac{(\bar{g}_1^y - 1)p_1^y}{\xi_l^y p_{2,l}^y}$. Since $\bar{g}_1^y = 1/p_l > 1$, the optimal tax rate for middle income workers at young age is positive.

Due to the existence of a transfer scheme at old age, the tax rate for middle income workers (individuals earning z_2) at old age depends on the extensive elasticity for high ability types η_h^o. The tax rate for middle income at old age decreases with η_h^o if the term $(T_2^o - T_0^o)/(c_2^o - c_0^o)$ is positive, and increases with η_h^o if $(T_2^o - T_0^o)/(c_2^o - c_0^o)$ is negative. The intuition for this result is as follows. If the term is $(T_2^o - T_0^o)/(c_2^o - c_0^o)$ is negative, increasing taxes T_2 and T_3 by dT yields a "double dividend", in a sense that both mechanical tax effect and behavioral effect are positive. Increasing tax rates induces agents to react at the extensive margin, which increases tax return if the term $(T_2^o - T_0^o)/(c_2^o - c_0^o)$ is negative. By contrast, the behavioral effect of a tax increase is positive if the term $(T_2^o - T_0^o)/(c_2^o - c_0^o)$ is positive. Moreover, the tax rate for middle income workers at old age decreases as $\bar{g}_2^t$, the average welfare weight for individual for individuals earning z_2, increases. Since $\bar{g}_2^t = \bar{g}_2^o = \frac{p_{2,l}^o}{p_2^o}\frac{1}{p_l}$, the average social welfare weight for individuals earning z_2 increases as the relative share of low ability agents in the group of individuals earning z_2 increases.

Last, the tax rate for low income workers, $(T_1^o - T_0^o)/(c_1^o - c_0^o)$, decreases as the elasticity for low ability types increases, see equation (1.21). Moreover, the tax rate individuals earnings z_1 at old age is increasing in the average social welfare weight for individuals with zero income, $\bar{g}_t^0$. The term $\bar{g}_t^0$ increases as the relative share of low ability types versus high ability types in the inactive population increases. The intuition behind this result is that the government is more willing to redistribute towards the inactive population if the relative share of low ability individuals among the inactive population is high. If high ability agents are over-proportionally represented in the inactive population, $\bar{g}_0^o < 1$ and the first term in the denominator in equation (1.21) is negative, see also Proposition 2.

1.6 Conclusion

In this chapter, I present a new argument for age-dependent taxes relying on age varying marginal social welfare weights. In a simple framework with discrete earnings choice and early retirement revealing information about effort characteristics, I provide a potential setting for age varying marginal social welfare weights. This chapter points out an additional mechanism that has been neglected by the literature. In the analysis, I show that the welfare weights of the working population decrease if low ability agents are overproportionally represented in the inactive population. If welfare weights of the working population decrease with age and the change is sufficiently large, an age increasing tax reform for the working population can be welfare improving. Note that the discrete choice framework presented in this chapter is highly stylized. Therefore, one should be careful when deriving policy implications from the analysis.

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Chapter 2

Labor or Leisure? Labor Supply of Older Couples and the Role of Full Retirement Age[1]

2.1 Introduction

Declining fertility rates and increasing life expectancy force many developed countries to reform their pension systems. Designing policy reforms requires a detailed understanding of the labor supply behavior of older workers. For this reason, a large body of literature has estimated labor supply responses of individuals directly affected by pension reforms (*direct effect*), see e.g. Börsch-Supan and Schnabel (1999), or Mastrobuoni (2009).
The approach focusing on the *direct effect* abstracts from the fact that a large proportion of older workers are married.[2] Several studies find that older couples coordinate their exit from the labor force, see e.g. Gustman and Steinmeier (2004) or Hospido and Zamarro (2014). As a result, changes in incentives of one member of the couple may have spillover effects on labor supply of the spouse (*indirect effect*). In contrast to the evidence on the *direct effect*, existing studies on *indirect effects* find ambiguous results, depending on the particular country and reform under consideration. Previous studies examine the *indirect effect* on the participation decision (*extensive margin*).[3] Changes at the *extensive margin*, however, do not fully capture the change in total labor supply. Individuals may adjust their working hours to change their labor supply (*intensive margin*). The prevalence of gradual retirement indicates that older workers use working hours to adjust their labor

[1]This chapter is joint work with Elias Moor and was published as “Labor or Leisure? Labor Supply of Older Couples and the Role of Full Retirement Age”, *Netspar Working Paper Series, 03/2018*, see Hersche and Moor (2018).

[2]According to census data from the Swiss Federal Office for Statistics, 75% of men aged between 55 and 70, and 64% of women in Switzerland were married in 2010.

[3]An exception is Stancanelli (2017). Using survey data from France, she found evidence that working hours decrease upon a spouse’s retirement.

supply, see Kantarci and Van Soest (2008) for a summary of evidence in Europe and the US.

In this chapter, we estimate the effect of having a spouse at or above the full retirement age (FRA) on labor supply at *extensive margin* and *intensive margin* in Switzerland. FRA represents the age at which first pillar pensions can be claimed without deductions. The full retirement age is of interest in two ways. First, full retirement age in the first pillar represents the main policy instrument for the government. Knowledge on the expected spousal reaction will provide information on spillover effects of future pension reforms. Second, changes in hours and hazard rates of retirement peak at FRA. Therefore, the estimate on spousal labor supply reaction will be informative on the relationship between spousal retirement and own labor supply.

We find that the labor force participation rates of women drop by approximately 3 percentage points in response to the spouse reaching FRA. By contrast, men do not react at the extensive margin. At the intensive margin, we find only small and non-significant effects for both men and women. We argue that the response can be explained by *complementarity in leisure* and *liquidity effects*. For women, the absence of an intensive margin reaction can be explained by the presence of *fixed costs of work*.

We use two sources of variation to identify the effect. First, we exploit variation in age difference within couples. Second, we use a pension reform which increased the FRA of women from 62 to 64. In our analysis, the treatment group consists of individuals with a spouse who has reached FRA. The control group consists of individuals whose spouse has not yet reached FRA. The key identifying assumption of our approach is that, after controlling for observables, a difference in labor supply arises from the variation in the FRA status of the spouse. For example, we compare the labor supply of a 61-year-old woman with a husband aged 64 (FRA not reached) to a 61-year-old woman with a husband aged 65 (FRA reached).

At the extensive margin, we compare the labor force participation rate of individuals whose spouse has reached FRA to individuals whose spouse has not yet reached FRA. At the intensive margin, a simple treatment and control comparison of individuals with positive working hours does not provide a causal estimate for the intensive margin effect.[4] We employ a first difference estimator on positive hours to resolve the potential selection problem.

The analysis is based on data drawn from the Swiss Labor Force Survey for the time period between 1991 and 2009. In contrast to administrative Social Security data sets, this data set provides information on working hours. Furthermore, it includes rich information on labor supply and a large set of sociodemographic variables relating to the

[4]Comparing the positive hours of the treatment group to the positive hours of the control group involves a comparison of two possibly different groups: the group with positive hours under treatment and the group with positive hours under no treatment. The two groups will be different if some individuals are induced to switch from zero to positive hours because of treatment, or vice versa.

interviewed individual and the spouse. In this survey, individuals are interviewed every year for up to five consecutive years. We exploit the panel structure of the survey to estimate the effect at the intensive margin.
This chapter relates to the literature on labor supply of older couples pioneered by Hurd (1990), Zweimüller, Winter-Ebmer, and Falkinger (1996) and Blau (1998). In this literature, two effects are frequently studied. First, the literature studies the effect of spouse B retiring on the labor supply of spouse A. Second, studies examine the effect of spouse B reaching FRA on the labor supply of spouse A. In this chapter, we contribute to the latter literature. This study is closely related to recent contributions by Cribb, Emmerson, and Tetlow (2013), Selin (2017), Stancanelli (2017) and Lalive and Parrotta (2017). These contributions use social security reforms or pension legislation to identify the causal effect of the spouse reaching FRA. Stancanelli (2017) finds that the probability of men retiring increases when their wives reach early retirement age. By contrast, she finds no evidence that women react when their husbands reach early retirement age. Cribb et al. (2013) analyze the spillover effects of an increase in female FRA in England. They find positive spillover effects on the labor supply of men. Lalive and Parrotta (2017) use Swiss census data from 1990 and 2000 to estimate the effect of the spouse reaching FRA. They find that the labor supply of women drops by 3 percentage points, whereas the labor supply of men does not change. Selin (2017) exploits an occupational pension reform in Sweden which primarily affected female workers. He finds no evidence for a response of men married to affected women.
In contrast to contributions from Cribb et al. (2013), Selin (2017) and Lalive and Parrotta (2017), we additionally investigate the causal effect of the spouse reaching FRA on hours worked. In this respect, our chapter is related to that of Stancanelli (2017).
The remainder of this chapter is organized as follows. Section 2.2 describes the Swiss pension and tax system, outlining the financial incentives faced by older couples. In section 2.3, we outline mechanisms that can explain the labor supply reaction when the spouse reaches FRA. Sections 2.4 and 2.5 describe the data and general labor supply patterns. In section 2.6, we present our empirical approach. Results are presented in section 2.7 and discussed in section 2.8. The last section concludes.

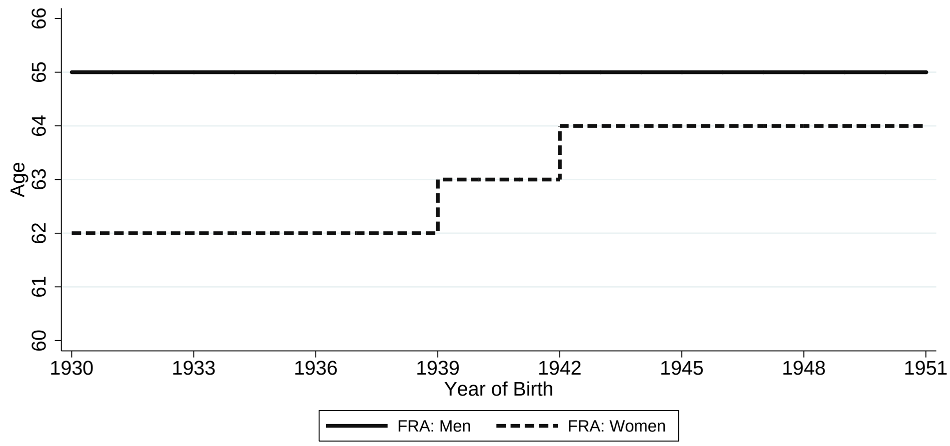
2.2 Incentives of older couples in Switzerland

In this section, we describe the financial incentives faced by older workers in Switzerland. In particular, we focus on the description of incentives for older married couples.

2.2.1 Pension system

The Swiss pension system consists of three pillars. The old age and survivor insurance (OASI) represents the first pillar. The OASI is a pay-as-you-go insurance with a strong redistributive motive. The OASI is financed by payroll taxes and government transfers. Its main purpose is to cover basic living costs. Individual pension entitlements are a function of contribution years and average earnings.[5] Individuals who contributed each year from age 20 to FRA are entitled to a full pension. The FRA is defined as the age at which a first pillar pension can be claimed without deductions. For each missing contribution year, benefits are reduced by at least 2.3%. Depending on average earnings, the monthly full pension in 2005 ranged from a minimum of 1'075 CHF to a maximum of 2'150 CHF.[6] The sum of the two individual pensions within a couple is capped at 150% of a maximum individual pension. It is not possible to borrow against future first pillar entitlements.

Figure 2.1: Full retirement age of men and women by year of birth



Evolution of first pillar full retirement age (FRA) and early retirement (ERA) for men and women by cohort.

Individuals reaching FRA can claim pensions and continue working. No earnings test applies for pensions from the first pillar. In addition, workers are able to postpone claiming pensions from the first pillar. The pension increases from 5.2% for a one-year delay to 31.5% for a five-year delay. Individuals working past FRA continue paying payroll taxes, with an allowance of 16'800 CHF. These contributions do not increase future pension entitlements. In the time period under consideration, the OASI was reformed once in 1997. Most prominently, the FRA for women was increased in two steps from 62 to 64. In 2001, the FRA was increased from 62 to 63. In 2004, the FRA was increased in a second step from 63 to 64. Furthermore, the possibility of claiming early retirement benefits from the first pillar was introduced. Figure 2.1 depicts the evolution of the FRA for men and women by year of birth. The second pillar is an

[5] Average earnings depend on the lifetime earnings, as well as on educational and care credits.
[6] As a comparison, the monthly median labor income in Switzerland amounted to 5'250 CHF (2005).

occupational pension scheme. The objective is to ensure the continuation of the living standard held prior to retirement. Contributions to the occupational pension system are age-dependent and compulsory for wage employed above a given threshold.[7] In general, the regulated retirement age of occupational pension schemes coincides with the FRA of the first pillar.[8] However, pension funds are free to set more generous regulations. Upon reaching the regulated retirement age, the retiree can choose between a lifelong monthly annuity, a lump-sum transfer of the accumulated capital, or a combination of both. The share of married men insured in the second pillar amounts to approximately 70%. By contrast, approximately 40% of women are insured in the second pillar.[9] This can be explained by the fact that women have lower labor force participation rates and are more likely to work part-time. The third pillar consists of voluntary, tax-favored savings.

2.2.2 Income Taxes

In contrast to the majority of OECD countries, Switzerland has a system where the income of married couples is taxed based on the concept of family taxation. Income from both partners is aggregated and taxed as a single unit. Tax rates for unmarried individuals and married couples are different. Income is taxed at community, cantonal, and federal level. Cantons are responsible for the collection of income and wealth taxes at community, cantonal, and federal level. Cantons have fiscal sovereignty, and are therefore free to set tax rates and establish deductions. The federal tax rates are determined by the federal state.

The income tax schedule in Switzerland is progressive by law. Gross labor income is subject to a set of deductions. The left graph in Figure 2.2 displays the average tax rates for a given *gross labor income* before social security deductions for the time period 1991-2006. The average tax rates decreased slightly for all income brackets in the time period under consideration. Pension income is not exempted from income taxation. First, second, and third pillar pensions are generally taxed at the same rate as labor income. Similar to labor income, retirees are eligible for a set of tax deductions.

The right graph in Figure 2.2 displays the average tax rates for a given *gross pension income*.[10] The average tax rates for retirees decreased moderately in the time period under consideration. The differences between the average tax rates, however, are small.[11] Occupational pension funds in Switzerland aim at a replacement rate of 50%-60%. Com-

[7] Only the amount exceeding the threshold is insured. Threshold 1991: yearly earnings 19'200 CHF, 2009: yearly earnings 20'520 CHF.

[8] The regulated retirement age of occupational pension schemes is the age at which occupational pensions can be claimed without deductions.

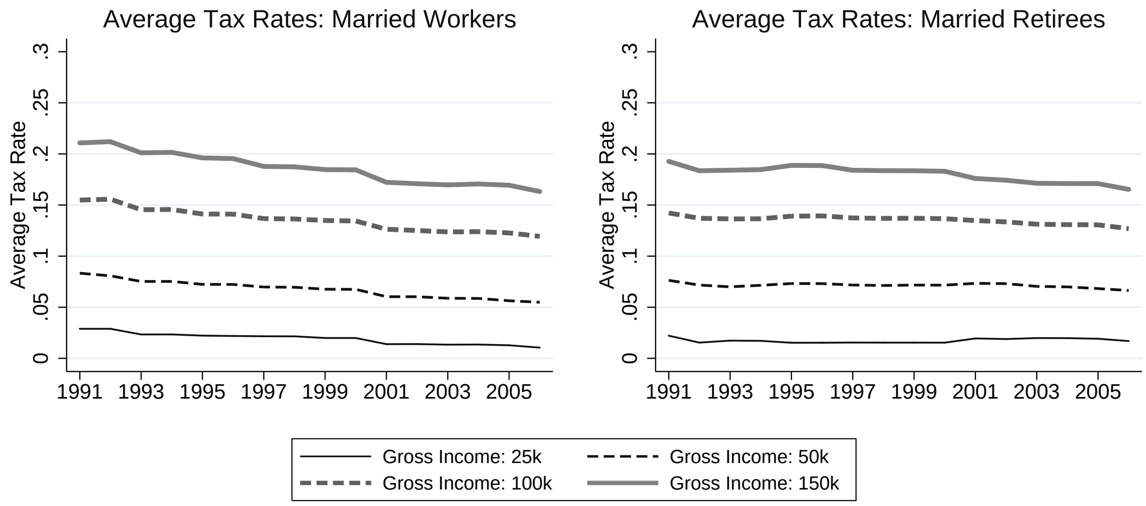
[9] See Figure 2.11 in Appendix 2.C.

[10] Before social security deductions.

[11] In 2007, the Federal tax administration changed the statistical procedure of reporting average tax rates for retirees. Therefore, we do not report tax rates after 2007.

bined with pension income from first pillar and third pillar, this results in a total replacement rate of 70%-80%, see Bütler (2009) for a discussion. Tax rates therefore generally decrease when an individual reaches FRA.

Figure 2.2: Average tax rates of married couples by gross labor income



Note: Average combined tax rates (federal, cantonal, community level) in cantonal capitals by year and gross labor/pension income for a married couple. Standard deductions without verification requirements for wage earners are applied. For retirees, standard deductions without verification requirements for the case where both individuals have reached FRA are applied. Data source: Own calculations, tax rates from Federal Tax Administration.

2.3 Mechanisms

Table 2.1 presents a non-exclusive list of mechanisms explaining a change in labor supply of individual A when spouse B reaches FRA. The labor supply reaction of A depends on whether the spouse B reduces labor supply when reaching FRA. Therefore, we divide the analysis into two parts: the case in which B reduces labor supply (left column), and the case in which B does not reduce labor supply (right column). The latter case includes the situation where B retired before FRA. Furthermore, it includes the case where B continues working without changing working hours. Although B does not reduce labor supply, a full pension can be claimed when reaching FRA. The resulting change in income can have an impact on A's labor supply.

First, we expect couples to enjoy their leisure time more when it is spent together. Previous studies find evidence that *complementarities in leisure* are a strong driver of labor market decisions in older couples, see e.g. Coile (2004) or Banks, Blundell, and Casanova Rivas (2010). Therefore, if B reduces labor supply, *complementarities in leisure* lead, ceteris paribus (cet. par.), to a decrease in labor supply of individual A. If B does not reduce labor supply, the expected effect is zero.

Table 2.1: Mechanisms and expected sign of labor supply reaction to spouse reaching FRA

Mechanism	Expected sign of labor supply reaction of individual A when spouse B reaches FRA and ...	
	B reduces labor supply	B does not reduce labor supply
1. Complementarity in leisure	Negative	Zero
2. Liquidity Effect	Positive	Negative
3. Joint Taxation	Positive	Negative
4. Housework	Positive	Zero

Second, *liquidity effects* can occur as soon as spouse B reaches FRA and claims a pension.[12] In the case where B reaches FRA, claims a pension, and reduces labor supply, there is a drop in household income, since replacement rates are below one.[13] Hence A, cet. par., increases labor supply to compensate the loss in household income. In the case where B reaches FRA and claims a pension, but does not reduce labor supply, the pension will, cet. par., increase household income. Hence A, cet. par., decreases labor supply.

Third, due to the system of progressive *joint taxation*, the marginal tax rate of A increases (decreases) if total household income increases (decreases). Evidence from other countries suggests that labor supply of older workers increases with decreasing tax rates (Alpert & Powell, 2014; Laun, 2017). If B reduces labor supply, cet. par., household income decreases.[13] This decrease leads to a lower marginal tax rate for individual A, and therefore to an expected increase in labor supply. If B does not reduce labor supply but claims a pension, the household income increases. Therefore, the marginal tax rate for A increases, and we expect a negative effect on the labor supply of individual A. Fourth, there is evidence that retirement increases hours of *housework* (Stancanelli & Van Soest, 2012; Ciani, 2016). If individual B reduces labor supply and increases housework, individual A may decrease housework. In this case, individual A may be willing to increase labor supply. If B does not reduce labor supply, we expect no effect on labor supply

[12]According to Bundesamt für Sozialversicherungen (2009), the proportion not claiming a first pillar pension at FRA amounted to less than 1% (2009). We disregard this possibility in the discussion of mechanisms.

[13] For both liquidity and tax mechanism, we assume that a reduction in labor income is not fully replaced by pension income. Therefore, we exclude the case that household income increases when labor supply decreases.

of individual A. To sum up, a negative labor supply reaction of individual A following a change in labor supply of individual B when reaching FRA can only be explained by strong complementarity in leisure effects. Liquidity and joint taxation may explain a labor supply reduction of A if B does not adjust labor supply when reaching FRA.

2.4 Data

For the analysis, we use data drawn from the Swiss Labor Force Survey (SLFS)[14] for the time period between 1991 and 2009. The SLFS is a rotating yearly panel of individuals above the age of 15. The survey is administered by the Federal Statistical Office (FSO). Participation in the survey is voluntary and individuals are interviewed for up to five consecutive years. For the sample of individuals aged between 58 and 70, 30% participated in one interview, 19% in two interviews, 14% in three interviews, 9% in four interviews, and 28% in five interviews. In the time period under consideration, the survey was carried out by telephone in the second quarter (April-June) of each year. The number of respondents aged between 58 and 70 increased from 2'230 in 1991 to 8'825 in 2009.

The survey provides extensive information on sociodemographic variables, labor supply status, earnings and household income of the respondent. The survey provides a variable for the year of birth of the respondent, but not the birth date. The spouse of the respondent is not directly interviewed. The respondent provides answers to questions on labor supply behavior and age of the spouse. There is information on the age of the spouse, but not on the year of birth. We impute the year of birth using the year of the interview and the age of the spouse.[15] There is sparse information on the health of the respondent and no information on the health of the spouse.

These two variables are arguably important determinants of retirement. Therefore, we have to assume that conditional on observables, pension incentives and health do not differ between those respondents whose spouse reached FRA and those respondents whose spouse did not yet reach FRA (see section 2.2).

For working individuals, the SLFS provides a set of variables describing the amount of time spent at work. The set includes *usual hours*, *contracted hours* and *actual hours in the previous week*. In this chapter, we use *contracted hours per week* as a measure of

[14]In German: Schweizerische Arbeitskräfteerhebung (SAKE).

[15]Given the year of interview and the age, the exact year of birth of the spouse is not identified (only a range of two years is identified). Since treatment classification is based on year of birth, there are spouses in the sample for whom we are not able to identify whether they have reached FRA or not. For example, the year of birth of a female spouse aged 61 and observed in 2000 could be either 1939 (FRA 63) or 1938 (FRA 62), depending on whether the birthday is before or after the day of the interview in that year. Mastrobuoni (2009) and Barrett and Atalay (2015) deal with this issue by assuming that all birth dates within a year are equally likely. In contrast to their approach, we do not include observations with uncertain treatment status.

labor supply for wage employed. The underlying survey question is: "How many hours do you work according to your written or verbal contract per week?".[16] For self-employed, our measure of labor supply is *usual working hours per week* and the underlying survey question is: "How many hours do you usually work per week?".[17] We classify an individual as being in the labor force if the individual reports positive weekly working hours. In the sensitivity analysis, we check whether the results differ when using *actual working hours in the previous week* as an alternative measure for labor supply.

Based on a set of questions, the SLFS classifies each respondent as being either employed, apprentice, unemployed, or non-participating. The group of non-participants includes disabled individuals, retirees and others. Non-participants are not asked about their working hours. We set the hours of unemployed and non-participants to zero.

In order to examine possible labor market frictions, we use *desired hours* as measure of *desired labor supply*. The underlying question is: "How many hours per week would you like to work?".[18] In addition, we use variables on the amount of housework to estimate the effect of retirement on home production. Finally, we use data from the Swiss State Secretariat for Economic Affairs on aggregate GDP growth rates and aggregate unemployment rates.

Last, we use *total household income* as a measure to evaluate the impact of wealth on the response. Since there is substantial measurement error associated with this variable, the Federal Office for Statistics only reports the quintile membership. The underlying question for the variable is: "What is the combined income including the labor income, pension income, unemployment benefits, social assistance etc. of all household members?"[19]

2.5 Labor supply patterns

Before presenting the causal analysis, we examine the labor force patterns of older married individuals in Switzerland. Figure 2.3 displays the labor force participation rates by age

[16]German: "Wieviele Stunden pro Woche schaffen Sie gemäss mündlichem oder schriftlichem Arbeitsvertrag?". The corresponding SLFS variable is EK01.

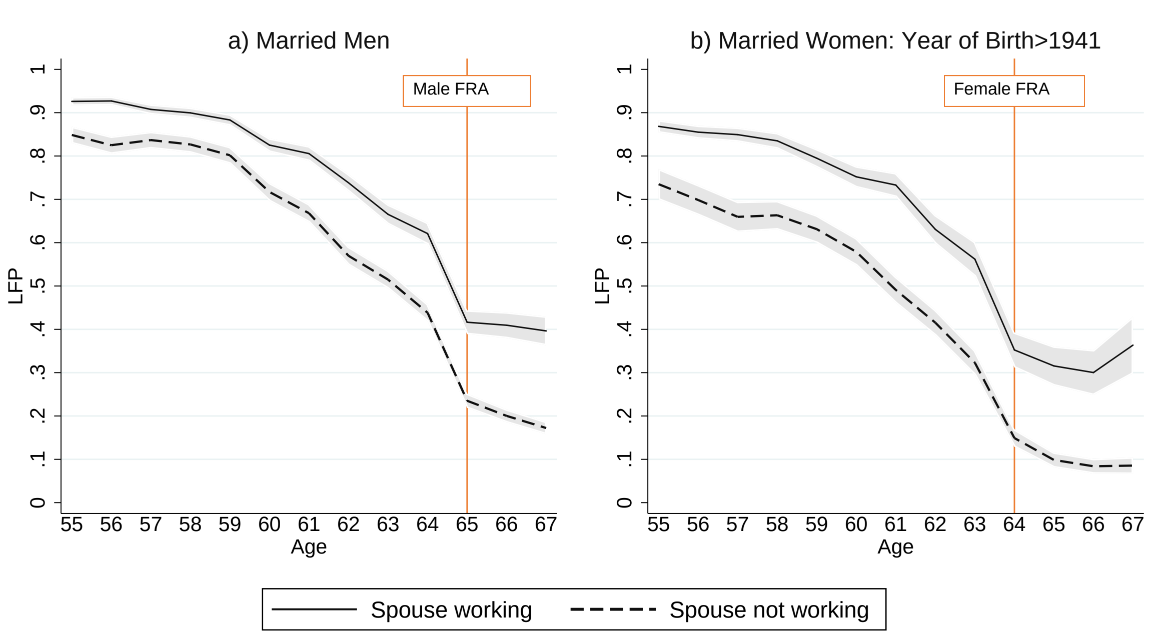
[17]German: "Wieviele Stunden schaffen Sie normalerweise pro Woche?". The corresponding SLFS variable is EK01.

[18]German: Wieviele Stunden in der Woche würden Sie gerne schaffen? The corresponding SLFS variable is EK07. In contrast to similar surveys in other countries, individuals are not asked to assume a constant hourly wage rate when answering the question for desired hours.

[19]German: Uns interessiert das Gesamteinkommen von allen Haushaltsmitgliedern. Dazu gehören alle Erwerbseinkommen, alle Kapitalerträge wie z.B. Zinsen, Aktien oder Mieteinnahmen, aber auch alle staatlichen und privaten Renten oder Zuschüsse wie z.B. AHV, Arbeitslosenunterstützung, IV, Sozialhilfe, Stipendien, Unterhaltsbeiträge, etc.

and labor market status of the spouse for the time period 1991-2012.[20]

Figure 2.3: Labor force participation rates by labor market status of the spouse



Note: Labor force participation rates (LFP) by age and labor market status of the spouse. Average values for period 1991-2012. Single and widowed individuals excluded. For women, only cohorts born after 1941 (FRA 64) are considered. Shaded grey area represents the 95% confidence interval for the mean estimate. Data source: Own calculations based on SLFS data, FSO.

As illustrated in Figure 2.3a, labor force participation rates of married men with a working spouse are between 5 and 25 percentage points higher than the rates of men with a non-working spouse. The difference in participation rates between the two groups increases with age. Furthermore, male participation rates remain high - at above 80% - until the age of 60.

Female labor force participation rates are set out in Figure 2.3b. Again, the labor force participation rates are substantially higher for women with a working spouse than for women with a non-working spouse. In contrast to men, female labor force participation rates start to drop before the age of 60.

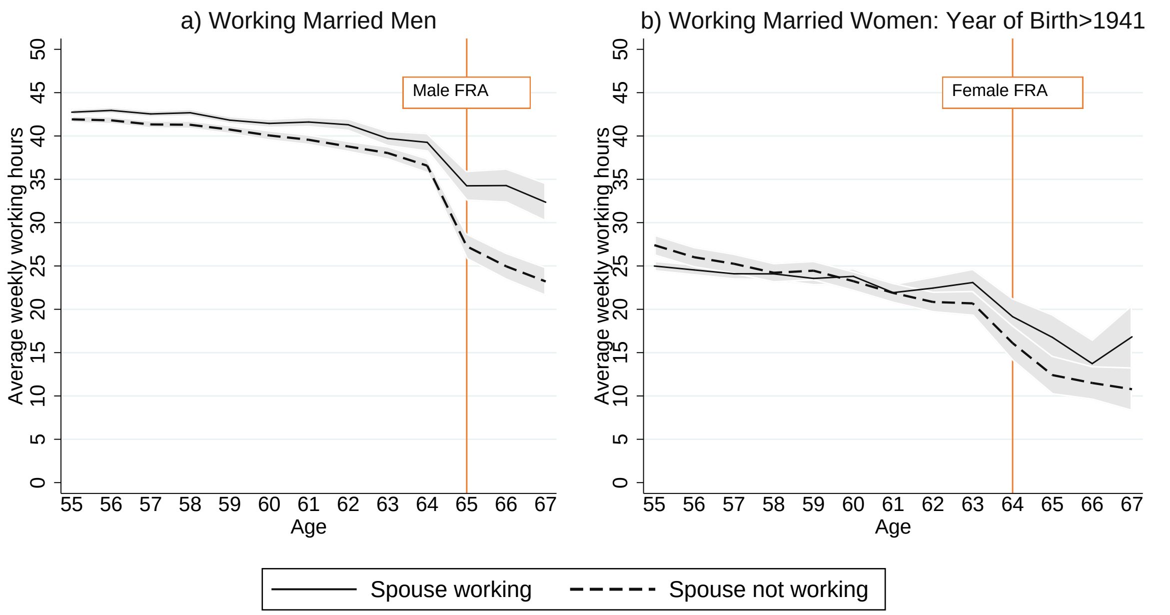
Figure 2.4 displays the average weekly hours worked by individuals participating in the labor market. Men work an average of approximately 40 hours per week before FRA is reached. In Switzerland, working 40 hours corresponds to a full-time employment.[21] There is a drop in hours worked at FRA. On average, men whose wives are not in the labor market work fewer hours at all ages. The difference is increasing with age.

[20]Unlike our estimation samples (1991-2009), we use data until 2012 in order to have a larger sample size for working individuals past FRA. The pattern is very similar for the time period 1991-2009.

[21]The legal maximum weekly working time in Switzerland is set at 45 hours for industrial, administrative, commercial, technical and sales jobs. All other sectors have a maximum of 50 hours. Working time regulation did not change in the period under consideration (1991-2009).

Until the age of 57, women with a working husband work, on average, fewer hours than women with a non-working husband. There is no difference in working hours between the ages of 58 and 61. Beyond the age of 62, women with a working husband work, on average, more hours than women with a non-working husband. Since the confidence intervals for the mean estimates overlap in most cases, these differences should be interpreted with caution.

Figure 2.4: Average weekly working hours (only workers) by labor market status of the spouse



Note: Estimated average weekly working hours conditional on positive hours by age and labor market status of the spouse. Contracted hours for wage employed and usual hours for self-employed are used. Average values are for the period 1991-2009. Single and widowed individuals are excluded. For women, only cohorts born after 1941 (FRA 64) are considered. Shaded grey area represents the 95% confidence interval for the mean estimate. Data source: Own calculations based on SLFS data, FSO.

2.6 Empirical approach

We estimate the causal effect of having a spouse B at or above FRA (treatment) on the labor supply of individual A. The total labor supply effect induced by having a spouse at or above FRA can be decomposed into 1) the average change in working hours of those working irrespective of treatment, plus 2) the average hours worked of those working in the case of treatment, and not working in the case of no treatment, minus 3) the average hours worked of those not working in the case of treatment, and working in the case of no treatment.[22]

[22] The formal decomposition is based on the joint distribution of potential outcomes (Staub, 2014), and given by: $ATE = E(h_i^1 - h_i^0) = E(h_i^1 - h_i^0 | h_i^1 > 0, h_i^0 > 0)P(h_i^1 > 0, h_i^0 > 0) + E(h_i^1 | h_i^1 > 0, h_i^0 =$

We are interested in two causal effects. First, the causal effect of treatment on the probability of working (extensive margin).[23] Second, the causal effect of treatment on working hours of individuals having positive hours irrespective of treatment, i.e. individuals working irrespective of whether their spouse has reached FRA or not (intensive margin).

2.6.1 Extensive Margin

Let h_{it} denote weekly working hours of individual i in interview year t. We estimate the extensive margin effect using a probit model of the form

$$P(h_{it} > 0|T_{it}, \mathbf{X_{it}}) = \mathbf{\Phi}(\beta_0 + \beta_1 T_{it} + \mathbf{X_{it}}\boldsymbol{\beta_2}), \tag{2.1}$$

where $\mathbf{\Phi}(\cdot)$ denotes the cumulative normal distribution. The treatment variable T_{it} is defined as

$$T_{it} = \begin{cases} 1 & \text{if the spouse of individual i is at or above FRA in period t,} \\ 0 & \text{otherwise.} \end{cases}$$

The matrix of controls $\mathbf{X}$ includes dummies for age, education, whether the respondent is a Swiss citizen, and whether the household size is larger than two. Furthermore, $\mathbf{X}$ includes the age of the spouse, the age of the spouse squared, the log of GDP, and the unemployment rate.

We are interested in the average partial effect of T_{it}, which measures the causal effect of having a spouse at or above the FRA on the probability of working. Our identifying assumption is that after controlling for potential confounders $\mathbf{X}$, respondents whose spouse has not yet reached FRA (control group) do not differ from respondents whose spouse has reached FRA (treatment group) with respect to the distribution of unobservables. Therefore, the remaining differences in labor supply participation rates between the treatment and the control group can be attributed to having a spouse at or above the FRA.

We use two sources of variation to identify the effect. First, we exploit variation in age difference within couples. The variation in age difference is depicted in Figure 2.9 in Appendix 2.A. Second, we use a pension reform which increased the FRA for women

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$0)P(h_i^1 > 0, h_i^0 = 0) + E(-h_i^0|h_i^1 = 0, h_i^0 > 0)P(h_i^1 = 0, h_i^0 > 0)$, where h_i^1 denotes the potential outcome in the case of treatment and h_i^0 the outcome in the case of no treatment.

[23] The difference in probabilities $P(h_i^1 > 0) - P(h_i^0 > 0)$ corresponds to the difference in the group fractions $P(h_i^1 > 0, h_i^0 = 0) - P(h_i^1 = 0, h_i^0 > 0)$ outlined in footnote 22, since $P(h_i^1 > 0, h_i^0 = 0) - P(h_i^1 = 0, h_i^0 > 0) = \{P(h_i^1 > 0, h_i^0 = 0) + P(h_i^1 > 0, h_i^0 > 0)\} - \{P(h_i^1 = 0, h_i^0 > 0) + P(h_i^1 > 0, h_i^0 > 0)\} = P(h_i^1 > 0) - P(h_i^0 > 0)$.

in two steps. In 2001, the FRA was increased from 62 to 63. In 2004, the FRA was increased in a second step from 63 to 64, see section 2.2.

A threat to our identification strategy are unobserved confounders correlated with both; FRA status of spouse B, and the labor supply of individual A. Potential unobserved confounders include the health of spouse B, the birth of grandchildren, and unobserved preferences.

The health of spouse B potentially affects the decision whether and how much individual A works. Moreover, the health status of spouse B is associated with the age of spouse B, and therefore also with whether the spouse has reached FRA. On average, the older a spouse is, the lower the health status. We control for age of the spouse with a linear and a quadratic term. If this approximation is not sufficient to capture the effect of spousal health, this poses a threat to our identification strategy. However, if reaching FRA affects the health of spouse B directly, we would not want to control for the health of spouse B. This case is part of the causal effect we want to measure. The case of the birth of grandchildren is very similar. Grandchildren potentially affect the decision whether and how much individual A works. Moreover, having grandchildren is associated with the age of spouse B, and therefore also with whether the spouse has reached FRA. On average, the older a spouse is, the older the children. The older the children, the more likely are the children to have children themselves. Again, we assume that controlling for the age of individual A using dummies, and the age of spouse B with a linear and a quadratic term is sufficient to capture unobserved effects from grandchildren. Finally, the characteristics and preferences of individual A that affect the labor supply of A may also be associated with the age of spouse B, see e.g. Bloemen and Stancanelli (2015). For example, individuals with preferences for a younger spouse could be willing to work more or work longer.

2.6.2 Intensive Margin

At the intensive margin, we are interested in the causal effect of treatment on working hours of individuals working irrespective of whether their spouse has reached FRA or not. In general, a comparison of labor supply of treated and non treated conditional on positive hours does not provide an unbiased estimate for the causal intensive margin effect (Angrist, 2001; Staub, 2014). The reason is that the sample of working individuals includes two different groups - individuals who have positive hours irrespective of treatment (the group of interest) and individuals who have positive hours only because they are treated, and would leave the labor market if they were not treated.[24]

[24]The simple comparison of positive outcomes is unbiased in two cases. First, if individuals leaving the labor market due to treatment have the same distribution of working hours as the individuals working

To deal with the selection issue, we apply a difference-in-difference estimator on positive outcomes. We estimate the linear regression

$$\Delta h_{it} = \gamma_1 \Delta \mathrm{T}_{it} + \Delta \mathbf{X_{it}} \boldsymbol{\gamma_2} + \nu_{it} \qquad \text{for } h_{it} > 0, h_{it-1} > 0, \tag{2.2}$$

where $\Delta z_{it} = z_{it} - z_{i,t-1}$ for $z \in \{h_{it}, T_{it}, \mathbf{X}_{it}\}$. Treatment variable T_{it} is defined as

$$T_{it} = \begin{cases} 1 & \text{if the spouse of individual i is at or above FRA in period t,} \\ 0 & \text{otherwise.} \end{cases}$$

We are interested in γ_1, the causal intensive margin effect. The coefficient γ_1 captures the effect of having a spouse B at or above FRA on the labor supply of individual A. The matrix of controls $\mathbf{X}$ includes dummies for age and whether the household size is larger than two. Furthermore, $\mathbf{X}$ includes the age of the spouse, the age of the spouse squared, the log of GDP, and the unemployment rate. Time-constant dummies such as education and being a Swiss citizen are excluded.

Under assumptions stated below, we demonstrate in chapter 3 that the difference-in-difference estimator on positive outcomes (2.2) identifies the causal effect at the intensive margin.

1. Common trend in positive outcomes: We assume that individuals in the treatment group would experience the same change in hours as the control group from period $t-1$ to period t in the absence of treatment. The validity of the common trend assumption can be examined in the data using pretreatment observations. We compare the change in hours from the penultimate period $(t-2)$ to the previous period $(t-1)$ for the treatment group (spouse reaches FRA in period t), and the control group (spouse does not reach FRA in period t). We find no evidence for a difference in trends relating to working hours between the two groups, see Table 2.5 in Appendix 2.A.

2. Treatment monotonicity at the extensive margin: Given that an individual works in the case where the spouse has reached FRA, we assume that the individual also works in the case where the spouse has not yet reached FRA. This assumption excludes the possibility that individuals work when their spouse has reached FRA, and do not work when their spouse has not yet reached FRA. It is important to note that we do not assume monotonicity with respect to the hours worked, but only with respect to the participation decision.

3. Negative time monotonicity at the extensive margin: We assume that having positive hours in period t also implies having positive hours in $t-1$. In our case, this assumption

irrespective of treatment. Second, if there is no extensive margin reaction, i.e. there are no individuals who have positive hours only because they are treated, and would leave the labor market if they were not treated.

excludes unretirement, i.e. a return to the labor market after a period of non activity. In our estimation sample, we find that 9.1% of men and 8.1% of women who work in period t were retired in $t-1$. These individuals are excluded from the analysis, since we condition on having positive outcomes in both periods.

4. No anticipation: We assume that on average, having a spouse who reaches FRA in period t does not affect the respondent's labor supply in period $t-1$. If this assumption is violated, it is likely that individuals adjusted their labor supply in the same direction in $t-1$. In this case, the estimated causal effect is biased downwards in absolute terms, and would therefore represent a lower bound of the true causal effect (again in absolute terms).

Table 2.2 presents the summary statistics for the sample used to estimate the extensive margin effect (left panel), as well as the sample used to estimate the intensive margin effect (right panel). The differences between the means of treatment and control group are largest for *age* and *age spouse*. For differences in *age*, we control using age dummies. For differences in *age spouse*, we control using a linear and a quadratic term of age of the spouse.

Table 2.2: Summary Statistics

	Extensive Margin Sample				Intensive Margin Sample			
	Men		Women		Men		Women	
	Treatment Mean / SD	Control Mean / SD	Treatment Mean / SD	Control Mean / SD	Treatment Mean / SD	Control Mean / SD	Treatment Mean / SD	Control Mean / SD
Year of Interview	2003.19	2003.78	2003.70	2002.33	2002.14	2002.94	2002.74	2002.53
	(4.08)	(4.36)	(3.98)	(4.47)	(5.18)	(4.65)	(4.73)	(4.38)
Age	66.05	63.12	64.66	61.64	63.13	62.44	61.79	61.06
	(2.87)	(3.01)	(2.81)	(2.68)	(2.54)	(2.82)	(2.27)	(2.48)
Age Spouse	65.74	60.17	67.41	61.75	62.92	61.42	65.02	63.43
	(2.18)	(1.56)	(1.68)	(1.84)	(0.84)	(3.03)	(0.13)	(3.39)
Swiss Citizenship	0.78	0.74	0.81	0.84	0.85	0.81	0.87	0.86
	(0.41)	(0.44)	(0.39)	(0.36)	(0.35)	(0.40)	(0.33)	(0.34)
Household size > 2	0.07	0.16	0.09	0.11	0.14	0.17	0.12	0.14
	(0.26)	(0.37)	(0.28)	(0.32)	(0.34)	(0.37)	(0.33)	(0.34)
Education								
Lower Education	0.18	0.17	0.41	0.34	0.12	0.13	0.34	0.31
	(0.38)	(0.38)	(0.49)	(0.47)	(0.33)	(0.34)	(0.47)	(0.46)
Secondary Education	0.53	0.49	0.51	0.55	0.49	0.49	0.52	0.56
	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)
Higher Education	0.30	0.34	0.08	0.10	0.38	0.37	0.13	0.12
	(0.46)	(0.47)	(0.27)	(0.30)	(0.49)	(0.48)	(0.34)	(0.33)
GDP growth in %	0.72	0.81	0.77	0.76	0.61	0.84	0.77	0.85
	(0.80)	(0.82)	(0.81)	(0.73)	(0.80)	(0.76)	(0.79)	(0.71)
Unemployment Rate in %	3.76	3.83	3.80	3.76	3.81	3.83	3.84	3.84
	(0.63)	(0.57)	(0.60)	(0.63)	(0.54)	(0.57)	(0.59)	(0.59)
Observations	7012	7878	8151	5765	313	3682	290	2703

2.7 Results

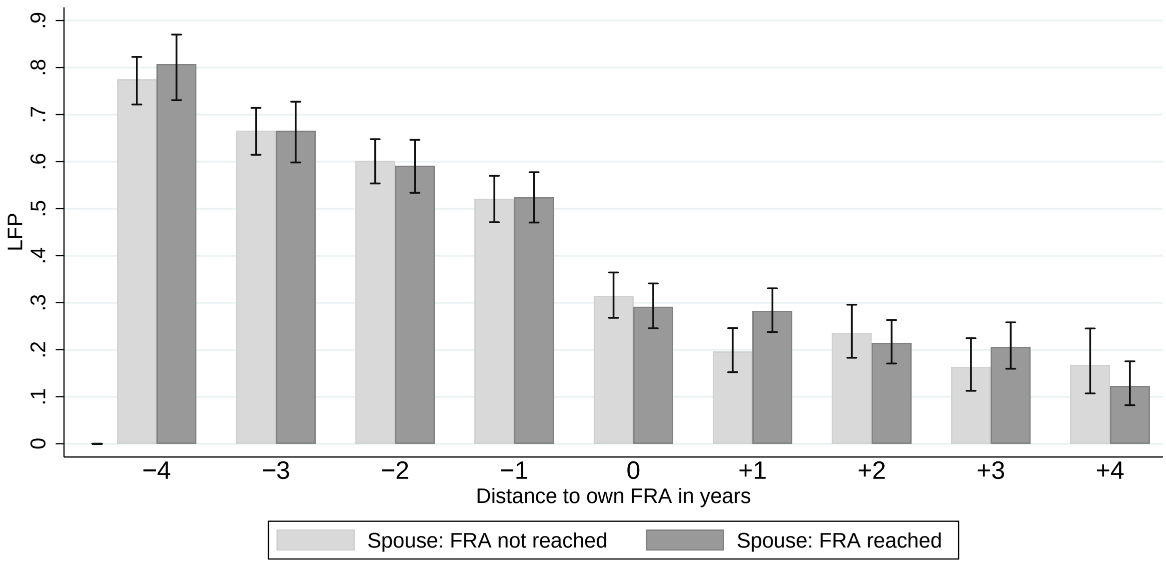
The results section is divided into extensive and intensive margin. Both parts start with simple graphical evidence. Subsequently, we present estimates of the causal effect of having a spouse at or above the full retirement age on labor supply. The estimation results refine the graphical analysis by controlling for more potential confounders.

2.7.1 Extensive margin

Graphical Evidence

Figure 2.5 plots the LFP rates for men. Negative years to own FRA indicate that the respondent has not yet reached FRA; zero or positive years to own FRA indicate that the respondent has reached FRA. For each age bin, the light-grey bars on the left indicate the LFP rates of men with a spouse who has not yet reached FRA and is at most two years away from reaching FRA; the dark-grey bars on the right indicate the LFP rates of men with a spouse who has reached FRA and is at most two years above FRA.

Figure 2.5: Labor force participation rate of men by FRA status of spouse

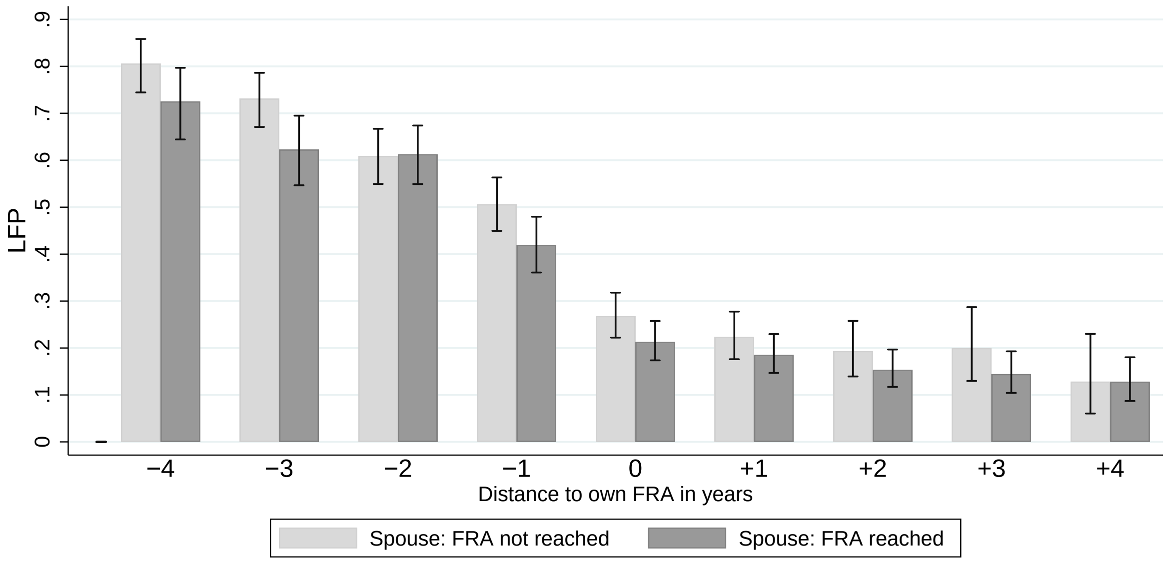


Note: Labor force participation rates (LFP) of men by FRA status of their wife. Only married men with a spouse who is between two years before reaching FRA and two years after FRA are considered. Disabled and unemployed individuals are not included. Data source: Own calculations based on SLFS data, FSO.

For almost all ages, the differences in LFP between men with a spouse who is below FRA and men with a spouse who is above FRA are neither economically nor statistically significant. The only exception is at age 66 (distance to own FRA equals +1). At age 66, men with a spouse who is above FRA are approximately 9 percentage points more likely

to be in the labor force. Confidence intervals of the mean estimate are overlapping. This indicates that the difference in means is not significantly different from zero.
Figure 2.6 plots the LFP rates for women. The graph indicates that labor force participation rates among women whose spouse has reached FRA are lower compared to women whose spouse has not yet reached FRA.

Figure 2.6: Labor force participation rate of women by FRA status of spouse



Note: Labor force participation rates (LFP) of women by FRA status of their husband. Only married women with a spouse who is between two years before reaching FRA and two years after reaching FRA are considered. Disabled and unemployed individuals are not included. Data source: Own calculations based on SLFS data, FSO.

Estimation Results

In the graphical analysis, we controlled for age of the respondent, but not for other potential confounders. By estimating the probit model described in section 2.6.1, we can both control for potential confounders and increase precision of the estimate of interest. The results are presented in Table 2.3.
Besides controlling for age and age of the spouse, we also control for education, household size, whether the respondent is Swiss, GDP, and the unemployment rate. In the case of men, having a spouse at or above FRA has no effect on LFP. This finding is line with graphical results from Figure 2.5. By contrast, women react when their spouses reach FRA. On average, women whose spouses have reached FRA are 3.3 percentage points less likely to be in the labor force than women whose spouses have not yet reached FRA. Since there is variation in the FRA of women, we are also able to identify the effect of women reaching their own FRA.[25] Women who have reached their own FRA are 13.7

[25]If there was no variation in the FRA, reaching the own FRA would be multicollinear with the age

percentage points less likely to work compared to women who have not yet reached their own FRA. Therefore, the *direct* effect of -13.7 percentage points is approximately four times larger than the *indirect* effect of -3.3 percentage points. Our results are in line with Lalive and Parrotta (2017). Using census data for Switzerland, they find that reaching their own FRA reduces the LFP rate of women by approximately 12 percentage points. For the indirect effect, they find that women reduce their LPF rate by approximately 2 to 3 percentage points when their spouses reach FRA.

Table 2.3: Estimation extensive margin

	Dependent variable: Indicator $\mathbb{1}$(weekly working hours > 0)			
	Men		Women	
	APE	SE(APE)	APE	SE(APE)
Spouse FRA reached	0.013	(0.014)	-0.033^{***}	(0.013)
FRA reached			-0.137^{***}	(0.015)
Age dummies	Yes		Yes	
Age spouse	Yes		Yes	
Age spouse squared	Yes		Yes	
Education dummies	Yes		Yes	
Household size > 2	Yes		Yes	
Swiss citizenship	Yes		Yes	
Log GDP	Yes		Yes	
Unemployment rate	Yes		Yes	
Observations	14890		13916	

Note: Results Probit estimation. Average partial effects (APE) reported. Interviewed individuals and spouses are aged between 58 and 70. Disabled and unemployed individuals are not included. Standard errors are clustered at the individual level. $^{*}p < 0.1$. $^{**}p < 0.05$. $^{***}p < 0.01$.

We checked whether the effect of having a spouse at or above FRA varies with respect to education levels and the different full retirement ages of the women. We do not find significant heterogeneity.

2.7.2 Intensive margin

Graphical Evidence

We first illustrate the differences in working hours among respondents whose spouse is between two years before and two years after FRA. For respondents with at least two consecutive observations in which they were working, Figure 2.7 plots the average change in working hours for different distances to their own FRA. Negative years to own FRA

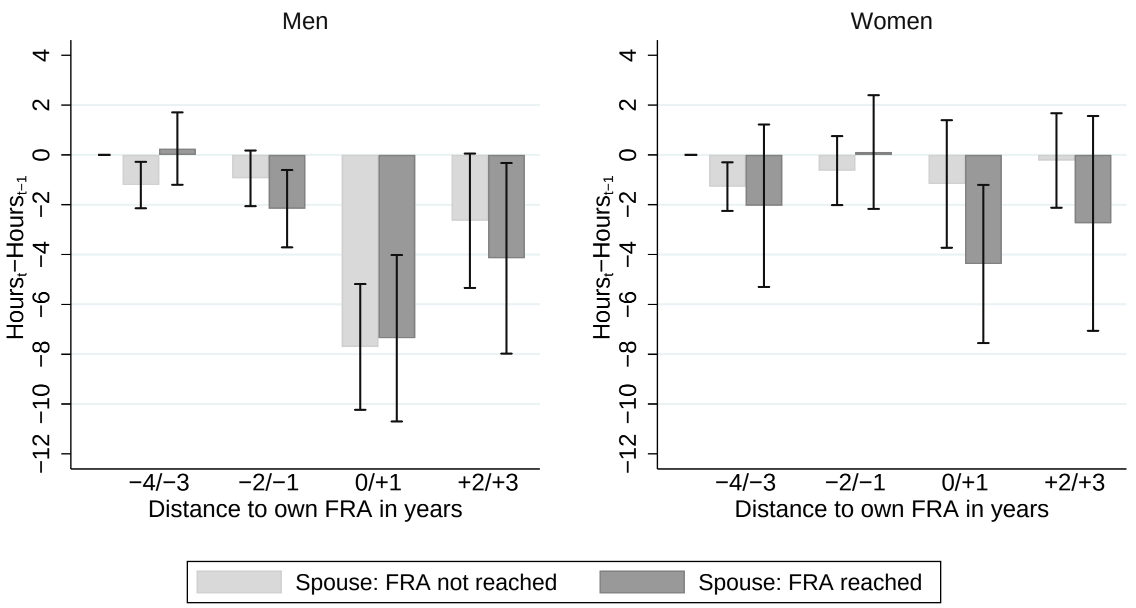
dummies.

indicate that the respondent has not yet reached FRA; zero or positive years to own FRA indicate that the respondent has reached FRA. The left panel plots the change in hours for men, the right panel the change for women. Again, the light-grey bars on the left indicate the change in hours for respondents whose spouse has not yet reached FRA; the dark-grey bars on the right indicate the change in hours for respondents whose spouse has reached FRA. We combine two years into one bin to increase precision of the mean estimate. No pattern is observable for either men or women between respondents whose spouse has reached FRA and respondents whose spouse has not yet reached FRA.

Estimation results

The results are presented in Table 2.4. We do not find evidence that men or women adjust their working hours when their spouses reach FRA. The estimated causal effects are negative, but not significantly different from zero. We cannot rule out that there is an effect, but if there is, the effect is likely to be small in magnitude. In combination with the graphical evidence presented in Figure 2.7, we find that the intensive margin is a margin at which workers adjust their labor supply, but there is no evidence of spillover effects within a couple.

Figure 2.7: Change in weekly working hours by FRA status of the spouse



Note: Change in weekly working hours between time $t-1$ and t. Spouse between two years before reaching FRA and two years after reaching FRA. Disabled and unemployed individuals are not included. Data source: Own calculations based on SLFS data, FSO.

Table 2.4: Estimation intensive margin

	Dependent variable: Δ(weekly working hours)			
	Men		Women	
	Coef.	SE(Coef.)	Coef.	SE(Coef.)
Spouse FRA reached	-0.796	(0.698)	-1.176	(0.768)
FRA reached			-1.769	(1.177)
Age dummies	Yes		Yes	
Age spouse	Yes		Yes	
Age spouse squared	Yes		Yes	
Education dummies	No		No	
Household size > 2	Yes		Yes	
Swiss citizenship	No		No	
Log GDP	Yes		Yes	
Unemployment rate	Yes		Yes	
Observations	3995		2993	

Note: Results difference-in-difference estimation on positive hours. Interviewed individuals and spouses are aged between 58 and 70. Disabled and unemployed individuals are not included. Standard errors are clustered at the individual level. $^{*}p < 0.1$. $^{**}p < 0.05$. $^{***}p < 0.01$.

2.7.3 Robustness

Extensive Margin

Our results are not sensitive with respect to the definition of labor supply. Instead of using contracted working hours as the dependent variable, we use actual working hours of the previous week as an alternative measure for labor supply. The estimation results are presented in Table 2.7 in Appendix 2.D. The results are very similar in both sign and magnitude. We find no evidence that men adjust their labor force participation rate when their wives reach FRA. The LFP of women is 2.6 percentage points lower when their spouse has reached FRA. Differences between having positive contracted working hours and having positive working hours in the previous week arise for example when a respondent was sick or on holidays in the previous week. Hence there are natural situations in which contracted working hours are positive and actual working hours in the previous week are zero. Vice versa, a situation where actual working hours in the previous week are positive and contracted working hours are zero is unlikely. Overall, this means that actual working hours in the previous week contains more zeros than contracted working hours. This explains why the treatment magnitude is slightly smaller when using actual working hours in the previous week.

As discussed in section 2.6, we control for the age of the spouse with a linear and a quadratic term in the main specification. In a robustness check, we test whether the results are robust to this specification. We exclude the age of the spouse as a control variable, but restrict the age of the spouse to be between two years before and two years after reaching FRA. The results are presented in Table 2.9, Appendix 2.D. For men, the effect of the spouse reaching FRA is, once again, small and not significant. For women, the effect is -4.4 percentage points and significant.

We further examine whether the inclusion of the years during which the financial crisis took place changes the results in any way. Therefore, we rerun the analysis for the limited dataset including only the interviews from 1991 to 2006. The results remain very similar to the main dataset (1991 to 2009).

In the spirit of treatment effect analysis, we examine the results of two placebo treatments. The original treatment variable equals 1 if the spouse has reached FRA, and 0 if not. The first placebo treatment variable equals 1 if the spouse is older than FRA minus two years (63 for men, 60/61/62 for women), the second placebo treatment variable equals 1 if the spouse is older than FRA plus two years (67 for men, 64/65/66 for women). Table 2.11 in Appendix 2.E presents the results of the placebo analysis. We find no significant placebo treatment effect.

Intensive Margin

At the intensive margin, the results are again not sensitive with respect to the definition of the dependent variable. Instead of using contracted working hours, we used actual working hours of the previous week. The results are set out on Table 2.8 in Appendix 2.D. The estimated causal effect is negative but not significant for both men and women. As for the extensive margin, the results remain unchanged if we restrict the age of the spouse (Table 2.10 in Appendix 2.D) or if we limit the time period to 1991 to 2006. Furthermore, we conduct the same placebo treatment analysis as we did at the extensive margin. The results are presented in Table 2.12 in Appendix 2.E. In case of both placebo treatments, having a spouse who has reached FRA has no significant effect on working hours.

2.8 Discussion

General

As indicated in Table 2.1, the sign of the expected labor supply reaction of individual A to spouse B reaching FRA depends on whether B reduces labor supply. In our estimation sample, approximately 33% of men and 22% of women reduce their labor supply by 8 or more hours when reaching FRA. Of those who do not reduce their labor supply, approximately 76% of men and 67% of women are already retired, while 24% of men and 33% of women are still working.

In the case of women, we observe a negative labor supply reaction. If the effect is driven primarily by women whose husbands reduce labor supply at FRA, complementarities in leisure must be sufficiently large to outweigh liquidity, joint taxation, and housework effects. The negative labor supply reaction, however, can also be explained by liquidity and joint taxation effects of women whose husbands do not reduce labor supply at FRA. In the case of men, we do not find evidence of a labor supply reaction. This does not rule out that men have preferences for joint leisure time, since liquidity, joint taxation, and housework effects possibly outweigh complementarity in leisure effects.

Difference between Men and Women

There is heterogeneity in complementarity in leisure, liquidity, joint taxation and housework effects, which may explain part of the asymmetric reaction of men and women. The change in labor supply of men reducing their workload when reaching their *own FRA* is larger than the reaction of women. Considering only individuals who adjust labor supply at FRA, we find that men reduce weekly working hours on average by 33 hours (extensive and intensive reaction combined) whereas women decrease their weekly working hours by 23 when reaching their *own FRA*. This difference can explain part of the asymmetry in the indirect effect since, cet. par., the complementarity effect is stronger the larger the labor supply reaction of the spouse.

The *liquidity* and *joint taxation* effect depend on the labor supply reaction of the spouse. We consider first the case where spouse B reduces labor supply at own FRA. In the analysis above, we found that men react more strongly to their own FRA. Assuming men and women achieve the same replacement rate, the drop in household income is larger when the husband reaches his FRA. Therefore, tax and liquidity effects are positive and larger for women than for men. For this reason, tax and liquidity effects partially offset the asymmetry stemming from differences in complementarity in leisure effects. In the case where spouse B does not reduce labor supply at own FRA, we do not find evidence for asymmetries with respect to *liquidity* and *joint taxation effects*. On the basis of questions on early retirement in the SLFS, we find that only 0.93% of men and 0.85% of women answered that taxes were the main determinant of their early retirement decision. These results suggest that tax considerations are only of secondary importance when deciding when to retire.

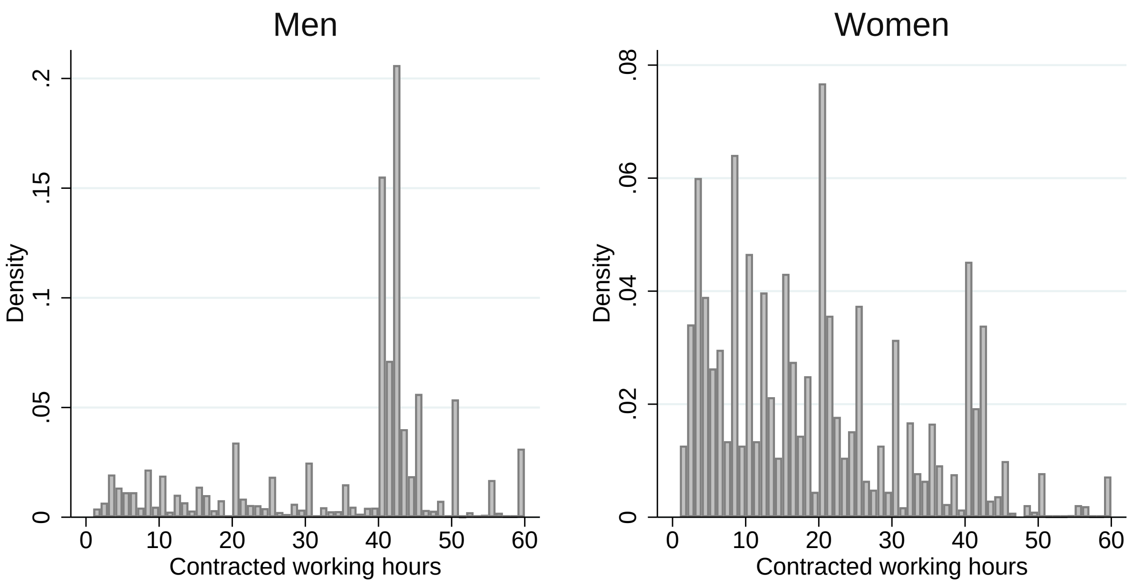
Changes in relation to housework upon retirement are similar for men and women. On the basis of questions on housework in the SLFS, we find that men increase the amount of housework they do by approximately 40 minutes a day, whereas this increase is approximately 60 minutes in the case of women.

To sum up, our analysis provides evidence that *complementarity in leisure effects* are an important mechanism for the indirect effect. *Liquidity effects* can play a role when reacting to the spouse reaching FRA. Finally, we cannot exclude the possibility that the asymmetric reaction is driven by gender differences in relation to preferences. Extensive/ Intensive Margin Channel

Margin of Reaction

We would like to point out several potential explanations for our finding that women react at the extensive, but not at the intensive margin. First, women may want to reduce their working hours, but are prevented from doing so by hours constraints set by firms. We examine this mechanism by analyzing desired working hours. We run the same difference-in-difference estimator on positive hours, but instead of contracted working hours as dependent variable, we use desired hours. The results are presented in Table 2.6 in Appendix 2.B. We do not find evidence that women would like to reduce their working hours in response to their husbands reaching FRA.

Figure 2.8: Distribution of weekly working hours of men and women



Note: Distribution of weekly working hours of married men and women aged 58-70. Only respondents who work between 1 and 60 hours per week are included. Own calculations based on SLFS.

Second, social norms in relation to working hours may discourage women from adjusting their working hours when their husbands reach FRA. The distribution of weekly working hours for men and women is presented in Figure 2.8. Graphical evidence suggests that social norms are less pronounced for women than for men. Third, *fixed costs of work* imply that individuals are not willing to work below a minimum number of hours. A large proportion of women work 21 hours per week or less, see Figure 2.8. This group is likely to react at the extensive margin as a result of the presence of fixed costs of work. Fourth, *complementarities in leisure* may be discontinuous at zero working hours. For example, it may be necessary for both partners to be out of the labor force if they want to change residence for retirement, or travel for an extended period.

2.9 Conclusion

In this chapter, we estimate labor supply responses to the spouse reaching FRA. We find that the LFP rates of women drop by approximately 3 percentage points when the their spouses reach FRA. By contrast, the LFP rates of men do not respond to their spouses reaching FRA. At the intensive margin, we find only small and non-significant effects for both men and women, although older workers use working hours to adjust their labor supply.

We identify four different mechanisms that could explain the effect on labor supply of having a spouse at or above FRA: complementarities in leisure, joint taxation, liquidity, and housework effects. Since we find a negative indirect effect for women, we argue that complementarities in leisure and liquidity effects are important mechanisms for the indirect effect. We explain the absence of an intensive margin reaction in the case of women on the basis of the presence of fixed costs of work.

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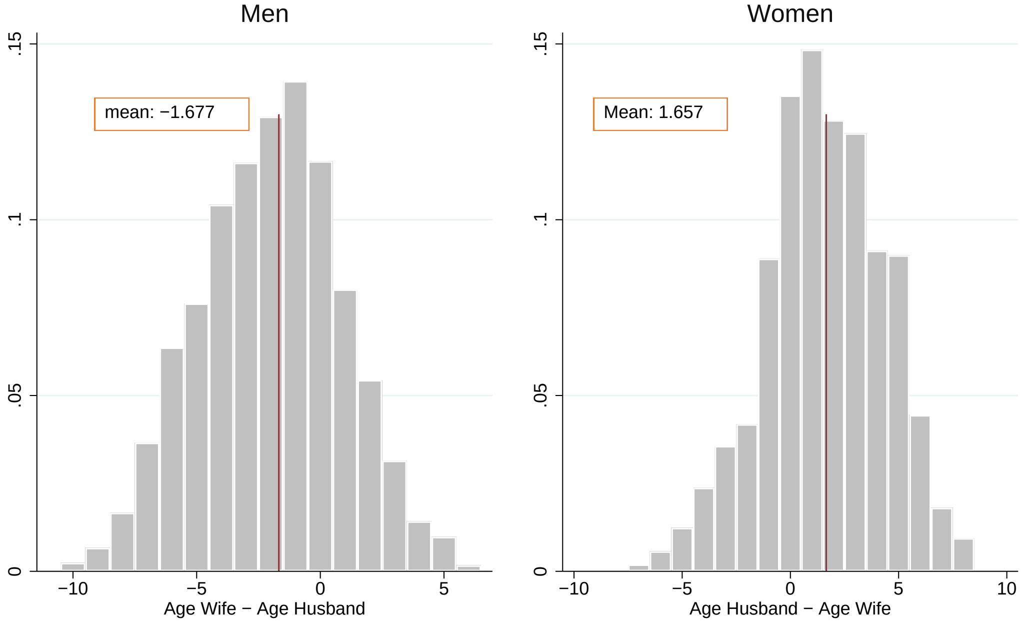
Appendix 2.A Identification

Figure 2.9: Identifying variation in age difference within couples



Note: Data source: Own calculations based on SLFS data, FSO.

Table 2.5: Estimation intensive margin $t-1$

	Dependent variable: Δ(weekly working hours, t-1)			
	Men		Women	
	Coef.	SE(Coef.)	Coef.	SE(Coef.)
Spouse FRA reached	−0.670	(0.945)	0.338	(0.801)
FRA reached	No		Yes	
Age dummies	Yes		Yes	
Education dummies	No		No	
Household size > 2	Yes		Yes	
Swiss citizenship	No		No	
Log GDP	Yes		Yes	
Unemployment rate	Yes		Yes	
Observations	2367		1751	

Note: Results difference-in-difference estimation on positive hours in period t-1. Interviewed individuals and spouses are aged between 58 and 70. Disabled and unemployed individuals are not included. Standard errors are clustered at the individual level. $^{*}p < 0.1$. $^{**}p < 0.05$. $^{***}p < 0.01$.

Appendix 2.B Discussion

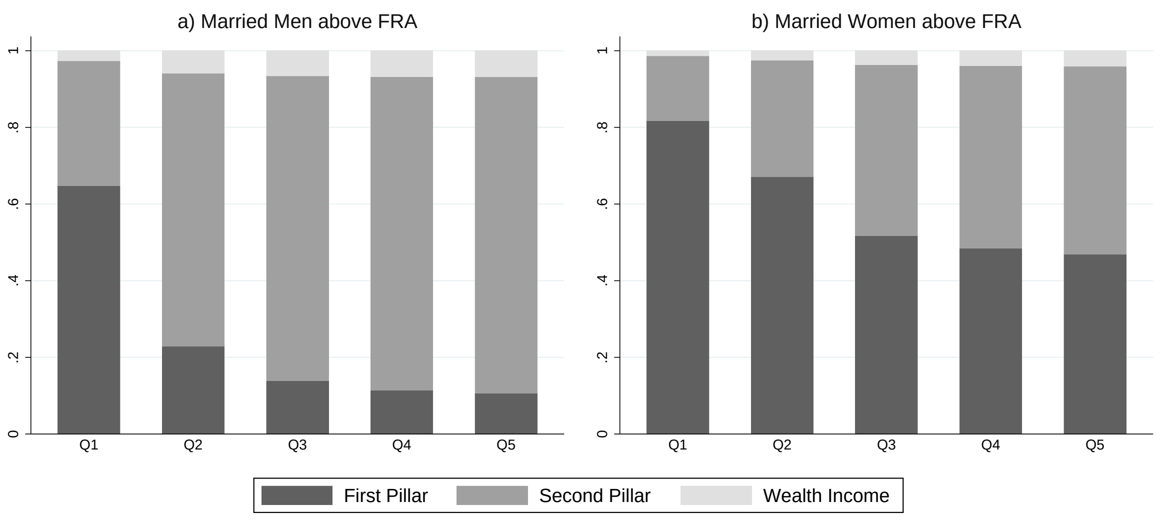
Table 2.6: Estimation desired intensive margin

	Dependent variable: Δ(desired weekly hours)			
	Men		Women	
	Coef.	SE(Coef.)	Coef.	SE(Coef.)
Spouse FRA reached	-0.209	(0.950)	0.369	(0.552)
FRA reached	No		Yes	
Age dummies	Yes		Yes	
Age spouse	Yes		Yes	
Age spouse squared	Yes		Yes	
Education dummies	No		No	
Household size > 2	Yes		Yes	
Swiss citizenship	No		No	
Log GDP	Yes		Yes	
Unemployment rate	Yes		Yes	
Observations	988		2176	

Note: Results difference-in-difference estimation on desired hours. Interviewed individuals and spouses are aged between 58 and 70. Disabled and unemployed individuals are not included. Standard errors are clustered at the individual level. $^{*}p < 0.1$. $^{**}p < 0.05$. $^{***}p < 0.01$.

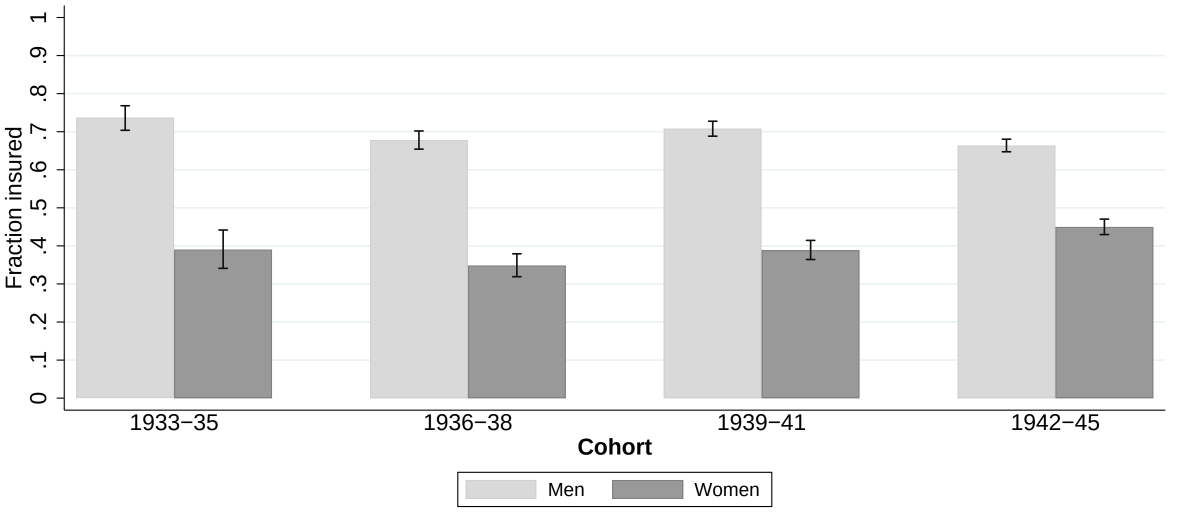
Appendix 2.C Institutional background

Figure 2.10: Sources of income after reaching FRA by household income quintile



Note: Fraction of income from different sources after reaching FRA by gender and household income quintile. Q1 represents the lowest income quintile, Q5 the highest quintile. Labor income is not considered. Data source: Own calculations based on special module on social security in Swiss Labor Force Survey (SLFS).

Figure 2.11: Fraction of individuals insured in the 2nd pillar



Note: Fraction of individuals insured in 2nd pillar by gender and cohort. Data source: Own calculations based on special module on social security in Swiss Labor Force Survey (SLFS).

Appendix 2.D Sensitivity analysis

2.D.1 Alternative dependent variable: Hours worked last week

Table 2.7: Estimation extensive margin hours worked last week

	Dependent variable: Indicator $\mathbb{1}$(hours worked last week > 0)			
	Men		Women	
	APE	SE(APE)	APE	SE(APE)
Spouse FRA reached	0.015	(0.014)	−0.026**	(0.013)
FRA reached			−0.122***	(0.016)
Age dummies	Yes		Yes	
Age spouse	Yes		Yes	
Age spouse squared	Yes		Yes	
Education dummies	Yes		Yes	
Household size > 2	Yes		Yes	
Swiss citizenship	Yes		Yes	
Log GDP	Yes		Yes	
Unemployment rate	Yes		Yes	
Observations	14890		13916	

Note: Results Probit estimation. Average partial effects (APE) reported. Interviewed individuals and spouses are aged between 58 and 70. Disabled and unemployed individuals are not included. Standard errors are clustered at the individual level. $^{*}p < 0.1$. $^{**}p < 0.05$. $^{***}p < 0.01$.

Table 2.8: Estimation intensive margin hours worked last week

	Dependent variable: Δ(hours worked last week)			
	Men		Women	
	Coef.	SE(Coef.)	Coef.	SE(Coef.)
Spouse FRA reached	-0.671	(0.727)	-1.304	(1.018)
FRA reached			-2.516^{*}	(1.293)
Age dummies	Yes		Yes	
Age spouse	Yes		Yes	
Age spouse squared	Yes		Yes	
Education dummies	No		No	
Household size > 2	Yes		Yes	
Swiss citizenship	No		No	
Log GDP	Yes		Yes	
Unemployment rate	Yes		Yes	
Observations	3193		2231	

Note: Results difference-in-difference estimation on positive hours. Interviewed individuals and spouses are aged between 58 and 70. Disabled and unemployed individuals are not included. Standard errors are clustered at the individual level. $^{*}p < 0.1$. $^{**}p < 0.05$. $^{***}p < 0.01$.

2.D.2 Restricting the age of the spouse

Table 2.9: Estimation extensive margin

	Dependent variable: Indicator $\mathbb{1}$(weekly working hours > 0)			
	Men		Women	
	APE	SE(APE)	APE	SE(APE)
Spouse FRA reached	0.005	(0.013)	-0.044^{***}	(0.012)
FRA reached			-0.169^{***}	(0.025)
Age dummies	Yes		Yes	
Age spouse	No		No	
Age spouse squared	No		No	
Education dummies	Yes		Yes	
Household size > 2	Yes		Yes	
Swiss citizenship	Yes		Yes	
Log GDP	Yes		Yes	
Unemployment rate	Yes		Yes	
Observations	4887		5190	

Note: Results Probit estimation. Average partial effects (APE) reported. Interviewed individuals are aged between 58 and 70. Spouse of the interviewed person aged between 2 years prior and 2 years after reaching FRA. Disabled and unemployed individuals are not included. Standard errors are clustered at the individual level. $^{*}p < 0.1$. $^{**}p < 0.05$. $^{***}p < 0.01$.

Table 2.10: Estimation intensive margin

	Dependent variable: Δ(weekly working hours)			
	Men		Women	
	Coef.	SE(Coef.)	Coef.	SE(Coef.)
Spouse FRA reached	-0.580	(0.807)	-0.945	(0.867)
FRA reached			-2.616	(1.770)
Age dummies	Yes		Yes	
Age spouse	No		No	
Age spouse squared	No		No	
Education dummies	No		No	
Household size > 2	Yes		Yes	
Swiss citizenship	No		No	
Log GDP	Yes		Yes	
Unemployment rate	Yes		Yes	
Observations	1326		1150	

Note: Results difference-in-difference estimation on positive hours. Interviewed individuals are aged between 58 and 70. Spouse of the interviewed person aged between 2 years prior and 2 years after reaching FRA. Disabled and unemployed individuals are not included. Standard errors are clustered at the individual level. $^{*}p < 0.1$. $^{**}p < 0.05$. $^{***}p < 0.01$.

Appendix 2.E Placebo tests

Table 2.11: Estimation extensive margin placebo test

	Dependent variable: $\mathbb{1}$(weekly work. h. > 0)			
	Men APE	Women APE	Men APE	Women APE
Placebo Spouse FRA-2years reached	0.022 (0.015)	0.002 (0.015)		
Placebo Spouse FRA+2years reached			-0.014 (0.016)	0.000 (0.014)
Age dummies	Yes	Yes	Yes	Yes
Age spouse	Yes	Yes	Yes	Yes
Age spouse squared	Yes	Yes	Yes	Yes
Education dummies	Yes	Yes	Yes	Yes
Household size > 2	Yes	Yes	Yes	Yes
Swiss citizenship	Yes	Yes	Yes	Yes
Log GDP	Yes	Yes	Yes	Yes
Unemployment rate	Yes	Yes	Yes	Yes
Observations	14890	13916	14890	13916

Note: Results Probit estimation. Average partial effects (APE) reported. Interviewed individuals and spouses are aged between 58 and 70. Disabled and unemployed individuals are not included. Standard errors are clustered at the individual level. $^{*}p < 0.1$. $^{**}p < 0.05$. $^{***}p < 0.01$.

Table 2.12: Estimation intensive margin placebo test

	Dependent variable: Δ(weekly working hours)			
	Men Coef.	Women Coef.	Men Coef.	Women Coef.
Placebo Spouse FRA-2years reached	0.301 (0.506)	-0.337 (0.595)		
Placebo Spouse FRA+2years reached			0.841 (0.863)	0.076 (0.765)
Age dummies	Yes	Yes	Yes	Yes
Age spouse	Yes	Yes	Yes	Yes
Age spouse squared	Yes	Yes	Yes	Yes
Education dummies	No	No	No	No
Household size > 2	Yes	Yes	Yes	Yes
Swiss citizenship	No	No	No	No
Log GDP	Yes	Yes	Yes	Yes
Unemployment rate	Yes	Yes	Yes	Yes
Observations	3995	2993	3995	2993

Note: Results difference-in-difference estimation on positive hours. Interviewed individuals and spouses are aged between 58 and 70. Disabled and unemployed individuals are not included. Standard errors are clustered at the individual level. $^{*}p < 0.1$. $^{**}p < 0.05$. $^{***}p < 0.01$.

Chapter 3

Identification and Estimation of Causal Intensive Margin Effects by Difference-in-Difference Methods[1]

3.1 Introduction

In many cases, a decomposition of a binary treatment (e.g. policy intervention) into extensive and intensive margin effects is of special interest when studying economic outcomes with a corner solution at zero.[2] Economic outcomes with corner solutions include health expenditures, working hours, or trade volumes. The average effect of a treatment on a non-negative outcome can be decomposed into 1) the average change in the outcome of those with a positive outcome irrespective of treatment (always-takers or participants), plus 2) the average outcome of those with a positive outcome in the case of treatment, and a zero outcome in the case of no treatment, minus 3) the average outcome of those with a zero outcome in the case of treatment, and a positive outcome in the case of no treatment (Staub, 2014; Lee, 2012, 2017). Part 1) represents the weighted *causal intensive margin effect.* The sum of 2) and 3) captures the weighted *causal extensive margin effect.* The weights are given by the relative size of the group in the population.

Even if treatment is randomly assigned, a mean comparison of treatment and control groups with positive outcomes does not identify the causal intensive margin effect without additional assumptions (Angrist, 2001). This can be illustrated by the following example. Assume we have data from an experiment in which the outcome of interest is

[1]This chapter is joint work with Elias Moor and was published as "Identification of Causal Intensive Margin Effects by Difference-in-Difference Methods", *CER ETH Working Paper Series, 11/2018*, see Hersche and Moor (2018).

[2]Corner solutions at alternative thresholds are possible as well. For simplicity and illustration, we consider the case where the threshold is at zero.

health expenditure. A randomly assigned treatment group receives an insurance contract with a low co-payment rate, a control group receives a contract with a high co-payment rate. Suppose we are interested in the treatment effect of those having positive health expenditures irrespective of whether they face a high or a low co-payment rate *(intensive margin effect)*. The sample of individuals with positive health expenditures consists of two groups: 1) the group of individuals with positive health expenditures irrespective of whether they face a high or a low co-payment rate, and 2) the group of individuals with positive health expenditures only because they face a low co-payment rate, and would have zero health expenditures in case they face a high co-payment rate. For the causal intensive margin effect, we are interested in the first group only. Group membership, however, is not observed in the data, since we only observe either the outcome in case of treatment or the outcome in case of no treatment. Unobserved characteristics of the two groups are likely to be different. On average, individuals in the second group are likely to be in better health than individuals in the first group, since they exhibit zero health expenditure when facing the high co-payment rate. Therefore, the health expenditure in the first group is higher than the health expenditure in the second group. Since the two groups are potentially different, mean comparison conditioning on positive outcomes does not have a causal interpretation due to a potential selection bias, even if treatment is randomly assigned.

The literature on policy evaluation has developed well established methods to deal with selection problems. The list of methods includes difference-in-difference, instrumental variable, regression discontinuity, control function approaches, and matching. For this reason, it appears appropriate to use these methods to overcome the potential selection bias and estimate the causal intensive margin effect.

In this chapter, we discuss difference-in-difference (DiD) methods[3] to estimate the causal intensive margin effect. In contrast to standard DiD estimators, we condition on the sample of individuals with positive outcomes. We derive sufficient conditions under which the causal intensive margin effect is identified.

In addition to studying the total effect, a decomposition into extensive and intensive margin effects can provide valuable information for policy design. Take as an example the effect of the introduction of partial retirement policy. Suppose that in the status quo, individuals have to withdraw the full pension at a given age, but are allowed to continue working. Under the partial retirement policy, individuals have the choice between a partial and a full pension, and are allowed to continue working. The total effect on labor supply of such a policy may be zero or negative, suggesting that the policy has been

[3] In what follows, we consider the term DiD to include both difference and difference-in-difference methods.

ineffective.[4] The zero result, however, could be explained by a positive extensive margin effect that was offset by a negative intensive margin effect. Older workers who would have retired in the absence of a partial retirement policy, now decide to stay in the labor market. At the same time, individuals who would have worked full-time in the absence of a partial retirement policy, decide to work part time. The welfare effect of such a policy may be positive through retained human capital, although the total effect on labor supply is small.

This chapter is related to the literature on models for non-negative outcomes with a mass point at zero. This includes Tobit models (Tobin, 1958; McDonald & Moffitt, 1980), two-part models (Cragg, 1971; Duan, Manning, Morris, & Newhouse, 1983), and selection models (Heckman, 1979). Moreover, the chapter is closely related to the literature employing *principal stratification* following (Frangakis & Rubin, 2002) to study causal extensive and intensive margin treatment effects for variables with nonnegative outcomes (Staub, 2014; Lee, 2012, 2017). This literature decomposes the average treatment effect into a population-weighted sum of treatment effects on participants and switchers.[5] Studying outcomes with a corner solution at zero, (Staub, 2014) derives nonparametric bounds for the treatment effects on participants and switchers. He further discusses point identification of causal intensive and extensive margin effects in censored regression, selection, and two-part models. Lee (2012, 2017) analyzes total, extensive, and intensive margin effects in general sample selection models, with the corner solution outcome as a special case. Lee (2012) analyzes nonparametric methods to estimate extensive and intensive margin effects, whereas Lee (2017) discusses point identification of intensive and extensive margin effects in semiparametric linear models.

This chapter is connected to the literature on policy evaluation in the potential outcomes framework. See Angrist and Pischke (2009) for a summary. In particular, we apply difference-in-difference methods to identify the causal intensive margin effect. See Lechner (2010) for a survey on difference-in-difference methods from a potential outcomes perspective. The difference-in-difference estimator presented in this chapter relies on a common trend assumption similar to the common trend assumption of standard difference-in-difference estimators. In contrast to standard difference-in-difference methods, monotonicity assumptions are additionally required to identify the causal intensive margin effect.

The main contribution of this chapter is to extend the literature on identification of

[4]See e.g. Börsch-Supan, Bucher-Koenen, Kutlu-Koc, and Goll (2018) for evidence on the effect of partial retirement policies on labor supply in eleven OECD countries.

[5]Switchers (compliers and defiers) represent individuals with a positive outcome in the case of treatment and a zero outcome in the case of no treatment, as well as individuals with a zero outcome in the case of treatment and a positive outcome in the case of no treatment.

intensive margin effects by borrowing well established difference-in-difference methods from the policy evaluation literature. The difference-in-difference estimator on positive outcomes represents an alternative to estimate intensive margin effect when pretreatment information is available. Moreover, this chapter discusses sufficient conditions under which a mean comparison conditional on a positive outcome (treatment-versus-control estimator on positive outcomes) identifies the causal intensive margin effect. A mean comparison is often applied in two-part models to estimate the intensive margin effect. Therefore, this chapter clarifies in which cases estimates of two-step estimators possess a causal interpretation.

The remainder of the chapter is organized as follows. In section 3.2, we describe how the intensive margin effect is embedded in the causal decomposition based on potential outcomes. Identification and estimation of the causal intensive margin effect is described in section 3.3. In section 3.4, we discuss how the identifying assumptions can be verified. The last section concludes.

3.2 Causal decomposition of a treatment effect

3.2.1 Notation and setup

We consider the standard potential outcomes framework with a non-negative outcome Y and a *random* binary treatment D (Rubin, 1974). Each individual i is endowed with two potential outcomes. The potential outcome in case of treatment ($D_i = 1$) is denoted by Y_i^1, the potential outcome in case of no treatment ($D_i = 0$) is represented by Y_i^0. We observe only one of the two potential outcomes. We observe individuals in the pre-treatment period $t-1$, and in the post-treatment period t, i.e. $Y_{i,t}$ and $Y_{i,t-1}$. A randomly assigned binary treatment D_i takes place between period $t-1$ and period t. Potential outcomes of individual i are denoted with superscript, i.e.

a) $Y_{i,t}^1$: Potential outcome in period t in case of treatment.

b) $Y_{i,t-1}^1$: Potential outcome in period $t-1$ in case of treatment.

c) $Y_{i,t}^0$: Potential outcome in period t in case of no treatment.

d) $Y_{i,t-1}^0$: Potential outcome in period $t-1$ in case of no treatment.

Observed outcomes are denoted without superscript, i.e. $Y_{i,t}$ and $Y_{i,t-1}$. As an implication of random treatment assignment, treatment is independent of potential outcomes.[6]

[6]More precisely, treatment is independent of the joint distribution of $(Y_{i,t}^1, Y_{i,t-1}^1, Y_{i,t}^0, Y_{i,t-1}^0)$. It follows, for example, that $E(Y_{i,t}^1|Y_{i,t}^1 > 0, D_i = 1) = E(Y_{i,t}^1|Y_{i,t}^1 > 0, D_i = 0) = E(Y_{i,t}^1|Y_{i,t}^1 > 0)$.

3.2.2 Decomposition

We define four exhaustive and mutually exclusive subgroups based on the joint distribution of potential outcomes in period t following Lee (2012) and Staub (2014):

Table 3.1: Decomposition based on joint distribution of potential outcomes

	$Y_{i,t}^0 = 0$	$Y_{i,t}^0 > 0$
$Y_{i,t}^1 = 0$	Nonparticipants (NP)	Switchers 2 (S2)
$Y_{i,t}^1 > 0$	Switchers 1 (S1)	Participants (P)

Based on this definition, we decompose the average treatment effect (ATE) at time t as follows

$$ATE_t = E(Y_{i,t}^1 - Y_{i,t}^0) \tag{3.1}$$

$$= E(Y_{i,t}^1 | Y_{i,t}^1 > 0, Y_{i,t}^0 = 0) P(Y_{i,t}^1 > 0, Y_{i,t}^0 = 0) \tag{3.2}$$

$$+ E(-Y_{i,t}^0 | Y_{i,t}^1 = 0, Y_{i,t}^0 > 0) P(Y_{i,t}^1 = 0, Y_{i,t}^0 > 0) \tag{3.3}$$

$$+ E(Y_{i,t}^1 - Y_{i,t}^0 | Y_{i,t}^1 > 0, Y_{i,t}^0 > 0) P(Y_{i,t}^1 > 0, Y_{i,t}^0 > 0) \tag{3.4}$$

The terms in lines (3.2) and (3.3) represent the weighted extensive margin effect. Line (3.2) describes the effect of treatment on the outcome of individuals with positive outcome in case of treatment and zero outcome in case of no treatment (switchers 1), weighted by the fraction of switchers 1. Line (3.3) describes the effect of treatment on the outcome of individuals with zero outcome in case of treatment and positive outcome in case of no treatment (switchers 2), weighted by the fraction of switchers 2. The contribution of individuals with zero outcome in case of treatment and in case of no treatment (nonparticipants), is zero and therefore dropped.
The term in line (3.4) represents the weighted intensive margin effect. It captures the effect of treatment on the outcome of individuals having a positive outcome irrespective of treatment status (participants), weighted by the fraction of participants.

3.3 Identification

We are interested in the causal intensive margin effect

$$\gamma_t \equiv E(Y_{i,t}^1 - Y_{i,t}^0 | Y_{i,t}^1 > 0, Y_{i,t}^0 > 0). \tag{3.5}$$

We derive sufficient conditions under which the causal intensive margin effect is identified in difference-in-difference methods on positive outcomes. Analogous to the standard difference-in-difference literature, we discuss the treatment-versus-control, the pre-versus-post, and the difference-in-difference estimator.

3.3.1 Treatment-versus-control estimator on positive outcomes

The *treatment-versus-control estimator on positive outcomes* is given by the difference in conditional expectation of treated and untreated individuals with positive outcomes

$$\gamma_t^{TC} = E(Y_{i,t}|Y_{i,t} > 0, D_i = 1) - E(Y_{i,t}|Y_{i,t} > 0, D_i = 0). \tag{3.6}$$

Proposition 5 (Identification treatment-vs-control estimator on pos. outcomes) *Sufficient conditions to identify the causal intensive margin effect using the treatment-versus-control estimator on positive outcomes are*

1. *SUTVA (assumption 1), and*
2. *no switchers (assumption 2).*

or

1. *SUTVA (assumption 1), and*
2. *conditional mean independence (assumption 3).*

Assumption 1 (SUTVA) *The stable unit treatment value assumption is given by*

$$Y_{i,t} = (1 - D_i)Y_{i,t}^0 + D_i Y_{i,t}^1 \quad \textit{and} \quad Y_{i,t-1} = (1 - D_i)Y_{i,t-1}^0 + D_i Y_{i,t-1}^1 \quad \forall i,$$

where $D_i \in \{0, 1\}$ denotes treatment status.

The *SUTVA* ensures that we actually observe the potential outcomes in treatment and control group. In case individual i is treated, we observe $Y_{i,t} = Y_{i,t}^1$ and $Y_{i,t-1} = Y_{i,t-1}^1$. In case individual i is not treated, we observe $Y_{i,t} = Y_{i,t}^0$ and $Y_{i,t-1} = Y_{i,t-1}^0$. *SUTVA* implies that the observed outcome of individual i only depends on the potential outcomes and the treatment status D_i, but not on the treatment status D_j of any other individual. Hence, *SUTVA* excludes general equilibrium effects and spill-over effects.

Assumption 2 (No switchers) *The assumption of no switchers is given by*

$$Y_{i,t}^1 > 0 \quad \Leftrightarrow \quad Y_{i,t}^0 > 0 \quad \forall i.$$

The assumption of *no switchers* states that the potential outcome in case of treatment is positive if and only if the potential outcome in case of no treatment is positive. It therefore excludes the possibility that individuals have a positive outcome in case of treatment and a zero outcome in case of no treatment (switchers 1), or vice versa (switchers 2).

Assumption 3 (Conditional mean independence) *The assumption on conditional mean independence is given by*

$$E(Y^1_{i,t}|Y^0_{i,t}=0,Y^1_{i,t}>0)=E(Y^1_{i,t}|Y^0_{i,t}>0,Y^1_{i,t}>0),\ and$$
$$E(Y^0_{i,t}|Y^0_{i,t}>0,Y^1_{i,t}=0)=E(Y^0_{i,t}|Y^0_{i,t}>0,Y^1_{i,t}>0).$$

The assumption states that the expected potential outcome of switchers 1 is equal to the expected potential outcome of participants in case of treatment. And the expected potential outcome of switchers 2 is equal to the expected potential outcome of participants in case of no treatment.

Proof Under *SUTVA* and *random treatment*, and by the law of iterated expectations, equation (3.6) can be rewritten as

$$\begin{aligned}\gamma_t^{TC} &= \left[pE(Y^1_{i,t}|Y^0_{i,t}>0,Y^1_{i,t}>0)+(1-p)E(Y^1_{i,t}|Y^0_{i,t}=0,Y^1_{i,t}>0)\right]\\ &-\left[qE(Y^0_{i,t}|Y^0_{i,t}>0,Y^1_{i,t}>0)+(1-q)E(Y^0_{i,t}|Y^0_{i,t}>0,Y^1_{i,t}=0)\right],\end{aligned}$$

where $p \equiv Pr(Y^0_{i,t}>0|Y^1_{i,t}>0)$ and $q \equiv Pr(Y^1_{i,t}>0|Y^0_{i,t}>0)$. This term is equal to the causal intensive margin of interest in two cases. First, the term is equal to the causal intensive margin effect if $p=q=1$. This is equivalent to the *no switchers* assumption. Second, the causal intensive margin effect is identified if the expected potential outcome of switchers 1 is equal to the expected potential outcome of participants in case of treatment, and the expected potential outcome of switchers 2 is equal to the expected potential outcome of participants in case of no treatment (*conditional mean independence*). □

3.3.2 Pre-versus-post estimator on positive outcomes

The *pre-versus-post estimator on positive outcomes* is given by the difference in the conditional expectations between pre-treatment and post-treatment outcomes for treated individuals with positive outcomes

$$\gamma_t^{PP}=E(Y_{i,t}-Y_{i,t-1}|Y_{i,t-1}>0,Y_{i,t}>0,D_i=1) \tag{3.7}$$

Proposition 6 (Identification pre-versus-post estimator on positive outcomes)

Sufficient conditions to identify the causal intensive margin effect using the pre-versus-post estimator on positive outcomes are

1. *SUTVA (assumption 1), and*
2. *no anticipation (assumption 4), and*
3. *treatment monotonicity at the extensive margin (assumption 5), and*
4. *time monotonicity at the extensive margin (assumption 6), and*
5. *no time trend in positive outcomes (assumption 7).*

Assumption 4 (No anticipation) *The no anticipation assumption is given by*

$$E(Y^1_{i,t-1} - Y^0_{i,t-1}|Y^1_{i,t-1} > 0, Y^1_{i,t} > 0) = 0$$

The *no anticipation* assumption states that individuals with a positive outcome in both periods in case of treatment do not differ in their expected potential outcomes in period $t-1$. Hence, individuals do not change their behaviour in period $t-1$ in anticipation of their treatment between period $t-1$ and t.

Assumption 5 (Treatment monotonicity at extensive margin) *The treatment monotonicity at extensive margin assumption is given by*

$$Y^1_{i,t} > 0 \;\; \Rightarrow \;\; Y^0_{i,t} > 0 \quad or \quad Y^0_{i,t} > 0 \;\; \Rightarrow \;\; Y^1_{i,t} > 0 \quad \forall i.$$

This assumption states that a positive outcome in case of treatment implies a positive outcome in case of no treatment (or vice versa). Therefore, the treatment response is monotone with respect to the extensive margin decision. Note that thereby this assumption only restricts the sign of the extensive margin effect. Thus, given the potential outcome in case of treatment is positive, the potential outcome in case of treatment is allowed to be higher or lower than the potential outcome in case of no treatment. The assumption of *treatment monotonicity at extensive margin* is weaker than the *no switchers* assumption, because *treatment monotonicity at extensive margin* allows for one type of switchers (either switchers 1 or switchers 2).

Assumption 6 (Time monotonicity at extensive margin) *The time monotonicity at extensive margin assumption is given by*

$$\begin{aligned} Y_{i,t}^0 > 0 \quad &\Rightarrow \quad Y_{i,t-1}^0 > 0 \quad \forall i, \textit{ and} \\ Y_{i,t}^1 > 0 \quad &\Rightarrow \quad Y_{i,t-1}^1 > 0 \quad \forall i. \end{aligned}$$

This assumption states that a positive outcome in period t implies a positive outcome in period $t-1$, both in case of treatment and in case of no treatment. Hence, we assume that there are no individuals participating in period t, but not participating in period $t-1$. Like assumption 5, this assumption only restricts the sign of the extensive margin effect for every individual. Thus, given the potential outcome in period t is positive, the potential outcome in period $t-1$ is allowed to be higher or lower than the potential outcome in period t.

Assumption 7 (No time trend in positive outcomes) *The assumption of no time trend in positive outcomes is given by*

$$E(Y_{i,t}^0 - Y_{i,t-1}^0 | Y_{i,t-1}^1 > 0, Y_{i,t}^1 > 0) = 0$$

This assumption states that there is no time trend in the expected outcome of those with positive outcome in both periods in case of treatment if they had not been treated.

Proof Under *SUTVA* and *random treatment*, equation (3.7) can be rewritten as $E(Y_{i,t}^1 - Y_{i,t-1}^1 | Y_{i,t-1}^1 > 0, Y_{i,t}^1 > 0)$. By the *no anticipation* assumption, $E(Y_{i,t}^1 - Y_{i,t-1}^1 | Y_{i,t-1}^1 > 0, Y_{i,t}^1 > 0) = E(Y_{i,t}^1 - Y_{i,t-1}^0 | Y_{i,t-1}^1 > 0, Y_{i,t}^1 > 0)$. By the *no time trend in positive outcomes* assumption, $E(Y_{i,t}^1 - Y_{i,t-1}^0 | Y_{i,t-1}^1 > 0, Y_{i,t}^1 > 0) = E(Y_{i,t}^1 - Y_{i,t}^0 | Y_{i,t-1}^1 > 0, Y_{i,t}^1 > 0)$. Using *time* and *treatment monotonicity at the extensive margin*, $E(Y_{i,t}^1 - Y_{i,t}^0 | Y_{i,t-1}^1 > 0, Y_{i,t}^1 > 0) = E(Y_{i,t}^1 - Y_{i,t}^0 | Y_{i,t}^1 > 0, Y_{i,t}^0 > 0)$, which equals the causal effect of interest. □

3.3.3 Difference-in-difference estimator on positive outcomes

The *difference-in-difference estimator on positive outcomes* combines the aforementioned estimators and is given by the difference of differences

$$\gamma_{DiD} = E(Y_{i,t} - Y_{i,t-1} | Y_{i,t-1} > 0, Y_{i,t} > 0, D_i = 1) - E(Y_{i,t} - Y_{i,t-1} | Y_{i,t-1} > 0, Y_{i,t} > 0, D_i = 0) \tag{3.8}$$

Proposition 7 (Identification using DiD estimator on positive outcomes) *Sufficient conditions to identify the causal intensive margin effect using the difference-in-difference estimator on positive outcomes are*

1. SUTVA (assumption 1), and

2. no anticipation (assumption 4), and

3. treatment monotonicity at the extensive margin (assumption 5), and

4. time monotonicity at the extensive margin (assumption 6), and

5. common trend in positive outcomes (assumption 8).

Assumption 8 (Common trend in positive outcomes) *The common trend in positive outcomes assumption is given by*

$$E(Y_{i,t}^0 - Y_{i,t-1}^0 | Y_{i,t-1}^1 > 0, Y_{i,t}^1 > 0) = E(Y_{i,t}^0 - Y_{i,t-1}^0 | Y_{i,t-1}^0 > 0, Y_{i,t}^0 > 0).$$

The *common trend in positive outcomes* assumption represents the key assumption for identification. The *common trend in positive outcomes* assumption is closely related to the standard common trend assumption[7], except that we require the common trend to hold between two specific subgroups: the subgroup with a positive outcome in both periods in case of treatment, and the subgroup with a positive outcome in both periods in case of no treatment.

Graphical derivation

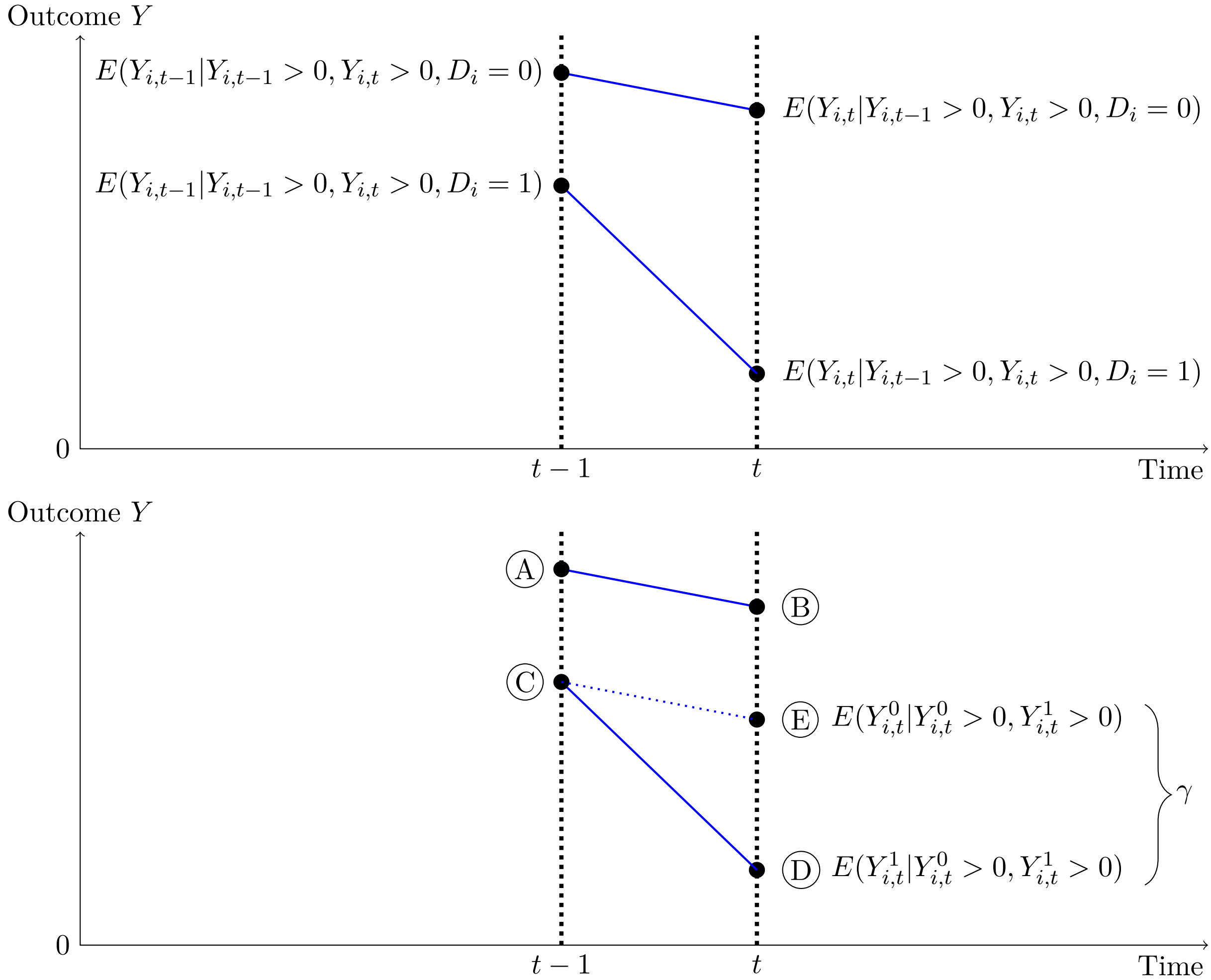
Figure 3.1 illustrates the graphical derivation. It is important to note that even though treatment is randomly assigned, the expected outcome of treatment and control group with a positive outcome in period t and $t-1$ are possibly different in period $t-1$. This is due to conditioning on positive outcomes in *both* periods t and $t-1$. For illustration purpose, we specify the expected outcome of the control group in both t and $t-1$ to be above the expected outcome of the treatment group.

To get intuition, consider the partial retirement policy example from the introduction. Individuals reach the retirement age between period $t-1$ and t. Suppose that in the control group, individuals have to claim the full pension at a given age (retirement age), but are allowed to continue working. Continued work does not increase future pension entitlements. Individuals in the treatment group have the choice between a partial and a full pension. A partial pension can be claimed if they reduce working hours. If they claim a partial pension, continued work increases future pensions. Therefore, individuals in the control group have strong incentives to leave the labor market at the retirement age, while individuals in the treatment group have incentives to work part-time after reaching the

[7] In the standard DiD, the common trend assumption is given by $E(Y_{i,t}^0 - Y_{i,t-1}^0 | D_i = 1) = E(Y_{i,t}^0 - Y_{i,t-1}^0 | D_i = 0)$.

retirement age. In period t, individuals in the treatment group have lower working hours compared to individuals in the control group. Individuals in the treatment group face partial retirement incentives and therefore continue working, but with reduced working hours. In period $t-1$, no individual is treated. Individuals in the treatment group, however, have lower working hours in period $t-1$ compared to individuals in the control group. Control group individuals with a positive outcome in period t participate in the labor market, although they have strong incentives to leave the labor market. Therefore, they possibly have a higher attitude towards work and tend to work more than treatment group individuals with a positive outcome in period t. As a result, individuals in the control group with a positive outcome in t are likely to work more hours in period $t-1$ than individuals in the treatment group with a positive outcome t.

Figure 3.1: Graphical derivation of the *difference-in-difference estimator*



Note: Observed quantities in the upper graph. Causal intensive margin effect in the lower graph.

The four bold dots in the upper graph of figure 3.1 depict the observed quantities. For both treatment ($D_i = 1$) and control ($D_i = 0$) group, we observe outcomes in period t and in period $t-1$. In the next steps, we use the identifying assumptions to rewrite the observed quantities, denoted by (A), (B), (C) and (D) in the lower graph of figure 3.1. Moreover, we identify (E). See the formal derivation below for details.

In (A), *SUTVA* and random treatment implies that the observed quantity is equal to $E(Y^0_{i,t-1}|Y^0_{i,t-1} > 0, Y^0_{i,t} > 0)$. In (B), *SUTVA* and random treatment implies that the observed quantity is equal to $E(Y^0_{i,t}|Y^0_{i,t-1} > 0, Y^0_{i,t} > 0)$. In (C), *SUTVA* and random treatment assignment and the *no anticipation* assumption imply that the observed quantity is equal to $E(Y^0_{i,t-1}|Y^1_{i,t-1} > 0, Y^1_{i,t} > 0)$. In (D), random treatment as well as *time* and *treatment monotonicity* imply that the observed quantity is equal to $E(Y^1_{i,t}|Y^0_{i,t} > 0, Y^1_{i,t} > 0)$. The *common trend in positive outcomes* assumption implies that the rewritten quantities in (A), (B) and (C) identify (E) $= E(Y^0_{i,t}|Y^1_{i,t-1} > 0, Y^1_{i,t} > 0)$. Using *time* and *treatment monotonicity*, this can be rewritten to $E(Y^0_{i,t}|Y^0_{i,t} > 0, Y^1_{i,t} > 0)$. As shown in the lower graph of figure 3.1, the difference between the rewritten quantities in (D) and (E) is the causal effect of interest γ.

Proof Assuming *SUTVA*, the *difference-in-difference* estimator on positive outcomes in equation (3.8) can be rewritten as

$$\hat{\gamma} = E(Y^1_{i,t} - Y^1_{i,t-1}|Y^1_{i,t-1} > 0, Y^1_{i,t} > 0, D_i = 1) - E(Y^0_{i,t} - Y^0_{i,t-1}|Y^0_{i,t-1} > 0, Y^0_{i,t} > 0, D_i = 0) \tag{3.9}$$

Since potential outcomes are independent of treatment, we can remove the treatment status D_i from the conditioning set.[8] Adding and subtracting the terms $E(Y^0_{i,t-1}|Y^1_{i,t-1} > 0, Y^1_{i,t} > 0)$ and $E(Y^0_{i,t}|Y^1_{i,t-1} > 0, Y^1_{i,t} > 0)$ to (3.9) and rearranging yields

$$\begin{aligned}
\gamma_{DiD} &= E(Y^1_{i,t} - Y^0_{i,t}|Y^1_{i,t-1} > 0, Y^1_{i,t} > 0) &(3.10)\\
&+ E(Y^0_{i,t-1} - Y^1_{i,t-1}|Y^1_{i,t-1} > 0, Y^1_{i,t} > 0) &(3.11)\\
&+ E(Y^0_{i,t} - Y^0_{i,t-1}|Y^1_{i,t-1} > 0, Y^1_{i,t} > 0) &(3.12)\\
&+ E(Y^0_{i,t-1} - Y^0_{i,t}|Y^0_{i,t-1} > 0, Y^0_{i,t} > 0) &(3.13)
\end{aligned}$$

Under the *common trend assumption*, the sum of the two terms in line (3.12) and (3.13) equals 0. Moreover, under the *no anticipation assumption*, the sum of the term in line (3.11) is equal to zero. This reduces the expression to $\gamma_{DiD} = E(Y^1_{i,t} - Y^0_{i,t}|Y^1_{i,t-1} > 0, Y^1_{i,t} > 0)$.

Under *time monotonicity at the extensive margin*, the first part $E(Y^1_{i,t}|Y^1_{i,t-1} > 0, Y^1_{i,t} > 0)$ can be rewritten as $E(Y^1_{i,t}|Y^1_{i,t} > 0)$. Under *treatment monotonicity*, this term can be further rewritten as $E(Y^1_{i,t}|Y^1_{i,t} > 0) = E(Y^1_{i,t}|Y^0_{i,t} > 0, Y^1_{i,t} > 0)$. Similarly, using *time* and

[8]Since $D_i \perp\!\!\!\perp (Y^1_{i,t}, Y^1_{i,t-1}, Y^0_{i,t}, Y^0_{i,t-1})$, this implies $E(Y^1_{i,t} - Y^1_{i,t-1}|Y^1_{i,t-1} > 0, Y^1_{i,t} > 0, D_i = 1) = E(Y^1_{i,t} - Y^1_{i,t-1}|Y^1_{i,t-1} > 0, Y^1_{i,t} > 0)$ and $E(Y^0_{i,t} - Y^0_{i,t-1}|Y^0_{i,t-1} > 0, Y^0_{i,t} > 0, D_i = 0) = E(Y^0_{i,t} - Y^0_{i,t-1}|Y^0_{i,t-1} > 0, Y^0_{i,t} > 0)$.

treatment monotonicity, the second part $E(Y^0_{i,t}|Y^1_{i,t-1} > 0, Y^1_{i,t} > 0)$ can be rewritten as $E(Y^0_{i,t}|Y^0_{i,t} > 0, Y^1_{i,t} > 0)$. The remaining term equals the causal intensive margin effect.□

Estimation
Estimation of the causal intensive margin effects therefore reduces to estimating differences or differences-in-differences of conditional expectation functions. This is done by simple linear regression or by calculating the difference between the two sample means. For example, the *difference-in-difference estimator in positive outcomes* of section 3.3.3 is estimated by regression the difference between $Y_{i,t}$ and $Y_{i,t-1}$ on the treatment indicator D_i in the sample of individuals with a positive outcome in period t and period $t-1$.

3.4 Verification of identifying assumptions

In the following, we discuss how the identifying assumptions 1-8 can be motivated. With the exception of the *time monotonicity at extensive margin* assumption, we cannot directly test the assumptions. Instead, we propose alternative tests which can be used to motivate the identifying assumptions. We cannot rule out the possibility that a given identifying assumption is violated even though the alternative test was not able to reject the null hypothesis that the assumption is fulfilled. The opposite is also possible. A given identifying assumption could be fulfilled, even if the alternative test rejects the null that the assumption is fulfilled.
Table 3.2 provides an overview of the assumptions for identification of the causal intensive margin effect by the estimators presented in section 3.3. Moreover, Table 3.2 summarizes the alternative tests which aim to motivate the identifying assumptions.

1) SUTVA: This assumption cannot be tested. One has to judge to what extent general equilibrium effects and spill-over effects between individuals are possible.
2) No switchers: The *no switchers* assumption cannot be directly tested. Alternatively, one can perform a test that the difference in the fraction with positive outcomes between treatment and control group, i.e. $P(Y_{i,t} > 0|D_i = 1) - P(Y_{i,t} > 0|D_i = 0)$, is sufficiently close to zero. Under *SUTVA* and random treatment assignment, this term can be rewritten in terms of potential outcomes as follows, $P(Y^1_t > 0) - P(Y^0_t > 0)$. The expression $P(Y^1_t > 0) - P(Y^0_t > 0)$ can be expanded as

$$P(Y^1_{i,t} > 0) - P(Y^0_{i,t} > 0) = \underbrace{P(Y^0_{i,t} = 0, Y^1_{i,t} > 0)}_{\text{switchers 1}} - \underbrace{P(Y^0_{i,t} > 0, Y^1_{i,t} = 0)}_{\text{switchers 2}} \tag{3.14}$$

Even if $P(Y^1_{i,t} > 0) - P(Y^0_{i,t} > 0)$ is sufficiently close to zero, this does not exclude the case that the proportion of switchers 1 and switchers 2 are strictly positive and equal, i.e.

Table 3.2: Verification of identifying assumptions

		Estimators			Testing	
		TC	PP	DiD	Testable	Alternative
Identifying assumptions	*1) SUTVA*	x	x	x	No	
	2) No switchers	x*			No	Alternative test: $P(Y_{i,t} > 0 \vert D_i = 1) - P(Y_{i,t} > 0 \vert D_i = 0)$ has to be sufficiently close to zero.
	3) Conditional mean independence	x*			No	Alternative test: $E(Y_{i,t-1} \vert Y_{i,t-1} > 0, Y_{i,t} > 0, D_i = 1) - E(Y_{i,t-1} \vert Y_{i,t-1} > 0, Y_{i,t} > 0, D_i = 0)$ has to be sufficiently close to zero.
	4) No anticipation		x	x	No	Alternative test: $E(Y_{i,t-1} \vert D_i = 1) - E(Y_{i,t-1} \vert D_i = 0)$ has to be sufficiently close to zero.
	5) Treatment monotonicity at ext. margin		x	x	No	Assumption must be motivated by economic theory.
	6) Time monotonicity at extensive margin		x	x	Yes	$P(Y_{i,t} > 0 \vert Y_{i,t-1} = 0, D_i = 1)$ and $P(Y_{i,t} > 0 \vert Y_{i,t-1} = 0, D_i = 0)$ has to be sufficiently close to zero.
	7) No time trend in positive outcomes		x		No	Alternative test 1): $E(Y_{i,t} - Y_{i,t-1} \vert Y_{i,t-1} > 0, Y_{i,t} > 0, D_i = 0)$ has to be sufficiently close to zero. Alternative test 2): $E(Y_{i,t-1} - Y_{i,t-2} \vert Y_{i,t-2} > 0, Y_{i,t-1} > 0, Y_{i,t} > 0, D_i = 1)$ has to be sufficiently close to zero.
	8) Common trend in pos. outcomes			x	No	Alternative test: $E(Y_{i,t-1} - Y_{i,t-2} \vert Y_{i,t-2} > 0, Y_{i,t-1} > 0, Y_{i,t} > 0, D_i = 1)$ - $E(Y_{i,t-1} - Y_{i,t-2} \vert Y_{i,t-2} > 0, Y_{i,t-1} > 0, Y_{i,t} > 0, D_i = 0)$, has to be sufficiently close to zero.

Note: *Treatment-versus-control on positive outcomes* (TC), *pre-versus-post estimator on positive outcomes* (PP), *difference-in-difference estimator on positive outcomes* (DiD). *Either *no switchers* or *conditional mean independence* have to hold. Own illustration.

$P(Y^0_{i,t} = 0, Y^1_{i,t} > 0) = P(Y^0_{i,t} > 0, Y^1_{i,t} = 0)$. In this case we would mistakenly conclude that there are no switchers.

3) Conditional mean independence: This assumption cannot be tested using observed outcomes. Alternatively, one can compare pre-treatment outcomes of treatment and control group with positive outcomes in period $t-1$ and t, i.e. $E(Y_{i,t-1}|Y_{i,t-1} > 0, Y_{i,t} > 0, D_i = 1) - E(Y_{i,t-1}|Y_{i,t-1} > 0, Y_{i,t} > 0, D_i = 0)$. Thereby, we test whether A and C in figure 3.1 are congruent. As described in the example with partial retirement in the graphical derivation, congruent outcomes in period $t-1$ indicate that unobserved characteristics of treatment group and control group with positive outcome in period $t-1$ and t are similar.

4) No anticipation: The *no anticipation* assumption is not directly testable using observed outcomes. One can, however, inspect the difference in unconditional means in the pre-treatment period, i.e. $E(Y_{i,t-1}|D_i = 1) - E(Y_{i,t-1}|D_i = 0)$.

5) Treatment monotonicity at extensive margin: The assumption of *treatment monotonicity at extensive margin* cannot be tested using observed outcomes. Economic theory must be used to argue whether the assumption is fulfilled.

6) Time monotonicity at the extensive margin: This assumption can be directly tested. If $P(Y_{i,t} > 0|Y_{i,t-1} = 0, D_i = 1)$ and $P(Y_{i,t} > 0|Y_{i,t-1} = 0, D_i = 0)$ are sufficiently close to zero, this provides evidence that time monotonicity at extensive margin is fulfilled.

7) No time trend in positive outcomes: This assumption cannot be directly tested. We propose two ways to motivate the assumption. One possibility is to test whether the difference in outcomes between $t-1$ and t of the control group with positive outcomes in period t and $t-1$, i.e. $E(Y_{i,t} - Y_{i,t-1}|Y_{i,t} > 0, Y_{i,t-1} > 0, D_i = 0)$, is sufficiently small. Alternatively, one can test whether the pre-treatment differences of the treated with positive outcomes is sufficiently close to zero, i.e. $E(Y_{i,t-1} - Y_{i,t-2}|Y_{i,t-2} > 0, Y_{i,t-1} > 0, Y_{i,t} > 0, D_i = 1)$.

8) Common trend in positive outcomes: This assumption cannot be directly tested. As for the assumption of *no time trend in positive outcomes*, one can inspect pre-treatment outcomes. One can test whether the pre-treatment differences between the treatment and the control group is sufficiently close to zero, i.e. $E(Y_{i,t-1} - Y_{i,t-2}|Y_{i,t-2} > 0, Y_{i,t-1} > 0, Y_{i,t} > 0, D_i = 1)$ - $E(Y_{i,t-1} - Y_{i,t-2}|Y_{i,t-2} > 0, Y_{i,t-1} > 0, Y_{i,t} > 0, D_i = 0)$.

3.5 Conclusion

This chapter extends the literature on the identification of causal intensive margin effects. We borrow difference-in-difference methods from the policy evaluation literature to identify the causal intensive margin effect in a setting with random treatment assignment. We derive sufficient conditions under which the treatment-versus-control estimator on positive outcomes, the pre-versus-post estimator on positive outcomes, and the difference-in-difference estimator on positive outcomes identify the causal intensive margin effect. Furthermore, we discuss how the identifying assumptions can be motivated. We show that the treatment-versus-control estimator on positive outcomes, often applied in two-part models, provides a causal estimate if there are no switchers or if conditional mean independence holds. We show that the difference-in-difference estimator on positive outcomes, compared to the standard difference-in-difference estimator, additionally requires time and treatment monotonicity at the extensive margin. Although we focus on the setting with random treatment, the methods discussed in this chapter could be extended to a setting in which treatment is as good as randomly assigned conditional on observables.

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Chapter 4

The Association Between Ill Health and Labor Market Transitions among Older Workers in Switzerland

Executive Summary

Motivation and Objectives

To assess the welfare implications of future pension reforms, it is crucial to understand the labor market behavior of older workers with ill health. I study the association between having a disability that limits activities of daily living (ADL) and the transition rates between *wage-employment*, *self-employment*, *unemployment insurance*, *disability insurance* and *inactivity*. I analyse the transition behavior of older Swiss workers aged between 50 and the full retirement age (FRA). I use panel data drawn from the Swiss Labor Force Survey matched with social security records for the time period between 2003 and 2009.

Key findings

Cross sectional relationship

Reporting ADL is associated with 39.2 percentage points (95% CI, 38.1% to 40.3%) lower labor force participation rate for men and 30.1 percentage points (95% CI, 28.9% to 31.3%) lower labor force participation rate for women. Women reporting ADL have a higher probability to be inactive and a smaller probability to draw disability benefits than men reporting ADL.

Transition rates

Reporting ADL is associated with a 13.2 percentage points (95% CI, 11.4% to 15.0%) higher probability of leaving wage-employment for men and a 9.0 percentage points (95% CI, 7.3% to 10.6%) higher probability of leaving wage-employment for women. There is a strong association between reporting ADL and the transition rate from wage-employment to the unemployment insurance, disability insurance and inactivity for both sexes.

Socio-economic differences in transition rates

The association between reporting ADL and the transition rate from wage-employment to the disability insurance is stronger for men than for women. Moreover, I find that the association between reporting ADL and the transition rate from wage-employment to disability insurance is stronger for men with obligatory education than for men with tertiary education. By contrast, the association between reporting ADL and the transition rate from wage-employment to disability insurance is stronger for women with tertiary education than for women with obligatory education.

Limitations

It is important to note that the results should be interpreted as associations and not as causal effects. There are likely to be unobserved confounding factors affecting both, ADL status and the transition rate. Moreover, there are concerns associated with the use of self-reported disability measures, i.e. problems of comparability across individuals and justification bias.

4.1 Introduction

The first pillar old age insurance in Switzerland was last reformed in 1997. Since 1997, life expectancy at age 65 has increased - according to mortality tables from the Federal Office of Statistics - from 81.5 years for men and 85.4 years for women to 84.6 years for men and 87.5 years for women in 2016.[1] In the same time period, fertility rates remained constant at around 1.5 births per woman. High immigration rates could only partially offset the ageing of the Swiss population. The old age dependency ratio increased from 24.36% in 1997 to 29.26% in 2016.[2]

In international comparison, labor force participation rates of older workers in Switzerland are high. According to labor force statistics from the OECD, labor force participation rates of women aged 55-64 increased from 65.7% in 1997 (OECD average: 50.2%) to 74.3% in 2016 (OECD average: 62.1%).[3] Labor force participation rates of men are high, but did not keep up with increased life expectancy. Quite the contrary, labor force participation rates of men in the age group 55-64 decreased from 81.9% in 1997 (OECD average: 63.6%) to 80.7% in 2016 (OECD average: 71.4%).

Since 1997, the Swiss government proposed several reforms of the first pillar old age insurance to ensure the long run fiscal sustainability of the Swiss social security system. These reforms have either been rejected by the parliament or by popular vote. The proposed reforms of the old age insurance all included a raise of the first pillar pension eligibility age.[4] Old age is associated with declining health and an increasing occurrence of disabilities. Therefore, it is key to understand labor market behavior of individuals with ill health to be able to assess the welfare implications of future pension reforms.

There are diverse patterns of transitions from work to retirement. Evidence from other developed countries suggests that a non marginal share of older workers makes a transition from wage- to self-employment before fully retiring (Zissimopoulos & Karoly, 2007; Ramnath, Shoven, & Slavov, 2017). Another pathway to retirement encompasses a return to work after a period of inactivity (Maestas, 2010; Kanabar, 2015). Moreover, evidence suggests that individuals withdraw from employment through the disability and the unemployment insurance (Wise, 2015; Inderbitzin, Staubli, & Zweimüller, 2016).

In this chapter, I study the association between having a disability that limits activities of daily living (ADL) and the transition rates between *wage-employment*, *self-employment*,

[1] Retrieved from https://www.bfs.admin.ch/ on June 6, 2018.

[2] Here, the old age dependency ratio is defined as the ratio between individuals aged 65 and more to those aged between 20 and 64.

[3] Retrieved from https://data.oecd.org/emp/labour-force-participation-rate.htm on June 18, 2018.

[4] In the context of the 11th revision of first pillar old age insurance, it was planned to increase the female FRA from 64 to 65. In the context of old age reform 2020, it was planned to increase the female retirement age for women from 64 to 65 and to increase flexibility in the choice of retirement age.

unemployment insurance, *disability insurance* and *inactivity*. Additionally, I study the cross-sectional relationship between reporting ADL and the choice of the labor market state. I restrict the analysis to individuals aged between 50 and the full retirement age (FRA).[5] I use observations drawn from the social protection and labor market data set (SESAM) for the time period between 2003 and 2009.[6] In this data set, survey data from the Swiss Labor Force Survey (SLFS) is matched with administrative records from social security registers.[7]

I find that reporting ADL is associated with a higher probability of a transition from wage-employment to unemployment insurance, disability insurance and inactivity. I find that the association between reporting ADL and the exit rate from wage-employment is stronger for men than for women. Moreover, I find that the association between reporting ADL and the transition rate from wage-employment to disability insurance is stronger for men with lower education. By contrast, the association between reporting ADL and the transition rate from wage-employment to the disability insurance is stronger for women with higher education.

It is important to note that the relationship between reporting ADL and transition rates should not be interpreted as a causal effect. There are likely to be unobserved confounding factors affecting both, ADL status and the transition rate, i.e. in the case of reverse causality. Moreover, there are two additional concerns associated with the use of self-reported measures that impede a causal interpretation of the results. First, self-assessed health is by its very nature subjective. Individuals with the same underlying health impairment may respond differently to the question on disability (Kerkhofs & Lindeboom, 1995; Lindeboom & Van Doorslaer, 2004). Second, there is evidence that self-reported disability is used to rationalize the labor market status or welfare receipt (Black, Johnston, & Suziedelyte, 2017).[8]

This chapter connects to the literature studying the association between ill health and labor supply (Bound, Schoenbaum, Stinebrickner, & Waidmann, 1999; Riphahn, 1999; García-Gómez, von Gaudecker, & Lindeboom, 2011; French, 2005; Britton, Blundell, Dias, Britton, & French, 2017). In this literature, it is well established that ill health is an important determinant of premature labor force exits. Moreover, this paper relates to the literature studying non standard pathways to retirement (Zissimopoulos & Karoly, 2007; Kanabar, 2015). For the United States, Zissimopoulos and Karoly (2007) find that poor health increases the probability of making a transition from wage to self-employment

[5]After reaching FRA, a first pillar disability pension is converted to an old age pension, and unemployment benefits can no longer be claimed.

[6]German: Soziale Sicherheit und Arbeitsmarkt, Bundesamt für Statistik (BFS).

[7]German: Schweizerische Arbeitskräfteerhebung, Bundesamt für Statistik (BFS).

[8]See also Chapter 5 for evidence on the justification bias among disability beneficiaries in Switzerland.

at older ages. Studying the unretirement behavior of older English workers, Kanabar (2015) finds that being in good health is associated with a higher probability of making a transition from inactivity back to work. Last, this paper relates to contributions studying labor supply of older workers in Switzerland (Dorn & Sousa, 2005; Huguenin, Teppa, & Bütler, 2005; Hanel & Riphahn, 2012).

The remainder of this chapter is organized as follows. In section 4.2, the Swiss System is presented, outlining eligibility and financial incentives for the different retirement routes. Section 4.3 describes the data. In section 4.4, evidence on the cross sectional relationship between the labor market state and reporting ADL is presented. The results on the association between reporting ADL and labor market transition rates are presented in section 4.5.

4.2 Ill Health and Social Security in Switzerland

In Table 4.1, selected regulations related to the transition between *wage-employment*, *self-employment*, *unemployment insurance*, *disability insurance*, and *inactivity* are listed. The remainder of this section provides a detailed description of the Swiss system and may be skipped without any problems for understanding the empirical analysis.[9] The following description is focused on the regulation between 2004 and 2009, and provides information on changes after 2009.

The Swiss Social Security system can be divided into four distinct areas.[10]

1. Old age insurance (based on 3 pillar system)
2. Disability insurance (based on 3 pillar system)
3. Unemployment insurance
4. Accident and occupational disease insurance

The old age and survivor's insurance provides benefits upon reaching old age. The disability insurance covers the financial consequences of a *long term* inability to earn income.

[9] The following description of the Swiss system is mainly based on federal law on old-age and survivors' insurance, the federal law on occupational retirement, survivors' and disability pension plans and the federal law on accident insurance. Legal texts are retrieved from https://www.admin.ch/gov/de/start/bundesrecht.html.

[10] Additionally, social security encompasses family allowances, income compensation in case of maternity and compulsory service. These benefits, however, are less important for older workers and therefore skipped in the following description of the Swiss system.

Table 4.1: Selected regulations for transitions

Labor market status in period $t-1$	*Labor market status in period t* WE	SE	UE	DI	IA
WE	• Protected from dismissal for 30-180 days when partially or fully incapacitated for work (depending on tenure)	• For given gross earnings, social security contributions decrease	• 400 DA if age <55 and CP $\geq$ 12 months • 520 DA if age $\geq$ 55 and CP $\geq$ 18 months • 640 DA if < 4 years before FRA and CP $\geq$ 18 months	• Eligible for benefits if degree of invalidity $\geq$ 40% • First pension 12 months after occurrence of health problems	• Early 1st pillar pension two years before FRA • Means tested benefits can be claimed if ERA is reached • Social security contributions remain compulsory
SE	• For given gross earnings, social security contributions increase	• No specific regulation	• No benefits for self-employed • Eligible for benefits if contributed $\geq$ 12 months as wage-employed in 24 months before transition to self employment (max. 48 months before occurrence of unemployment)	• Eligible if degree of invalidity $\geq$ 40% • First pension 12 months after occurrence of health problems • No mandatory 2nd pillar insurance against the risk of disability	• Early 1st pillar pension two years before FRA • Means tested benefits can be claimed if ERA is reached • Social security contributions remain compulsory
UE	• No specific regulation	• 90 DA without search requirements if company is in planning phase	• Job search requirements have to be fulfilled • Disability I: Full benefits if work capacity $\geq$ 75% • Disability II: 50% of full benefits if 50%$\leq$ work capacity $\leq$ 75%	• Benefits expire once a *full* disability pension is granted • Possible to simultaneously draw a *partial* disability and unemployment benefits	• Eligible for social assistance (means tested) • Eligible for early 1st pillar pension if ERA is reached • Second pillar wealth is transferred to vested benefit account
DI	• Reintegration measures	• Reintegration measures	• Benefits can be claimed after termination (partial or complete) of disability pension • Exempted from minimal contribution duration	• Revision every 3-5 years	• Early 1st pillar pension can be claimed if ERA is reached
IA	• Eligible for reintegration measures from disability insurance	• Eligible for reintegration measures from disability insurance	• Eligible for benefits if contributed for $\geq$12 months in last 24 months	• Benefits for loss in ability to carry out day to day tasks	• No specific regulation

Source: Own illustration based on federal law on old-age and survivors' insurance, the federal law on occupational retirement, survivors' and disability pension plans, the federal law on unemployment insurance, and the federal law on accident insurance for time period between 2004 and 2009. ERA: Early retirement age. FRA: Full retirement age. CP: Contribution period in last 24 months. DA: Daily allowance entitlements.

Old age and disability insurance rest on a three pillar system. The first pillar is a pay-as-you-go insurance with a strong redistributive motive. Its main purpose is to cover basic living costs. The second pillar is an occupational pension scheme. The objective is to ensure the continuation of the living standard. The third pillar encompasses tax-favoured savings. The unemployment insurance grants temporary benefits to individuals seeking for a job. The accident and occupational disease insurance covers the *short term* as well as *long term* consequences of an accident or occupational disease.
Depending on the years of tenure, an employee who is not able to work due to health problems is protected against dismissal for a limited time period.[11] Moreover, the employer is obliged to continue paying the wage for a limited time period if the employee is not able to work due to illness.

4.2.1 Old age insurance

First Pillar
Before reaching full retirement age (FRA)[12], contributions to the first pillar old age insurance are compulsory for anyone working or living in Switzerland, including those who are not participating in the labor market.[13] Wage earners contribute 8.4% of the gross earnings (no ceiling) to the first pillar old age insurance. The contribution rate for self-employed amounts to 7.8% for earnings above 56'400 CHF and decreases below this threshold.[14] For wage- and self-employed, contributions remain compulsory after FRA is reached.[15] Non-employed individuals are obliged to pay social security contributions until they reach FRA. Contributions of non-employed individuals are calculated on the base of wealth, as well as on income received through benefits and pensions.
An ordinary old age pension can be claimed once the FRA is reached. In the time period from 2003 and 2009, the FRA for men was 65. The FRA for women was 63 until 2003 and was increased to 64 in 2004. First pillar pension entitlements depend on contribution years and indexed average life time earnings. Individuals who contributed each year from age 20 to FRA are entitled to a full pension. For each missing contribution year, benefits are reduced by at least 2.3%. Depending on indexed average earnings, the monthly full pension in 2005 ranged from 1'055 CHF (minimum full pension) to 2'110 CHF (maximum full pension). Indexed average earnings are a function of life time earnings (age 20-FRA) and an adjustment factor correcting for growth in wages.

[11]The notice period for employees who have been employed in the same company for less than 1 year is prolonged by 30 days, for 1-5 years tenure by 90 days, and for more than 5 years tenure by 180 days.
[12]FRA represents the age at which first pillar pensions can be claimed without deductions.
[13]The only exemption applies to married, non-employed individuals whose spouse or civil partner contributes more than twice the minimum contribution (2005: 425 CHF).
[14]The contribution rates by income are depicted in figure 4.10 in Appendix 4.B.
[15]After reaching FRA, only gross earnings above the yearly minimum full first pillar pension (2005: CHF 16'800) are subject to contributions.

Since 2001, men have the possibility to draw an early first pillar old age pension one or two years before reaching FRA. Benefits are reduced by 6.8% for each year the first pillar old age pension is paid out early. Since 2005, women have the possibility to draw an early first pillar old age pension two years before reaching FRA. For the time period between 2005 and 2012, benefits were reduced by 3.4% for each year pensions are paid out early.[16] Early and ordinary old age beneficiaries are entitled to need-based supplementary benefits if income is not sufficient to cover basic living costs.

Second Pillar

For occupational pension schemes, the law determines contributions and benefits for yearly earnings between the deduction offset, amounting to 22'575 CHF in 2005, and an upper threshold, amounting to CHF 77'400 CHF in 2005. This part is commonly referred to as the *mandatory part*. The law allows pension funds to insure earnings above this threshold, commonly referred to as the *super-mandatory part*. Contributions to the occupational pension plans are age dependent and borne by employee and employer.[17] Self employed are not obliged to insure themselves in an occupational pension plan.

There are two systems in place to compute second pillar old age entitlements. In a *contribution based scheme*, accrued savings are converted into an old age pension when retirement age is reached. In a *benefit based pension scheme*, benefits are a predefined fraction of previous earnings. According to the Pension Fund Study from Swisscanto, 52.25% of insured individuals in 2005 were in pension fund with a defined contribution plan for old age pensions (Swisscanto, 2006).

The law defines that occupational pension schemes have to offer the possibility to withdraw at least 25% of the second pillar old age savings as a lump sum. Pension funds do not have to offer the possibility for early withdrawal of second pillar pensions. Many pension funds, however, offer early retirement schemes (Swisscanto, 2006, p. 51).

Third Pillar

The third pillar encompasses tax favoured savings. In 2005, wage-employed could deduct a maximum amount of 6'192 CHF from their taxable earnings for third pillar savings. Self-employed, who are not insured in a second occupational pension scheme, have the possibility to deduct 20% from their taxable income or a maximum amount of 30'960 CHF (2005) for third pillar savings. Figure 4.11 in Appendix 4.B depicts the share of individuals insured in the third pillar by labor market status. In comparison to the second pillar, self-employed are more likely to be insured in third pillar pension plans.

[16] The adjustment factor for women was changed to 6.8% in 2012.

[17] Individuals aged 25-34 contribute 7% of their insured earnings, individuals aged 35-44 to 10%, individuals aged 45-54 to 15%, and individuals aged 55-FRA to 18%.

4.2.2 Disability Insurance

First Pillar

The first pillar disability insurance scheme is compulsory for anyone living in Switzerland. The contribution rate amounts to 1.4% of gross earnings (no ceiling).[18] To be granted with a first pillar disability pension, an individual must have a medically verifiable *long term invalidity* owing to a physical or mental impairment. Older individuals must fulfil the same medical criteria as younger applicants. For the employed, the disability insurance compensates for the loss of income which is causally linked to their disability. Non-employed individuals receive benefits for impairments causally affecting their ability to carry out day to day tasks. The procedure to receive benefits from the disability insurance is depicted in Figure 4.1. After the submission of a disability pension claim, cantonal disability offices assess eligibility for benefits based on medical and vocational factors.

An individual is entitled to a disability pension if the *degree of invalidity* amounts to at least 40% for a time period of at least 12 months and if the incapacity is expected to remain for at least another 12 months. Benefits are granted at earliest 12 months after occurrence of the disability and at earliest 6 months after submission of the disability insurance claim. First pillar disability benefits are calculated based on the degree of invalidity and average yearly indexed earnings.[19] Individuals whose earnings capacity is reduced by at least 70% are entitled to a full first pillar disability pension.

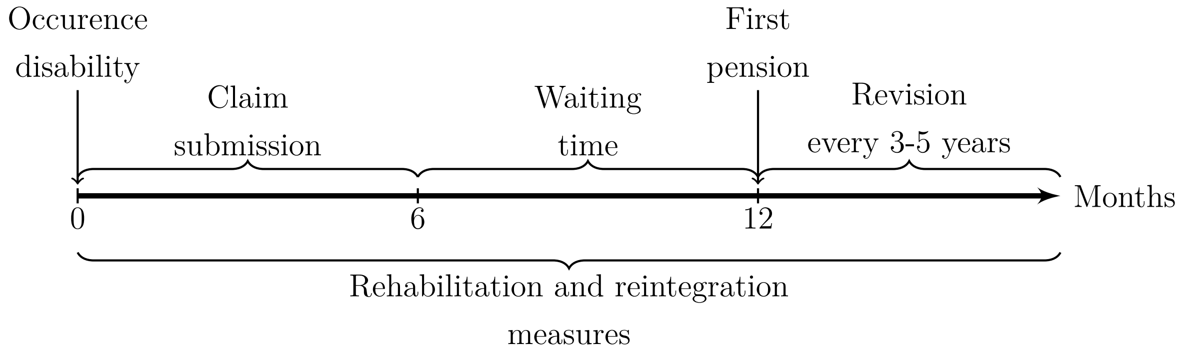
The degree of invalidity is calculated differently for employed, part-time employed and non-employed. For the employed, the income the applicant can achieve with the impairment, is compared to the hypothetical income the applicant could achieve in the absence of the impairment. For individuals who were non-employed before occurrence of the disability, the degree of invalidity is calculated by comparing the ability to carry out day-to-day activities before and after occurrence of the health impairment.[20] For the part-time employed, the degree of invalidity is computed as the weighted average for the employment part and the non-employment part. First pillar pension entitlements expire if the claimant no longer fulfils the medical eligibility criteria, reaches FRA, or dies. Cantonal disability offices are obliged to reassess pension entitlements every 3-5 years.

[18] Self-employed, whose earnings exceed 56'200 CHF (2005), pay 1.4% of their earnings. Below 56'200 CHF, the contribution rate for self-employed is decreasing, see 4.10 in appendix 4.B.

[19] The average indexed yearly earnings include past earnings as well as child-raising and care bonuses.

[20] The activities include housekeeping, nutrition, laundry, and care for family members.

Figure 4.1: Disability insurance claim process. Source: Own Illustration.



Second Pillar

Occupational pension schemes are obliged to insure employees against the risk of disability. Conditions to receive a second pillar disability pension depend on first pillar disability pension entitlement. The law states that occupational disability pensions are paid until the the individual restores ability to earn income or dies. As for the second pillar old age pension, there are two systems in place to compute second pillar disability entitlements. The *defined contribution scheme* represents the default scheme. Hypothetical contributions at constant wage rate are projected until FRA and then converted to a disability pension, using the same conversion factor as for old age pensions. In a *defined benefit scheme*, entitlements are calculated as a pre defined fraction of earnings before occurrence of the disability. In contrast to old age benefits, the majority of individuals are insured in a benefit based schemes for disability benefits. According to data from the Swisscanto Pension Fund survey, 83% of the insured individuals in 2005 were in a pension fund with a benefit based scheme for disability benefits (Swisscanto, 2006). 35% of insured individuals were in a pension fund with a contribution based system schemes for old age pensions and benefit based scheme for disability pensions (Swisscanto, 2006).

4.2.3 Unemployment Insurance

The unemployment insurance provides compensation for the loss of income during unemployment to previously wage-employed individuals. Self-employed are not insured by the unemployment insurance. Contributions to the unemployment insurance have to be made until the FRA is reached.[21]

Wage earners are entitled to benefits if they are partially or fully unemployed, contributed for at least 12 months in the two years before occurrence of unemployment, are employable and fulfil job search requirements. Benefits amount to 70-80% of the insured salary.[22]

[21]The contribution rate amounted to 2.5% in 2003 for yearly earnings below 106'800 CHF and to 1% for earnings above this threshold. From 2004 to 2008, wage earnings had to pay a contribution amounting to 2% for earnings below 106'000 CHF. Earnings above this amount were exempted from unemployment contributions. In 2009, the threshold was increased to 126'000 CHF.

[22]80% for individuals who are partially disabled, or have insured earnings below 3'797 CHF, or have

Unemployment benefits are paid in the form of daily allowances.[23] The maximum number of daily allowances depends on age and the contribution length before occurrence of unemployment. Individuals younger than 55 are entitled to 400 daily allowances if they contributed at least during 12 months in the two years previous to unemployment.[24] Individuals above 55 are entitled to 520 daily allowances if they contributed at least during 18 months in the two years previous to unemployment (400 if they contributed for at least 12 months). The entitlement increases by an additional 120 daily allowances if the insured individual becomes unemployed less than four years before reaching FRA. Individuals who are willing to leave unemployment through self-employment are entitled to 90 daily allowances for setting up a new company. During this time period, they do not have to search for a job or accept offers.

Unemployed individuals with health impairments can simultaneously apply for unemployment and disability benefits. Individuals whose work capacity is reduced by less than 25% are entitled to the full unemployment benefits. Unemployed whose work capacity is reduced by 25-50% are entitled to 50% of the full daily allowances for the same time period as unemployed individuals with no health impairment. Last, individuals whose work capacity is reduced by more than 50% are entitled to 44 full daily allowances.

Frequently, older employees are laid off and offered early second pillar pension benefits. An individual who is willing to continue working has two options. First, the person can draw the early second pillar pension and apply for unemployment benefits. In this case, the unemployment insurance pays the difference between 80% of the previous insured salary and the pension. Second, the individual can transfer the second pillar wealth to a vested benefit account and apply for full unemployment benefits. The disadvantage of this approach, however, is that vested benefit accounts only allow for lump sum withdrawal of benefits. Therefore, the individual runs into the risk of having no choice between annuity and lump sum when transferring the money to a vested benefit accounts.[25]

4.2.4 Accident and Disease Insurance

Accident and Occupational Disease Insurance

The accident and occupational disease insurance is mandatory for wage-employed individuals and voluntary for self-employed. Benefits include non-cash benefits, daily cash benefits, invalidity pensions, integrity allowances and survivors' pensions. To cover the

dependent children. The maximum insured salary amounted to 106'800 CHF from 2003-2008 and to 126'000 CHF since 2009.

[23]One year corresponds to around 260 daily allowances.

[24]The minimum contribution span for 400 daily allowances was increased to 18 months in 2011. Since 2011, individuals, who contributed between 12 and 18 months in the two years previous to unemployment, are entitled to 260 daily allowances.

[25]In case the individual successfully gets re-employed, funds are transferred to the occupational pension scheme of the new employer.

short term loss of income, insured individuals are entitled to daily cash benefits. Starting on the third day after the accident, the individual receives 80% of the insured salary in case of complete incapacity to work.[26] Unemployed receive the full daily cash benefits in case of an accident during unemployment. The number of daily cash benefits is not limited.
If the work incapacity resulting from an accident is expected to remain, the insured individual is entitled to a disability pension from the accident insurance. An individual is entitled to a full disability pension from the accident insurance if the earnings capacity is reduced by 100% and decreases linearly with increasing earnings capacity.[27] The full invalidity pension from the accident insurance amounts to 80% of insured earnings.[28] A disability pension from the accident insurance expires if the claimant no longer fulfils the medical requirements or dies.

Non Occupational Disease Insurance
An insurance against the loss of income due to non occupational illness is not mandatory. A large share of employees, however, is insured in a daily sickness benefits insurance. A survey by Pärli et al. (2013) showed that 93% of employees in the private sector have a daily sickness benefits insurance. Moreover, Pärli et al. (2013) found that the most prevalent contract is a collective insurance contract with a maximum of 720 daily sickness benefits. In contrast to wage earners, self-employed cannot insure themselves in a collective insurance scheme. Therefore, the premium for a disease insurance will directly depend on their individual characteristics (age, current health impairments). Individuals who become unemployed are allowed to stay in the collective insurance contract of their previous employer (for the same conditions).

4.3 Data

I use observations drawn from the social protection and labor market data set (SESAM) for the time period between 2003 and 2009.[29] This data set links survey data from the Swiss Labor Force Survey (SLFS)[30] with administrative social security records. See chapter 2 for a detailed description of the SLFS. Social security records include detailed information on earnings, as well as information on old age, disability and unemployment benefits in the month and year of the interview. The social security records and SLFS

[26] The maximum insured salary amounted to 106’800 CHF for the time period 2003-2007 and was increased to 126’000 CHF in 2008.

[27] To be entitled to a disability pension from the accident insurance, the minimum reduction in earnings capacity amounts to 10%.

[28] The combined benefits from first pillar pension (disability or old age) and invalidity pension from the accident insurance is not allowed to exceed 90% of the insured salary in the accident insurance.

[29] German: Soziale Sicherung und Arbeitsmarkt, Bundesamt für Statistik (BFS).

[30] German: Schweizerische Arbeitskräfteerhebung, Bundesamt für Statistik (BFS).

interview data do not include information on accident insurance benefit receipt. The classification into labor market states is based on administrative records. The variable on ADL and remaining socio-economic variables are based on survey information. A summary of all variables used in the analysis can be found in Table 4.4 in Appendix 4.A.

Labor Market Status

I classify individuals into five mutually exclusive labor market states; *wage-employment (WE), self-employment (SE), disability beneficiary (DI), unemployment (UE)*, and *inactive (IA)*. In Table 4.2, I listed the potential combinations of income sources from social security records in the month of the interview and the corresponding classification.

Table 4.2: Classification into exclusive labor market states

Observed income in month of interview: *Social security records*	*Classification:* *Exclusive state*	Men Share	Women Share
Wage-employment income	WE	60.94%	54.10%
Self-employment income	SE	6.68%	3.38%
Unemployment benefits	UE	1.34%	0.95%
Disability benefits	DI	7.59%	6.44%
No earnings, no benefits	IA	15.58%	29.99%
Wage- & self-employment income	SE	2.87%	1.37%
Wage-employ. income & unemployment benefits	UE	1.37%	1.28%
Wage-employ. income & disability benefits	DI	2.59%	2.17%
Self-employment income & unemployment benefits	UE	0.03%	0.01%
Self-employment income, & disability benefits	DI	0.64%	0.20%
Unemployment-, & disability benefits	UE	0.14%	0.05%
Wage- & self-employment income, & unemployment benefits	UE	0.03%	0.01%
Wage- & self-employment income, & unemployment benefits	UE	0.11%	0.20%
Wage income, unemployment- & disability benefits	DI	0.08%	0.04%
Self-employment, unemployment- & disability benefits	DI	0.00%	0.00%
Number of observations		33'266	34'620

Income source and classification into exclusive labor market states. Individuals aged 50-FRA and interviewed at least twice in the time period between 2003 and 2009 are included. Source: Own calculations based on SESAM, FSO.

I classify an individual as *inactive (IA)* if the respondent neither draws unemployment nor disability benefits, and has no earnings subject to social security contributions in the month of the interview. Individuals are classified as *disability beneficiaries (DI)* if respondents draw a first pillar disability pension in the month of the interview. In the sample, around of 30% of male disability beneficiaries and around 27% of female disability beneficiaries participate in the labor market (wage- or self-employed). Moreover, a small share simultaneously draws disability and unemployment benefits.

An individual is classified as an *unemployment beneficiary (UE)* if the respondent draws unemployment benefits, and does not draw disability benefits in the month of the interview. A substantial share of unemployment beneficiaries participates in the labor market. Unemployment beneficiaries can improve their income by accepting job offers yielding earnings below their insured salary. In this case, the unemployment insurance provides benefits for the difference between the insured earnings and the achieved income from the job.[31]

An individual is classified as *self-employed (SE)* if the respondent has income from self-employment and neither draws a disability pension nor unemployment benefits. The social security administration defines earnings as coming from self-employment if the respondent works on his or her own name and bears the full economic risk of the economic activity. Last, an individual is classified as *wage-employed (WE)* if the individual has income from wage-employment, but not from self-employment, and neither draws disability benefits nor unemployment benefits.

Disability that limits activities of daily living (ADL)

For the analysis, I exploit a question on ADL that was part of the SLFS in the time period between 2003 and 2009. The question is:

> *Many individuals face a physical or mental problem, which restricts them in their daily activities. Do you have such a problem or disease, lasting for more than one year?*[32]

The question was asked at the end of the interview. Importantly, the Federal Statistical office does not share individual level data with cantonal disability offices.

[31] E.g. an unemployed individual who has an insured monthly salary of 5'000 CHF and finds a temporary employment yielding 2'000 CHF, is entitled to monthly unemployment benefits amounting to 2'100 CHF.

[32] German: Es gibt heutzutage viele Leute, welche ein körperliches oder psychisches Problem haben, welches sie in den alltäglichen Aktivitäten einschränkt. Haben Sie ein solches Problem oder eine solche Krankheit, welche schon länger als ein Jahr dauert?
French: Il y a actuellement beaucoup de gens qui ont un problème physique ou psychique qui les limite dans leurs activités quotidiennes. Avez-vous un tel problème ou une maladie de ce type, qui dure déjà depuis plus d'une année?
Italian: Oggigiorno, ci sono tante persone che hanno un problema fisico psichico che le limita nelle attività quotidiane. Ha un problema o una malattia del genere, che dura da più di un anno?
The corresponding SLFS variable is IZ30.

Sample attrition

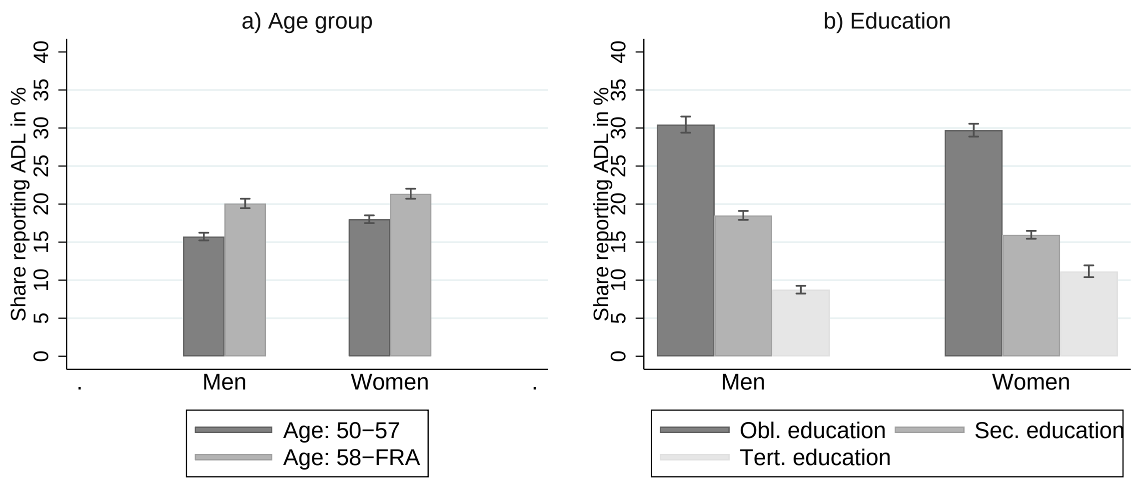
A concern when using survey data with voluntary participation is sample attrition. The attrition rates by labor market status, ADL status and gender are depicted in Figure 4.12 in Appendix 4.B. The attrition rate is defined as the probability of not being interviewed in the next period, conditional that the individual has not yet had five interviews or has been interviewed in 2009. For the sample of individuals aged 50-FRA and interviewed between 2003 and 2009, the attrition rate amounts to 24% for men and 22% for women. For men, unemployment beneficiaries have the highest probability of not being interviewed in the next period. For women, disability beneficiaries have the highest probability of not being interviewed in the next period. Moreover, reporting ADL is associated with a lower probability of being interviewed in the subsequent period.

4.4 Descriptive results 1: Cross sectional relationship

4.4.1 ADL by labor market status

Figure 4.2 depicts the share reporting ADL by age group and gender. The share reporting ADL increases with age for men and women. Women are more likely to report ADL than men, see Figure 4.2a). The finding that women have worse self rated health than men is well established in the literature (Lahelma, Martikainen, Rahkonen, & Silventoinen, 1999; Case & Paxson, 2005; Caroli & Weber-Baghdiguian, 2016). Explanations for the gender gap in self-reported health include differences in chronic diseases and differences in the severity of diseases. A complementary explanation are gender differences in health reporting behavior. For a given disease with a given severity, women tend to report worse health than men (Lindeboom & Van Doorslaer, 2004).

Figure 4.2: Share reporting ADL by age group, education, and gender

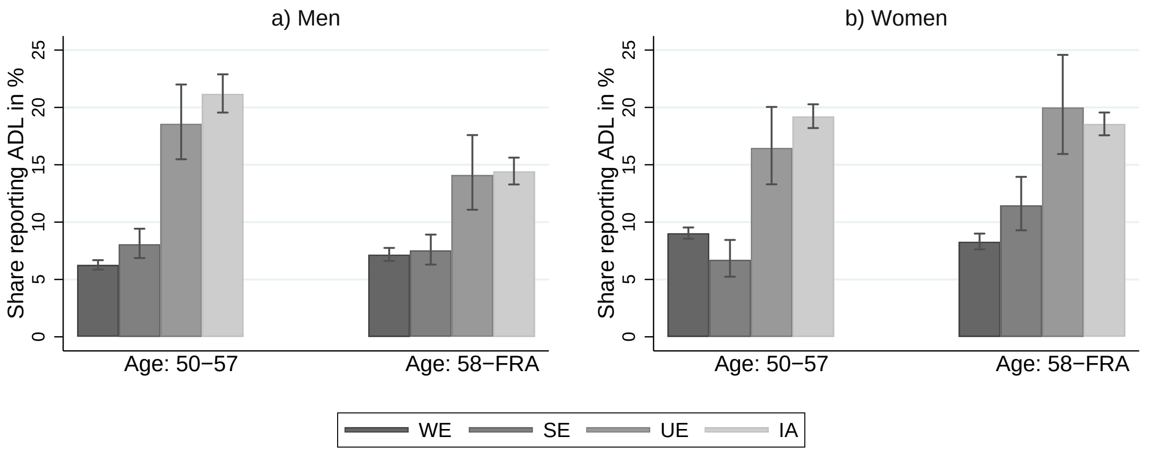


Share reporting ADL by gender, age group, and the person's highest educational attainment. The sample consists of individuals aged between 50 and FRA, interviewed in the time period between 2003 and 2009. Own calculations based on SESAM, FSO.

Figure 4.2b) displays the share of respondents reporting ADL by the person's highest educational attainment. Higher educated respondents tend to be in better health, which is a well established result in the literature (Cutler & Lleras-Muney, 2010; Choi & Cawley, 2018). Moreover, results from Figure 4.2b) indicate that the gender gap in self-reported ADL can be explained by gender differences among respondents with tertiary education. For respondents with an obligatory or secondary education, men are more likely to report ADL than women.

Figure 4.3 displays the share reporting ADL by labor market status, age group and gender.[33] In comparison to employed respondents, the unemployment beneficiaries have a higher probability to report ADL. The share of inactive men reporting ADL decreases with age. There are three - potentially complementary - explanations for this pattern. First, men in good health are more likely to exit from the labor market once FRA is close. Second, inactivity or retirement may have a positive effect on health. Third, inactive respondents in the age group 50-57 may justify their labor market status by overstating ADL. In contrast to men, the share of inactive women reporting ADL does not decrease with age.

Figure 4.3: Share reporting ADL by labor market status, age group, and gender



Share reporting ADL by labor market status, age group, and gender. The sample consists of individuals aged between 50 and the FRA, interviewed in the time period between 2003 and 2009. Disability beneficiaries are exlcuded. Data source: Own calculations based on SESAM, FSO.

[33] I excluded disability beneficiaries in the graph. Around 90 percent of male and female disability recipients report ADL.

4.4.2 Labor market status by ADL

In the age group of individuals aged 50-FRA, reporting ADL is associated with lower labor force participation rates (*WE* and *SE* combined) for both sexes. Reporting ADL is associated with a 39.2 percentage points (95% CI, 38.1% to 40.3%) lower labor force participation rate for men and 30.1 percentage points (95% CI, 28.9% to 31.3%) lower labor force participation rate for women.[34]

Figure 4.4 displays the population shares in the five mutually exclusive labor market states by gender, age, and ADL status. Labor force participation rates (*WE* and *SE*) of respondents who do not report ADL decrease with age for both men and women, see Figure 4.4a) and 4.4b). This result provides some evidence that labor market exits before FRA are not only driven by declining health. Labor force participation rates decrease from around 86% at age 50 to around 46% at age 64. Labor force participation rates of women reporting no ADL are lower. Participation rates of the latter group decrease from around 74% at age 50 to around 33% at age 64.

For men reporting ADL, labor force participation rates (*WE* and *SE*) decrease from around 35% at age 50 to around 13% at age 64, see Figure 4.4b). The share of DI beneficiaries among men reporting ADL increases with age. For men reporting ADL, around 42% at age 50 and around 60% at age 64 are disability beneficiaries. The share of inactive respondents among men reporting ADL remains roughly constant.

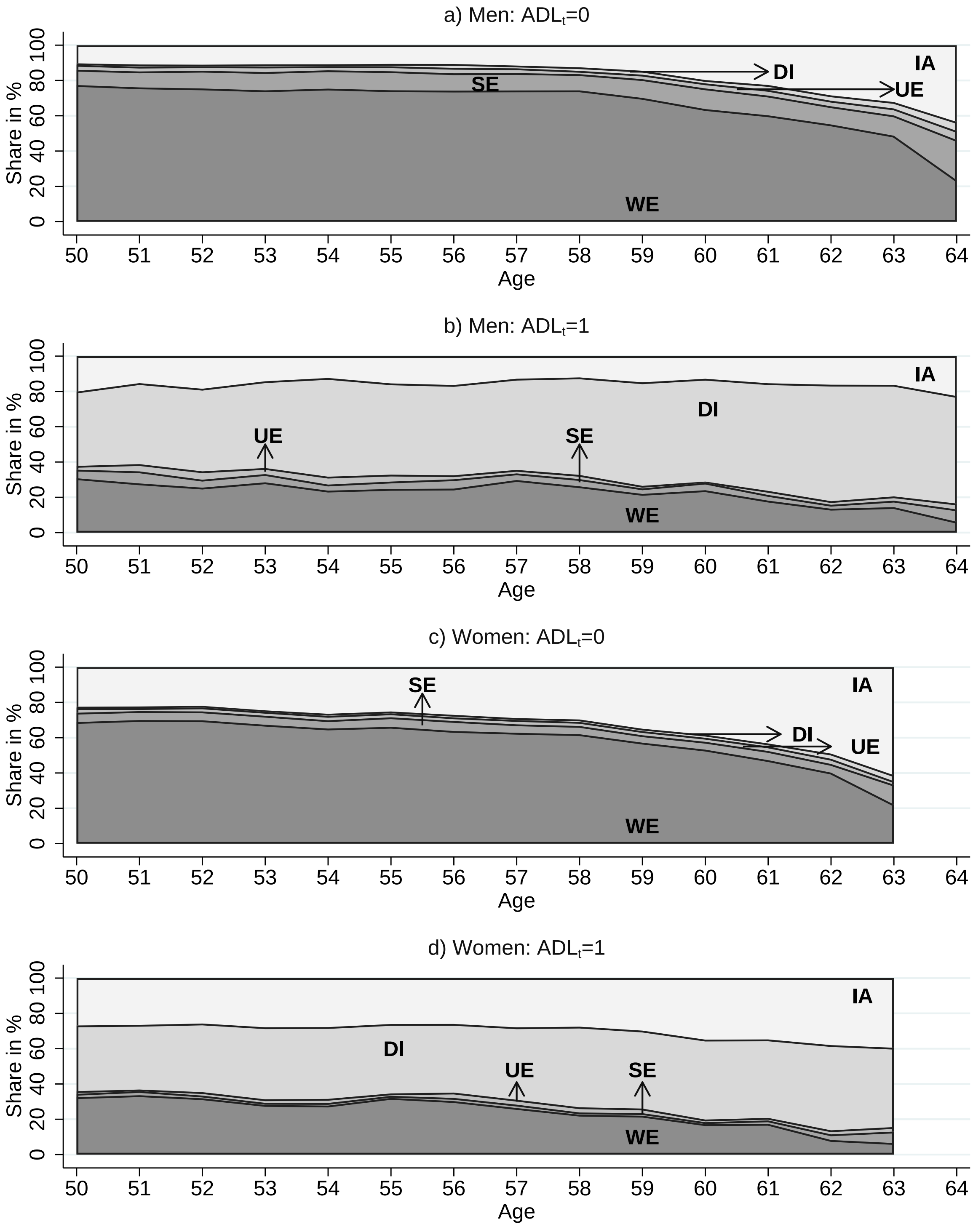
Labor force participation rates (*WE* and *SE*) of men and women reporting ADL are similar. Among women reporting ADL, labor force participation rates decrease from around 34% at age 50 to around 13% at age 63. The share of women drawing a disability pension among respondents reporting ADL increases from around 38% at age 50 to around 45% at age 63. By contrast, the share of the inactive among women reporting ADL increases with age from around 27% at age 50 to around 40% at age 63.

Population shares in different labor market states by age, ADL status, and the persons highest educational attainment are set out in Figure 4.5. For men who report no ADL, differences in labor force participation rates (*WE* and *SE*) by highest educational attainment are small. Compared to men with an obligatory education, men with a higher education have a higher probability of being self-employed, but a lower probability of being wage-employed, see Figure 4.5a). Moreover, men with a tertiary education and reporting no ADL have a higher probability of being inactive than men with a lower education. For men reporting ADL, labor force participation rates are higher for men with a tertiary eduction than for men with an obligatory education. By contrast, men with lower education have a higher probability of drawing a disability pension when reporting ADL, see Figure 4.5b). For men reporting ADL, there are no significant differences in

[34] To obtain confidence intervals, I regressed ADL status on labor force participation rates (no further controls).

the probability of being inactive.

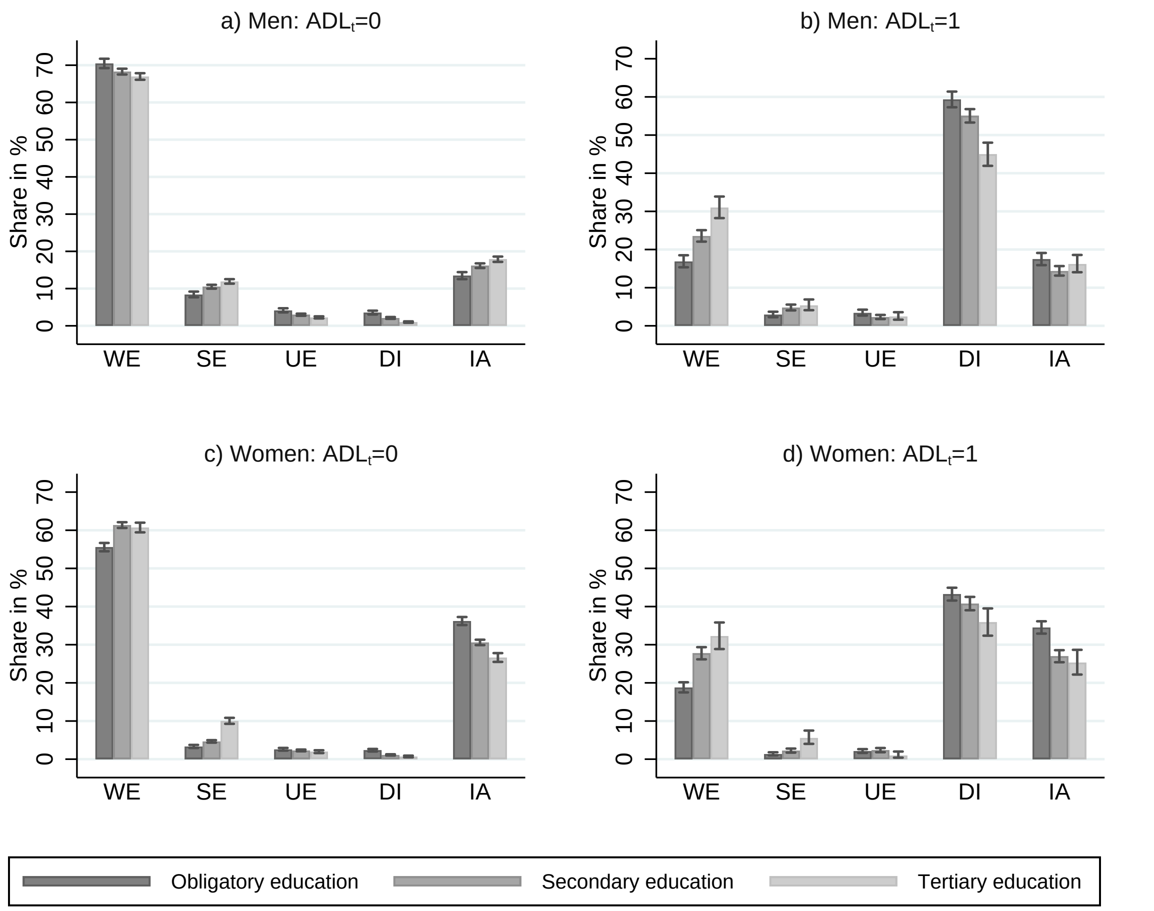
Figure 4.4: Labor market state by age, ADL status, and gender



Shares in exclusive labor market states by ADL status, age, and gender. Average values 2003-2009. WE=wage-employed, SE=self-employed, UE=unemployment beneficiary, DI=disability beneficiary, IA=inactive. Only women born in 1942 or later are included (FRA 64). The sample consists of individuals aged 50 to FRA, interviewed in the time period between 2003 and 2009. Data source: Own calculations, SESAM, FSO.

Labor force participation rates increase with education for women reporting no ADL, see Figure 4.5c). Women with an obligatory education are more likely to be inactive when reporting no ADL. For women reporting ADL, labor force participation rates increase with education, see Figure 4.5d). Moreover, women with obligatory education have a higher probability of drawing a disability pension when reporting ADL. Women with an obligatory education are more likely to be inactive compared to higher educated women when reporting ADL.

Figure 4.5: Shares in exclusive labor market states by education, ADL status, and gender



Shares in labor market states by gender, ADL status, and education. WE=wage-employed, SE=self-employed, UE=unemployment beneficiary, DI=disability beneficiary, IA=inactive. The sample consists of individuals aged between 50 and the FRA, interviewed in the time period between 2003 and 2009. Data source: Own calculations based on SESAM, FSO.

4.5 Descriptive results 2: Transitions

4.5.1 Level

The observed transition rates between the five labor market states by ADL status are presented in Table 4.3. The table presents the probability of being in a labor market state at time t conditional on being in a given labor market state in $t-1$. Therefore, each row sums up to one.

Table 4.3: Transition rates by ADL status and gender

	Men: $ADL_{t-1} = 0$					
	t: WE	t: SE	t: UE	t: DA	t: IA	Total
t-1: WE	93.4	0.6	2.1	0.3	3.7	100.0
t-1: SE	8.6	78.8	0.4	0.4	11.9	100.0
t-1: UE	31.7	2.6	49.7	0.4	15.6	100.0
t-1: DA	1.0	0.0	0.3	98.0	0.7	100.0
t-1: IA	7.0	4.1	0.6	0.7	87.6	100.0
	Men: $ADL_{t-1} = 1$					
	t: WE	t: SE	t: UE	t: DA	t: IA	Total
t-1: WE	80.2	0.8	3.4	7.7	7.9	100.0
t-1: SE	7.1	67.7	0.0	6.5	18.7	100.0
t-1: UE	31.7	1.0	43.6	5.9	17.8	100.0
t-1: DA	0.1	0.1	0.1	99.3	0.5	100.0
t-1: IA	5.2	3.2	2.6	7.8	81.3	100.0
	Women: $ADL_{t-1} = 0$					
	t: WE	t: SE	t: UE	t: DA	t: IA	Total
t-1: WE	93.0	0.5	2.0	0.3	4.2	100.0
t-1: SE	9.0	77.0	0.2	0.2	13.6	100.0
t-1: UE	41.5	0.9	45.2	0.7	11.8	100.0
t-1: DA	1.0	0.0	0.5	97.6	1.0	100.0
t-1: IA	4.2	2.0	0.3	0.2	93.3	100.0
	Women: $ADL_{t-1} = 1$					
	t: WE	t: SE	t: UE	t: DA	t: IA	Total
t-1: WE	84.0	0.7	3.2	4.2	7.9	100.0
t-1: SE	9.1	67.5	0.0	5.2	18.2	100.0
t-1: UE	27.7	0.0	37.3	6.0	28.9	100.0
t-1: DA	0.4	0.1	0.2	98.8	0.5	100.0
t-1: IA	2.9	0.9	0.5	3.6	92.0	100.0

Observed transitions by ADL status and gender in percentage points. The sample consists of individuals aged 50 to FRA, interviewed in the time period between 2003 and 2009. WE=wage-employed, SE=self-employed, UE=unemployment beneficiary, DI=disability beneficiary, IA=inactive. Average values for time 2003-2009. Data source: Own calculations based on SESAM, FSO.

In the sample, only few individuals make a transition from wage to self-employment. A substantial share of individuals in unemployment remain unemployed or make a transition to inactivity. The outflow from disability insurance is very small. Even among respondent reporting no ADL, the outflow rate does not exceed two percent. Last, a substantial share of individuals returns to the labor market after a period of inactivity. This phenomena is commonly referred to as *unretirement* (Maestas, 2010; Kanabar, 2015). The observed transition rates suggest that unretirement is not a marginal phenomena in Switzerland.

4.5.2 Difference by ADL status

In the following, I study the association between reporting ADL and the transition rates between between labor market states. Figure 4.6, 4.7, 4.8, and 4.9 are constructed as follows:

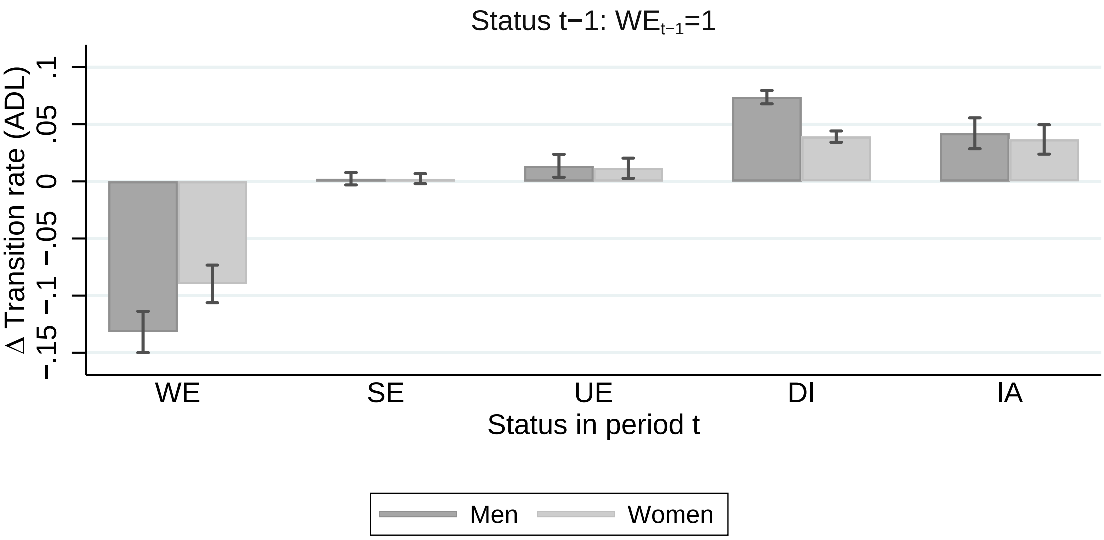
Construction difference graphs: Let LS_t denote the labor market status in period t, where LS_t takes the values $s \in \{WE, SE, UE, DI, IA\}$. I define the difference in the transition rates from labor market state s_2 to labor market state s_1 as

$$\begin{aligned} \Delta\text{TR} = &Pr(LS_t = s_1 | ADL_{t-1} = 0, LS_{t-1} = s_2, X_{t-1}) \\ &- Pr(LS_t = s_1 | ADL_{t-1} = 1, LS_{t-1} = s_2, X_{t-1}), \end{aligned} \tag{4.1}$$

where $s_1, s_2 \in \{WE, SE, UE, DI, IA\}$. Demographic characteristics are denoted by X_{t-1}. Standard errors of the difference in transition rates are calculated by regressing ADL_{t-1} on the transition rates.

The results for the transition rate from wage-employment are presented in Figure 4.6. Reporting ADL is associated with a higher probability of exiting wage-employment. The difference by ADL status is larger for men. The difference in exit rate from wage-employment amounts to 13.2 percentage points (95% CI, 11.4% to 15.0%) for men and to 9.0 percentage points (95% CI, 7.3% to 10.6%) for women. Moreover, I do not find evidence that reporting ADL is associated with a higher transition rate from wage to self-employment. Reporting ADL is associated with a higher probability of a transition from wage to unemployment. The difference in the transition rate from wage-employment to unemployment amounts to 1.7 percentage points (95% CI, 0.4% to 2.4%) for men and to 1.2 percentage points (95% CI, 0.3% to 2.0%) for women. Moreover, reporting ADL is associated with a higher probability of a transition from wage-employment to the disability insurance. The difference is larger for men. The difference in the transition rate by ADL status from wage-employment to the disability insurance amounts to 7.4 percentage points (95% CI, 6.7% to 8.0%) for men and to 4.0 percentage points (95% CI, 3.4% to 4.4%) for women. Last, reporting ADL is associated with a higher probability of making a transition from wage-employment to inactivity. The difference in the transition rate by ADL status from wage-employment to inactivity amounts to 4.2 percentage points (95% CI, 2.9% to 5.6%) for men and to 3.6 percentage points (95% CI, 2.4% to 5.0%) for women.

Figure 4.6: Difference in transition rates from wage-employment

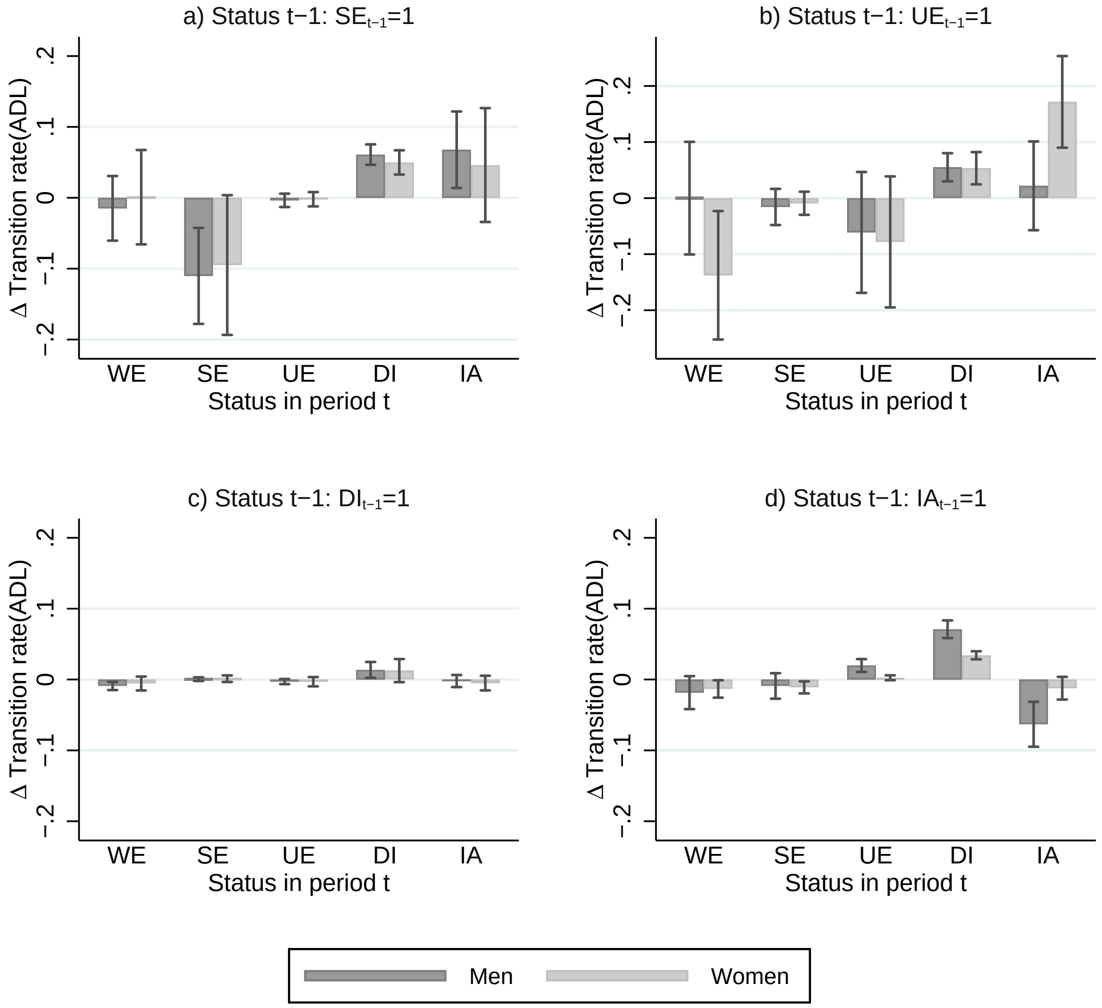


Difference in transition rates (ADL status) from wage-employment by gender. The sample consists of individuals aged 50 to FRA, interviewed in the time period between 2003 and 2009. WE=wage-employed, SE=self-employed, UE=unemployment beneficiary, DI=disability beneficiary, IA=inactive. Own calculations based on SESAM, FSO.

The results for the differences in transition rates from self-employment, unemployment, disability insurance, and inactivity are set up in Figure 4.7. Reporting ADL is associated with a higher probability of exiting self-employment, see Figure 4.7a). Moreover, reporting ADL is associated with a higher probability of a transition from self-employment to the disability insurance. The difference in the transition rate by ADL status from self-employment to the disability insurance amounts to 6.0 percentage points (95% CI, 4.6% to 7.5%) for men and to 4.9 percentage points (95% CI, 3.2% to 6.7%) for women.

There is an association between reporting ADL and a higher probability of making a transition from unemployment to the disability insurance, see Figure 4.7b). Moreover, reporting ADL is associated with a higher probability of making a transition from unemployment to inactivity for women. For men, I find that reporting ADL is associated with a higher probability of staying in the disability insurance, see Figure 4.7c). The difference, however, is small. The difference in the probability of staying in the disability insurance by ADL status amounts to 1.4 percentage points (95% CI, 0.2% to 2.5%) for men.

Figure 4.7: Difference in transition rates from SE, UE, DI, and IA



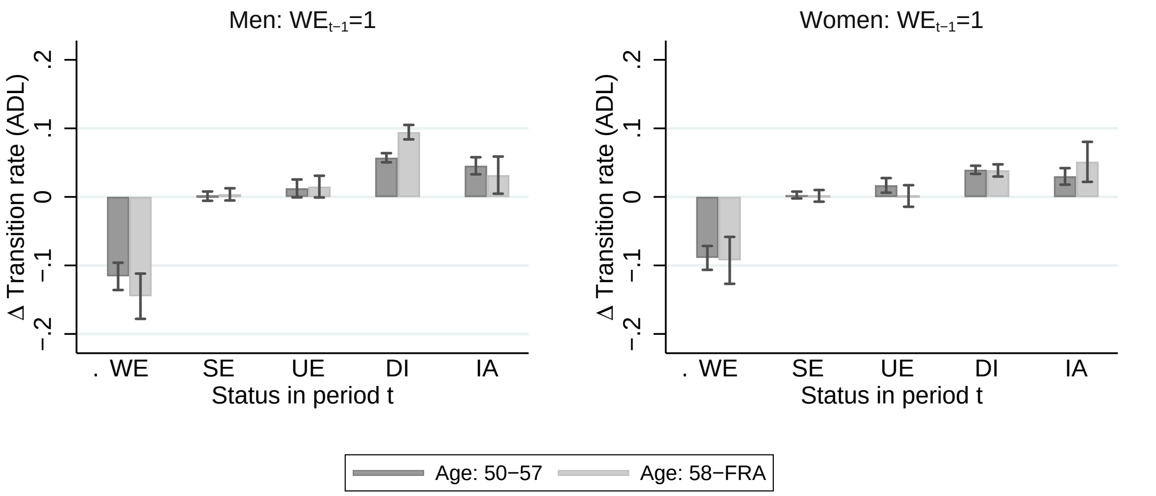
Difference in transition rates (ADL status) by gender from self-employment a), unemployment b), disability c), and inactivity d). The sample consists of individuals aged 50 to FRA, interviewed in the time period between 2003 and 2009. WE=wage-employed, SE=self-employed, UE=unemployment beneficiary, DI=disability beneficiary, IA=inactive. Data source: Own calculations, SESAM, FSO.

Last, reporting ADL is associated with a higher probability for a transition from inactivity to disability for both men and women, see Figure 4.7d). The association is stronger for men. The difference in the transition rate by ADL status from self-employment to the disability insurance amounts to 6.0 percentage points (95% CI, 4.6% to 7.5%) for men and to 4.9 percentage points (95% CI, 3.2% to 6.7%) for women. Moreover, reporting ADL is associated with a higher transition rate from inactivity to the unemployment insurance. The difference in transition rates amounts to 2.0 percentage points (95% CI, 1.1% to 2.9%) for men.

Heterogeneity: Age

Figure 4.8 displays differences in transition rates from wage-employment by age group and gender. For men, the association between reporting ADL and the probability of exiting wage-employment is stronger for men aged 58-FRA than for men aged 50-57. This result, however, should be interpreted with caution, since confidence intervals are overlapping. Moreover, the association between reporting ADL and the probability of a transition from wage-employment to the disability insurance is stronger for men aged 58-FRA than for men aged 50-57. In contrast to men, I do not find evidence for an age group difference in the association between reporting ADL and the transition rate from wage-employment to the disability insurance for women.

Figure 4.8: Difference transition rates from wage-employment by age group



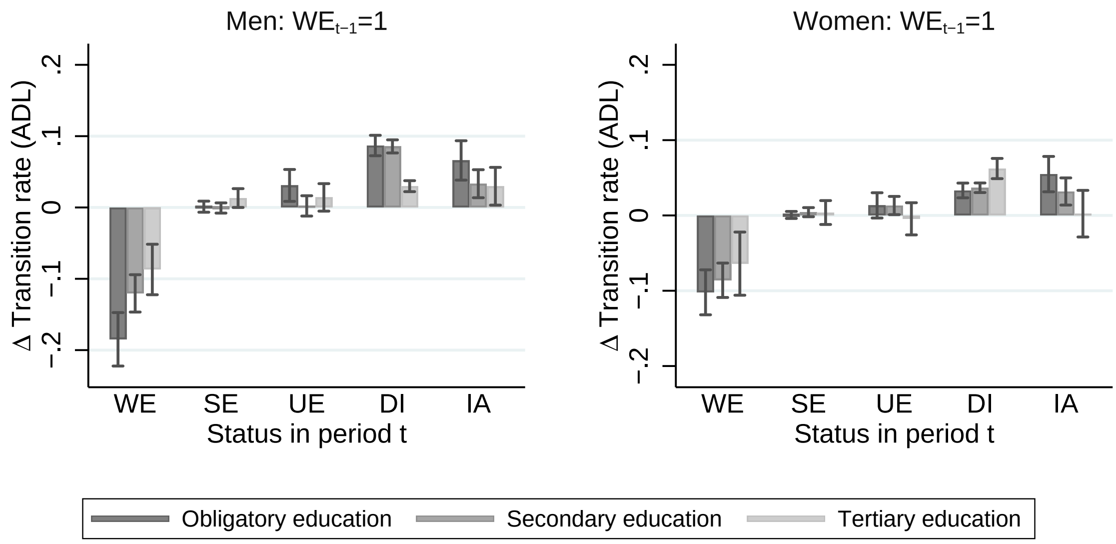
Difference in transition rates from wage-employment by gender and age group. The sample consists of individuals aged 50 to FRA, interviewed in the time period between 2003 and 2009. WE=wage-employed, SE=self-employed, UE=unemployment beneficiary, DI=disability beneficiary, IA=inactive. Data source: Own calculations, SESAM, FSO. Data source: Own calculations based on SESAM, FSO.

Heterogeneity: Education

Figure 4.8 displays differences in transition rates from wage-employment by education and gender. The association between reporting ADL and the exit rate from wage-employment is stronger for men with lower educational attainment. The difference in the probability of exiting wage-employment ranges from 18.5% (95% CI, 14.7% to 22.2%) for men with an obligatory education to 8.7 percentage points (95% CI, 5.2% to 12.2%) for men with a tertiary education. The association between reporting ADL and the transition rate between wage-employment and disability insurance is stronger for men with lower educational attainment. The difference in the probability of a transition from wage-employment to the disability insurance ranges from to 8.7 percentage points (95% CI, 7.3% to 10.1%) for men with an obligatory education to 3.0 percentage points (95% CI, 2.2% to 3.8%) for men with a tertiary education.

The association between reporting ADL and exit rate from wage-employment is stronger for women with lower educational attainment. The difference in the probability of exiting wage-employment ranges from to 10.2 percentage points (95% CI, 7.2% to 13.2%) for women with an obligatory education to 6.4 percentage points (95% CI, 2.2% to 10.6%) for women with a tertiary education. In contrast to men, the association between reporting ADL and the transition rate from wage-employment to the disability insurance is stronger for women with higher educational attainment. The difference in the transition rate from wage-employment to the disability insurance ranges from to 3.3 percentage points (95% CI, 2.3% to 4.3%) for women with an obligatory education to 6.2 percentage points (95% CI, 4.9% to 7.6%) for women with a tertiary education.

Figure 4.9: Difference in transition rates from WE by gender and education.



Difference in transition rates from wage-employment by gender and the respondents highest educational attainment. The sample consists of individuals aged 50 to FRA, interviewed in the time period between 2003 and 2009. WE: wage-employed, SE: self-Employed, UE: unemployed, DI: disability beneficiary, IA: inactive. Average values for time 2003-2009. Data source: Own calculations, SESAM, FSO.

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Appendix 4.A Variable definitions

Table 4.4: Variable definitions

Variable	Definition	Data source
Dependent Variable		
ADL	= 1 if reporting a disability restricting in activities of daily living(ADL) = 0 otherwise	SLFS
Labor market status		
Wage-employed (WE)	= 1 if positive earnings from wage-employment, no self-employment income, no disability benefits, and no unemployment benefits = 0 otherwise	Admin
Self-employed (SE)	= 1 positive earnings from self-employment, no disability benefits, and no unemployment benefits = 0 otherwise	Admin
Unemployed (UE)	= 1 if unemployment benefits recipient, and no disability benefits = 0 otherwise	Admin
Disability beneficiary (DI)	= 1 if disability beneficiary = 0 otherwise	
Inactive (IA)	= 1 if no earnings, no unemployment benefits, and no disability benefits = 0 otherwise	Admin
Socio-economic variables		
Age	age in years at time of the interview	SLFS
FRA reached	= 1 if FRA reached, = 0 otherwise	SLFS
Married	= 1 if married, = 0 otherwise	SLFS
Obligatory education	= 1 if highest degree of education is an obligatory education, = 0 otherwise	SLFS
Secondary education	= 1 if highest degree of education is a secondary degree, = 0 otherwise	SLFS
Tertiary education	= 1 if highest degree of education is a tertiary degree, = 0 otherwise	SLFS

Classification into labor market states based on status in month of the interview. SLFS: Swiss Labor Force Survey, Admin: Administrative social security records.

Appendix 4.B Supplementary graphs and tables

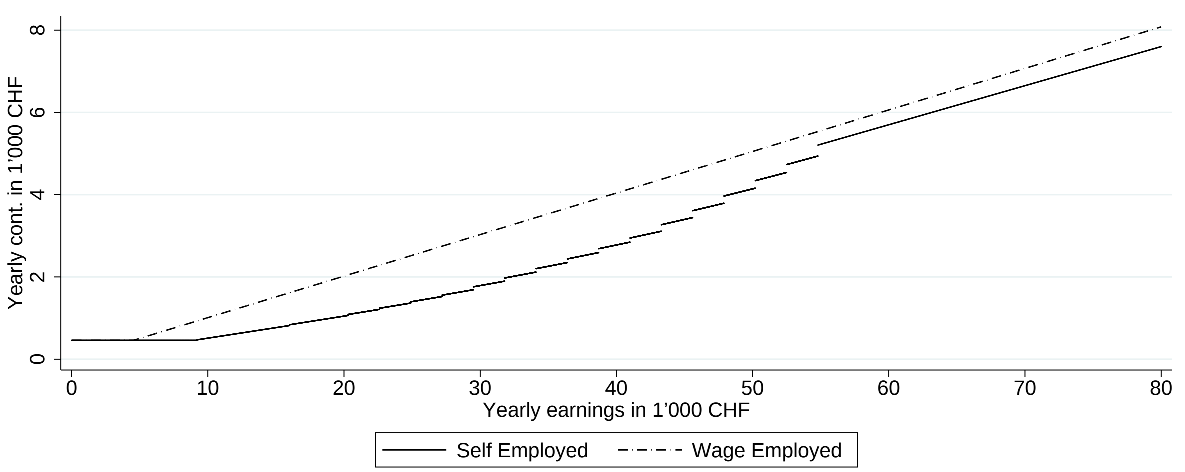


Figure 4.10: Earnings and Social Security contributions (old age and disability insurance) for wage-employed and self-employed (combined old age, survivors and disability insurance) in 2005.

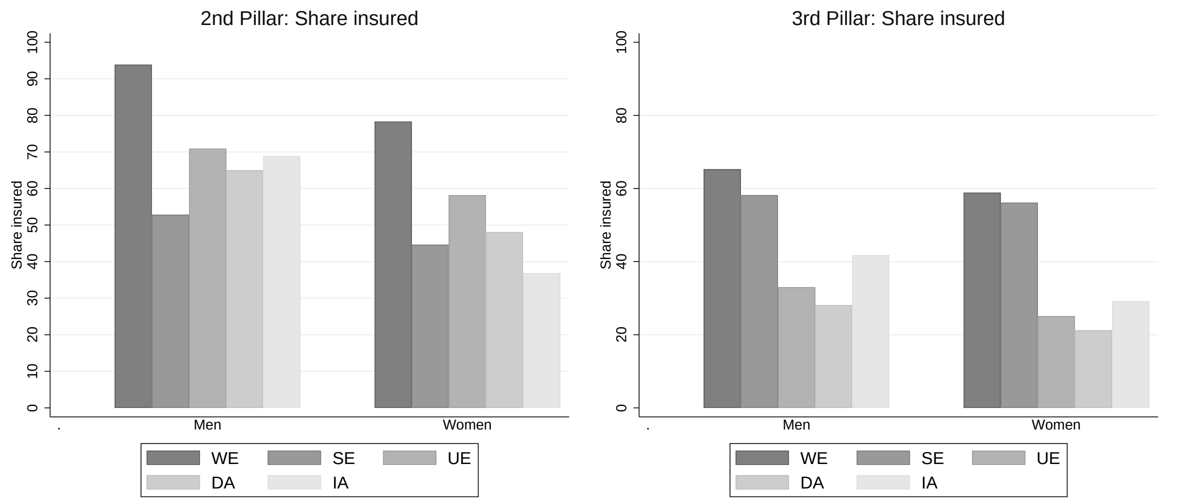
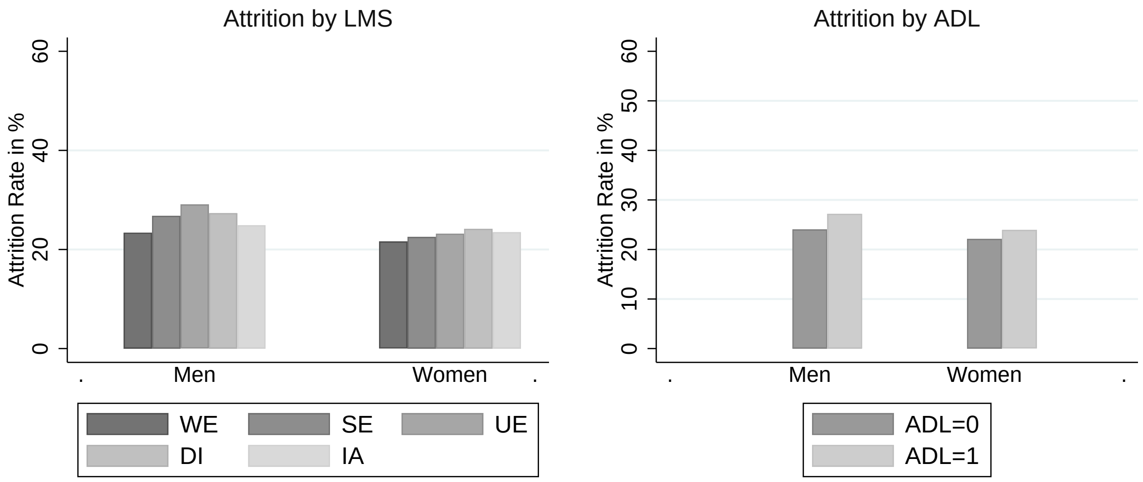


Figure 4.11: Share of individuals insured in 2nd and 3rd pillar in percentage. WE=wage-employed, SE=self-employed, UE=unemployment beneficiary, DA=disabled, IA=inactive. Labor market status based on social security status at time of the interview. Data source: Own calculations based on special module on social security (years 2002, 2005, 2008, 2012), SESAM, FSO.

Figure 4.12: Attrition rate by labor market states, ADL status, and gender



Attrition rate by labor market status and DAL status. The attrition rate is defined as the probability of not being interviewed in the next period, conditional that the individual has not yet had five interviews or has been interviewed in 2009. The sample consists of individuals aged 50 to FRA, interviewed in the time period between 2003 and 2009. Source: Own calculations based on SESAM, FSO.

Chapter 5

Self-Reported Disability and the Full Retirement Age: New Evidence on the Justification Bias

5.1 Introduction

A large literature studies the relationship between ill health and labor market status of older workers. In this literature, self-reported disability measures are frequently used. In contrast to more specific and objective disability measures, self-reported disability measures have the advantage that individuals can summarize in one measure how diseases affect them in their capacity to work or their ability to carry out day to day tasks. One problem associated with self-reported disability measures is that survey respondents exaggerate self-reported disability to rationalize their labor market status or welfare receipt (Butler et al., 1987; Bound, 1991). The extent to which individuals misreport is referred to as the *justification bias*.

In this chapter, I estimate the extent of justification bias among older disability insurance (DI) beneficiaries in Switzerland using a new identification strategy. I exploit the feature that a first pillar disability pension is converted to an old age pension at the full retirement age (FRA).[1] Pension receipt is no longer subject to medical criteria after the FRA. I compare the share of DI beneficiaries reporting a disability that limits them in activities of daily living (ADL) before and after reaching FRA. I attribute the difference in the share of DI beneficiaries reporting ADL to the justification bias. For the analysis, I use observations drawn from the social protection and labour market data set (SESAM) from the Federal office of statistics for the time period between 2003 and 2009.[2] This data set links survey data from the Swiss Labor Force Survey (SLFS)[3] with administrative social

[1]The FRA denotes the age at which an *old age pension* can be claimed without deductions.

[2]German: Soziale Sicherung und Arbeitsmarkt (SESAM), Bundesamt für Statistik (BFS).

[3]German: Schweizerische Arbeitskräfteerhebung, Bundesamt für Statistik (BFS).

security records.
For male DI beneficiaries, I find a large and statistically significant drop in the share reporting ADL when the FRA is reached. I attribute this drop to the presence of a justification bias. I find evidence that the effect is driven by male DI beneficiaries from cantons with above average DI enrolment rates. For women, I find a smaller and statistically non significant effect.
The main identifying assumption of the approach in this chapter is that relabelling a transfer from "disability benefit" to "old age pension" does not causally affect health. Arguably, there is stigma associated with drawing a disability pension, especially in the case of mental illness. If stigma directly affects health, e.g. through social exclusion, the conversion of a disability pension into an old age pension may improve health of former DI beneficiaries.
Different identification strategies have been applied to quantify the extent of the justification bias. Benítez-Silva et al. (2004) analyse whether self-reported working disability in the Health and Retirement Study (HRS) data set coincides with the disability assessment of the Social Security Administration (SSA). They find no evidence that self-reported working disability is systematically different from the disability assessment of the SSA. Lindeboom and Kerkhofs (2009) estimate a model with self-reported health as a dependent and a more general health measure as the independent variable. Conditional on the value of the general health measure, they attribute differences in reporting behavior between individuals in different labor market states to the justification bias. Using a sample of older Dutch workers, they find evidence for a strong justification bias among DI beneficiaries. The same methodology was applied by Gannon (2009) for a sample of Irish workers. For the time period between 1995 and 2001, she finds that DI beneficiaries systematically over-reported disability.
This chapter is closely related to Black, Johnston, and Suziedelyte (2017). They exploit a question on disability occurring twice in the Australian HILDA survey.[4] They find evidence for a strong justification bias among inactive individuals and DI beneficiaries. In contrast to their approach, I compare the evolution of ADL reporting behavior across time. In the setting of Black et al. (2017), it is likely that individuals are already primed to exaggerate disability when answering the question for the first time in the survey. Therefore, comparing the answers of the reoccurring question may not fully capture the extent of the justification bias. The problem of persistence in misreporting still exists when using the identification strategy of this chapter, although the extent is arguably smaller.
The remainder of the chapter is organized as follows. In section 5.2, I outline the different types of disability benefits in Switzerland. Section 5.3 describes the data and presents descriptive evidence on the relationship between ADL and disability pension

[4] Household, Income and Labour Dynamics (HILDA).

status. Graphical evidence is presented in section 5.4. Econometric strategy and estimation results are presented and discussed in section 5.5. The last section concludes.

5.2 Disability benefits and the FRA in Switzerland

Individuals with a disability are entitled to a list of benefits regulated by the law.[5] The disability insurance covers the financial consequences of a *long term* inability to earn income. The disability insurance rests on a three pillar system with a pay-as-you-go system (1st pillar), occupational pension scheme (2nd pillar), and tax favoured savings (3rd pillar). Moreover, the accident and occupational disease insurance covers the *short term* as well as *long term* consequences of an accident or occupational disease.
In Table 5.1, eligibility criteria for various benefits before and after reaching FRA are listed. The remainder of this section provides a description of the benefits from disability and accident insurance, outlining eligibility criteria before and after FRA. A comprehensive description of the Swiss system can be found in chapter 4 of this thesis.

1st Pillar Disability Insurance

To be granted with a first pillar disability pension, an individual must have a medically verifiable long term invalidity owing to physical or mental impairment. An individual is entitled to a disability pension if the capacity to earn income has been reduced by at least 40% for a time period of at least 12 months and if the incapacity is expected to remain for at least another 12 months.[6]
First pillar pension entitlements expire if the claimant no longer fulfils the medical eligibility criteria, reaches FRA, or dies. Cantonal disability offices are obliged to reassess first pillar pension entitlements every 3-5 years. When the DI beneficiary reaches FRA, the disability pension is converted to an old age pension. For the conversion, the principle of protection of vested rights applies, meaning that the first pillar pension does not decrease when converted from a disability to an old age pension.
DI beneficiaries are entitled to helplessness allowances from the disability insurance if they depend on informal or formal care. When reaching FRA, the helplessness allowance from the disability insurance is converted to a helplessness allowance from the old age insurance. As for disability benefits, the principle of vested right applies. Moreover, old age and DI beneficiaries are entitled to need-based supplementary benefits if income is not sufficient to cover basic living costs.

[5]The following description is restricted to benefits regulated by the law (with the exception of super-mandatory occupational disability benefits). On top of these benefits, individuals are likely to be entitled to benefits from private insurance contracts when becoming disabled.

[6]Individuals whose earnings capacity is reduced by at least 70% are entitled to a full pension. A full pension ranged from 1'075 CHF (minimum) to 2'150 CHF (maximum) in 2005.

In the time period from 2003-2009, the disability insurance was reformed twice. In the context of the fourth revision of the disability insurance in 2004, the supplementary pension for the spouse for new DI beneficiaries was abolished and helplessness allowances were doubled. Disability benefits of existing DI beneficiaries aged 50 and above remained unchanged. In the context of the fifth revision of the disability insurance in 2008, rehabilitations measures were strengthened. The reform targeted mostly young individuals with a disability. Moreover, the FRA for women was increased in 2004 from 63 to 64 in the context of the 10th reform of the first pillar old age insurance.

2nd Pillar Disability Insurance

Occupational pension funds are obliged to insure employed individuals against the risk of invalidity. The law states that occupational disability pensions are paid until the individual restores ability to earn income or dies. After reaching FRA, the second pillar disability pension is no longer subject to revisions. Occupational pension funds are free to deviate from the law and convert pensions at FRA if they provide the legal minimum benefits for the *mandatory part*.[7] In a pension fund with a *contribution based scheme* for old age pensions and a *benefit based scheme* for the disability pension, the second pillar disability pension may be converted to an old age pension, depending on the pension fund regulation in place.[8]

Accident Insurance: Disability pension

The accident and occupational disease insurance is mandatory for wage employed individuals. If the earnings incapacity resulting from an accident or occupational disease is expected to be permanent, the insured individual is entitled to a disability pensions from the accident insurance. Disability pension entitlements from the accident expire if the beneficiary no longer fulfils the medical criteria or dies. The accident insurance is allowed to revise disability pensions if first pillar disability entitlements are revised. After reaching FRA, the disability pension from the accident insurance is no longer subject to revisions.

[7] The law determines contributions and benefits for yearly earnings between the deduction offset (2005: 22'575 CHF) and maximum insured earnings regulated by the law (2005: CHF 77'400). This part is commonly referred to as the *mandatory part*.

[8] The *defined contribution scheme* represents the default scheme. Hypothetical contributions at constant wage rate are projected until FRA and then converted into a disability pension, using the same conversion factor as for the old age pensions. In a *defined benefit scheme*, entitlements are calculated as a fraction of earnings before the occurrence of disability.

Table 5.1: Selected regulations before and after FRA is reached

	Eligibility and benefits		
Insurance branch	Characteristic	Before FRA	After FRA
1st pillar			
Disability benefits	Label	DI benefits	Old age benefits
	Medical eligibility criteria	Strict	None
	Revision	Every 3-5 years	None
	Benefits	Monthly full pension (2005): CHF 1'075-2'150 CHF	Monthly full pension (2005): CHF 1'075-2'150 CHF
	Dependent on previous earnings	Yes	Yes
	Means tested	No	No
Helplessness allowances	Benefits	20-80% of max. old age pension	20-80% of max. old age pension
	Dependent on previous earnings	No	No
	Means tested	No	No
Suppl. OASI benefits	Label	Supplementary benefits for DI benefits	Supplementary benefits for old age benefits
	Means tested	Yes	Yes
	Dependent on previous earnings	No	No
2nd pillar			
Mandatory part	Label	DI benefits	DI benefits
	Medical eligibility criteria	Strict	None
	Revision	Every 3-5 years	None
Super-mandatory part	Label	DI benefits	DI benefits
	Medical eligibility criteria	Strict	None
	Revision	Every 3-5 years	None
Accident insurance			
Disability Benefits	Label	DI benefits	DI benefits
	Medical eligibility criteria	Strict	None

Note: Own illustration based on federal law on old-age and survivors' insurance, the federal law on occupational retirement, survivors' and disability pension plans, the federal law on unemployment insurance, and the federal law on accident insurance. Characteristics which change when FRA is reached are highlighted.

5.3 Data

For the analysis, I use observations drawn from the social protection and labor market data set (SESAM) from the Federal Statistical Office (FSO) for the time period between 2003 and 2009.[9] See chapter 4 for a description of the SESAM data. The classification into labor market states is based on administrative records. The variable on ADL and socio-economic variables are constructed using data from the SLFS survey. A summary of all variables used in the analysis can be found in Table 5.6 in Appendix 5.A.

I use social security records to classify individuals into five mutually exclusive labor market states; *employed, unemployed, disabled, disabled and working*, and *inactive*. I classify an individual as *employed* if the person has positive earnings in the month of the interview, and neither draws a first pillar disability pension nor unemployment benefits. Individuals drawing unemployment benefits in the month of the interview are classified as being *unemployed*. Individuals drawing a first pillar disability pension and having no additional earnings are classified as being *disabled*. Individuals with positive earnings receiving a partial first pillar disability pension are counted as *disabled and working*. The remaining individuals are classified as *inactive*. In the sample of male respondents aged between 58 and the FRA, 64.8% are *employed*, 4.9% *unemployed*, 10.0% *disabled*, 4.3% *working and disabled*, and 20.5% *inactive*. In the sample of female respondents aged 58 to FRA, 51.5% were *employed*, 3.7% *unemployed*, 7.9% *disabled*, 2.9% *working and disabled*, and 37.0% *inactive*.

For the analysis, I use two age variables: *Age in the year of the interview* (AYI) and *age at time of the interview* (ATI). Individuals report their age at the time of the interview and the year of birth. No information on the month of birth is available. *Age in the year of the interview* is one year larger if the respondents birthday is after the date of the interview.

For the analysis, I exploit a question on ADL that was part of the Swiss Labor Force Survey in the time period between 2003 and 2009.

> *Many individuals face a physical or mental problem, which restricts them in their daily activities. Do you have such a problem or disease, lasting for more than one year?*[10]

[9] German: Soziale Sicherung und Arbeitsmarkt, Bundesamt für Statistik (BFS).

[10] German: Es gibt heutzutage viele Leute, welche ein körperliches oder psychisches Problem haben, welches sie in den alltäglichen Aktivitäten einschränkt. Haben Sie ein solches Problem oder eine solche Krankheit, welche schon länger als ein Jahr dauert?
French: Il y a actuellement beaucoup de gens qui ont un problème physique ou psychique qui les limite dans leurs activités quotidiennes. Avez-vous un tel problème ou une maladie de ce type, qui dure déjà depuis plus d'une année?
Italian: Oggigiorno, ci sono tante persone che hanno un problema fisico psichico che le limita nelle attività quotidiane. Ha un problema o una malattia del genere, che dura da più di un anno?
The corresponding SLFS variable is IZ30.

After the question on ADL, the respondent is asked whether he or she receives a disability pension. Importantly, the Federal Statistical office does not share individual level data with cantonal disability offices. Therefore, the responses in the survey cannot be used to monitor welfare eligibility.

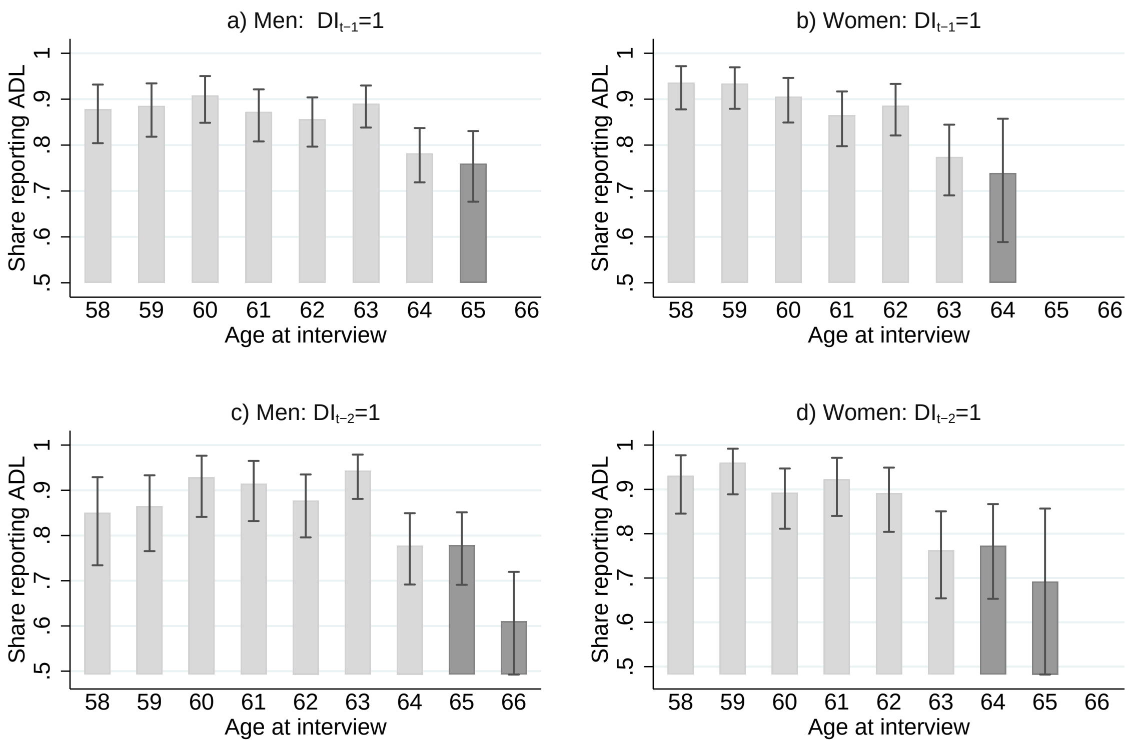
Moreover, I utilize aggregate data on disability pension enrolment rates by canton and year from the Federal Office for Social Insurance (FSIO). The average cantonal disability enrolment rates for the time period between 2003 and 2009 are displayed in Figure 5.5 in Appendix 5.A.

5.4 Graphical evidence

Share reporting ADL

Figure 5.1 depicts the share of DI beneficiaries reporting ADL by *age at time of the interview* (ATI) and gender. In Figure 5.1a) and 5.1b), the sample encompasses individuals who draw DI benefits in $t-1$. In Figure 5.1c) and 5.1d), the sample encompasses individuals drawing DI benefits in $t-2$. It is important to note that I make no restriction regarding labor market status in period t. Therefore, the sample includes DI recipients, but also respondents who left the disability insurance and are working or inactive in period t. It is important to include these individuals since at FRA, I no longer observe if the individual still was granted with DI benefits.

Figure 5.1: ADL by age at time of the interview (ATI) and gender

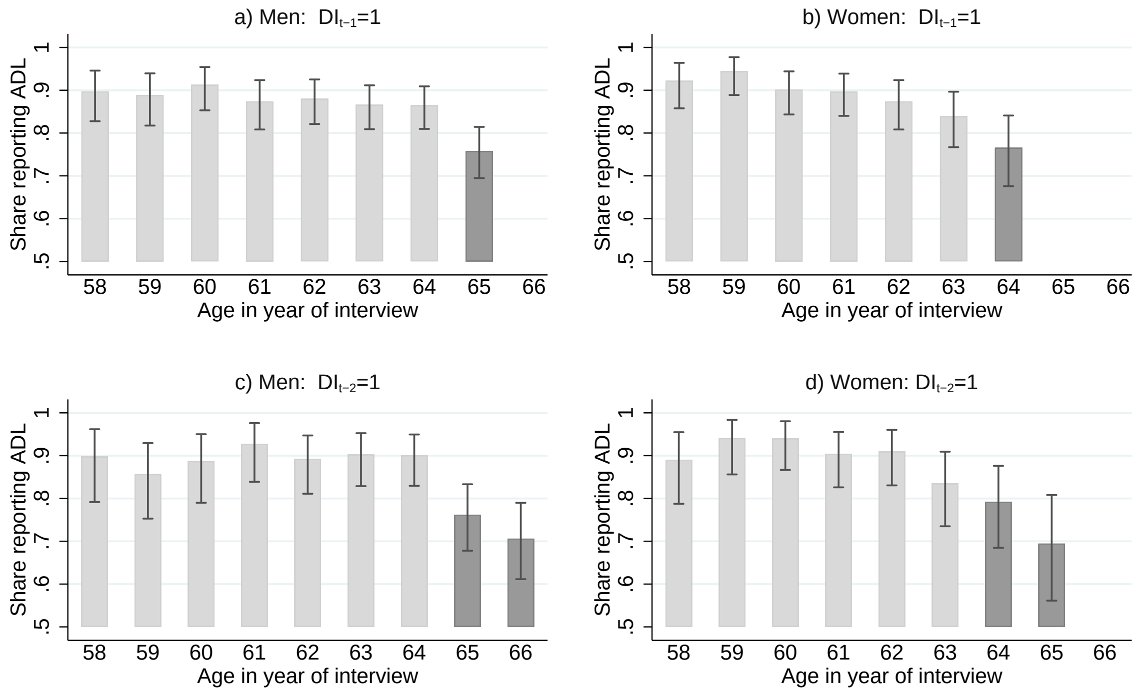


Share of DI beneficiaries reporting ADL by gender and *age at time of the interview* (ATI). Dark grey shaded bars indicate that FRA is reached at time of the interview. Only women born in 1942 or later are included. DI beneficiaries with positive earnings are excluded. Source: Own calculations based on SESAM, FSO (2003-2009).

Up to one year before FRA, the share of DI beneficiaries reporting ADL amounts to around 90% for both sexes. One year before FRA, there is a drop in the share reporting ADL for both men and women. The share reporting ADL drops from around 90% before FRA to less than 80% after FRA is reached. Moreover, results from Figure 5.1c) and 5.1d) indicate that the effect is larger for DI recipients who are two years after FRA.

Figure 5.2 displays the share reporting ADL by *age in the year of the interview* (AYI) instead of *age at time of the interview* (ATI). For men, the sharp drop in the share reporting ADL occurs once the respondent has reached the year of FRA. A similar pattern can be found for women, though the drop is less pronounced.

Figure 5.2: ADL by age in year of interview (AYI) and gender

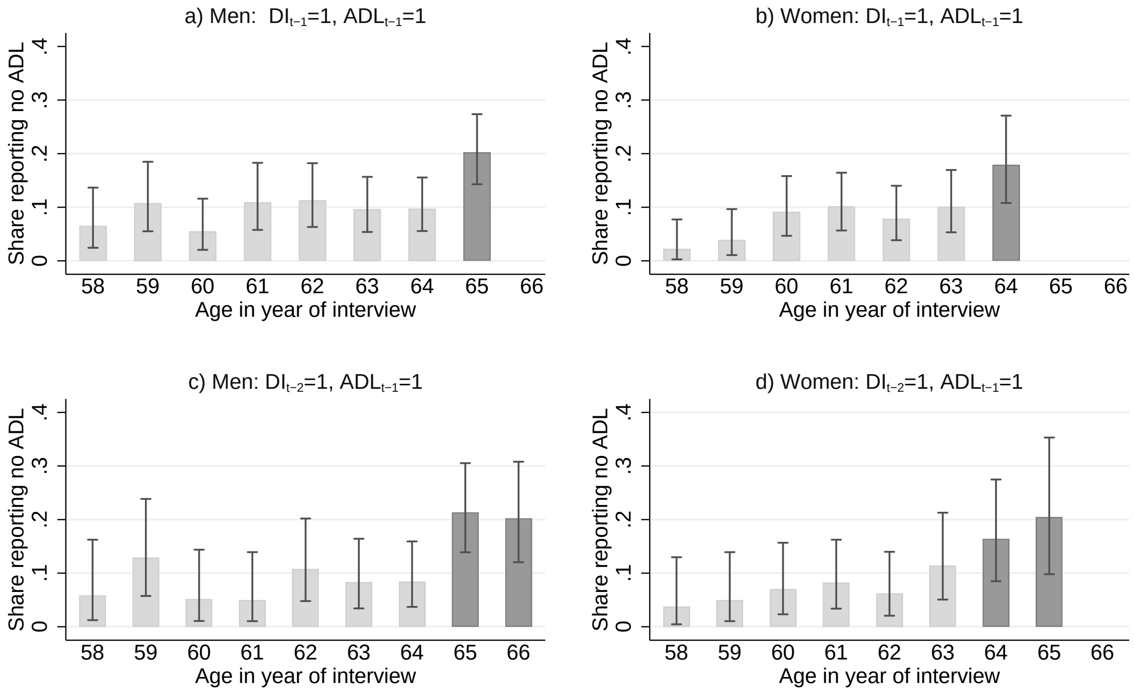


Share of DI beneficiaries reporting ADL by *age in the year of the interview* (AYI) and gender. Dark grey shaded bar indicate that FRA is reached in year of interview. Only women born in 1942 or later are included. DI beneficiaries with positive earnings are excluded. Source: Own calculations based on SESAM, FSO (2003-2009).

Transition in ADL status

One potential concern about the preceding analysis is sample attrition. DI beneficiaries in bad health may be more likely to drop out from the survey. I explore this issue by analysing how the ADL reporting behavior changes over time. Figure 5.3 displays the transition rate for ADL status by gender and *age in year of interview* (AYI). The transition rate is defined as the probability of reporting *no ADL* in period t, conditional that the respondent reported ADL in period $t-1$. Before FRA is reached, the share of DI beneficiaries reporting ADL in $t-1$ and reporting no ADL in period t amounts to around 10%. The share of DI beneficiaries making a transition increases sharply to around 20% once the respondent reaches the year of FRA. These results provide evidence that the findings from the previous section are driven by a change in the reporting behavior and not by sample attrition. Results on the transition rate for ADL status by gender and *age at time of interview* (ATI) can be found in Figure 5.7 in Appendix 5.A. Again, the transition rates increase sharply one year before FRA, which confirms results from the previous section.

Figure 5.3: Transition rates in ADL status by *age in year of interview* (AYI) and gender



DI beneficiaries: Probability of reporting no ADL in period t conditional on reporting ADL in $t-1$ by gender and *age in the year of the interview* (AYI). Dark grey shared bars indicate that FRA is reached in year of the interview. Only women born in 1942 or later are included. DI beneficiaries with positive earnings are excluded. Source: Own calculations based on SESAM, FSO (2003-2009).

5.5 Estimation

5.5.1 Econometric Strategy

Let ADL_{it} denote a dummy equal to one if individual i reports ADL in year t and zero otherwise. Conditional that individual i draws a disability pension s-years before period t, I estimate the effect of reaching FRA on the probability of reporting ADL in period t using a probit model of the form

$$P(ADL_{it} = 1 | T_{it}, \mathbf{X_{it}}) = \Phi(\beta_0 + \beta_1 T_{it} + \mathbf{X_{it}} \boldsymbol{\beta_2}) \qquad \text{for} \qquad DI_{t-s} = 1, \tag{5.1}$$

where $\mathbf{\Phi}(\cdot)$ denotes the cumulative normal distribution and where $s \in \{1, 2\}$. I estimate equation (5.1) separately for two different treatment status definitions. First, I use a treatment status definition based on *age at time of the interview* (ATI) defined as

$$T_{it}^{ATI} = \begin{cases} 1 & \text{if individual i has reached FRA at time of interview,} \\ 0 & \text{otherwise.} \end{cases}$$

Second, I use a treatment status definition based on *age in the year of the interview* (AYI) defined as

$$T_{it}^{AYI} = \begin{cases} 1 & \text{if individual i reaches or has reached FRA in year t,} \\ 0 & \text{otherwise.} \end{cases}$$

The vector of controls is denoted by $\mathbf{X_{it}}$. The set of controls includes a linear age trend, education dummies and a dummy for marital status. Moreover, I control for the age at which the respondent received DI benefits for the first time. I include year dummies to account for the reforms taking place in 2004 and 2008. Standard errors are clustered at the individual level. For the estimation, I restrict the sample to individuals aged 58 and above.

I am interested in the average partial effect of T_{it}, which measures the effect of reaching FRA on the probability of reporting ADL. Broadly speaking, I compare the probability of reporting ADL at time t of an individual who drew a disability pension in $t - s$ and has not reached FRA, with an individual who drew a disability pension in year $t - s$ and has reached FRA. After controlling for the variables mentioned above, I attribute the difference in self-reported ADL between the two groups to the justification bias. I estimate equation (5.1) separately for the sample of individuals who drew a disability pension one year before period t and the sample of individuals who drew a disability pension two years before period t.[11] It is important to note that I make no restriction

[11] The sample size does not allow to go back more than two periods.

regarding labor market status in period t.

I do not include individuals who simultaneously participate in the labor market and draw a first pillar disability pension. Retirement from work may have a positive or negative effect on health.[12] In this case, I would falsely attribute an actual improvement or decline of health to the justification bias.

In general, older workers do not have relaxed access to first pillar disability benefits. Cantonal disability offices, however, assess eligibility for DI benefits not only based on medical, but also on vocational factors. As shown in Müller and Boes (2016), age is an important determinant for the probability of being granted a disability pension. Compared to DI beneficiaries who have been receiving DI benefits since young ages, DI beneficiaries who are granted with a pension at an older age may be less likely to have a serious health impairment or have a higher probability of recovering from a disease or accident.[13] To account for the effect of relaxed implicit eligibility for disability benefits of older applicants, I control for age of the DI beneficiary and the age at which the DI beneficiary received a first pillar pension for the first time.

The main identifying assumption is that relabelling a transfer from "disability benefit" to "old age pension" does not causally affect health. Arguably, there is stigma attached to drawing disability pension, especially in case of mental illness. If the stigmatization of drawing disability benefits directly affects health, e.g. through social exclusion, the conversion of a disability pension into an old age pension may improve health of former DI beneficiaries. In this case, my estimate would be upward biased since I would falsely attribute actual improved health to the justification bias. It is important to note that the identification strategy does not require that DI benefit receipt has no causal effect on health.[14]

Moreover, former DI beneficiaries may still be primed to overstate self-reported disability after having reached FRA. The problem of misreporting persistence still exists when using the identification strategy in this chapter, although the extent is arguably smaller. Moreover, the analysis of individuals who drew a disability pension two years before the interview allows me to reveal part of this reporting persistence.

Furthermore, I study the association between the justification bias and the DI enrolment rate in cantons by estimating equation (5.1) with an interaction term. Details on how average partial effects are computed in the interacted model are presented in Appendix 5.B.

[12] Evidence on the causal relationship between retirement from work and health is mixed. Depending on country and health measure, studies find positive (Coe & Zamarro, 2011; Eibich, 2015; Bloemen, Hochguertel, & Zweerink, 2017) and negative effects (Rohwedder & Willis, 2010; Behncke, 2012; Mazzonna & Peracchi, 2012) of retirement from work on health.

[13] Müller and Boes (2016) contacted several heads of cantonal DI offices and found that DI benefits are used in many cases as a pathway for early retirement.

[14] See for example Börsch-Supan et al. (2017) who found that DI benefit receipt has a positive effect on self-reported health.

5.5.2 Results

The estimation results for men are presented in Table 5.2. In column 1) and column 2) of Table 5.2, the results for the sample drawing a disability pension in period $t-1$ are presented. Using the treatment status definition based on *age at time of the interview*, I find a negative but statistically insignificant effect. By contrast, the effect is larger and statistically significant using the treatment status definition based on *age at time of the interview*. I find that the share reporting ADL drops by around 8 percentage points when reaching the year of FRA. In column 3) and column 4) of Table 5.2, the results for the sample drawing a disability pension in period $t-2$ are presented. Compared to the sample of individuals drawing a disability pension in $t-1$, the effect is larger and statistically significant for both treatment status definitions. I find that the share of male DI beneficiaries reporting ADL drops by around 10 percentage points using the treatment status definition based on *age at time of the interview* (ATI) and by around 16 percentage points using the *age in the year of the interview* (AYI) definition.

Table 5.2: Results estimation men

	Dependent variable: Indicator $\mathbb{1}(ADL_t = 1)$			
	Men: $DI_{t-1} = 1$		Men: $DI_{t-2} = 1$	
	1) APE	2) APE	3) APE	4) APE
FRA reached (ATI)	−0.041 (0.032)		−0.104*** (0.035)	
FRA reached (AYI)		−0.082*** (0.029)		−0.163*** (0.042)
Age	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes
Education Dummies	Yes	Yes	Yes	Yes
Married	Yes	Yes	Yes	Yes
Age first DP	Yes	Yes	Yes	Yes
Observations	1337	1337	846	846

Note: Results Probit estimation. Average partial effects (APE) are reported. Standard errors are in brackets. Interviewed individuals are aged between 58 and FRA+2. Standard errors are clustered at individual level. $^{*}p < 0.1$. $^{**}p < 0.05$. $^{***}p < 0.01$.

The estimation results for women are presented in Table 5.3. In column 1) and column 2) of Table 5.3, the results for the sample drawing a disability pension in period $t-1$ are presented. Using the treatment status definition based on *age at time of the interview*, I find a negative but statistically insignificant effect for both treatment status definitions. In column 3) and column 4) of Table 5.3, the results for the sample drawing a disability pension in period $t-2$ are presented. Again, I find a negative but statistically insignificant effect for both treatment status definitions. Combining regression evidence with graphical evidence from Figure 5.1, Figure 5.2, and Figure 5.3, I cannot rule out the presence of a justification bias for female DI beneficiaries. Nevertheless, the results provide evidence that the effect is smaller for women compared to men.

Table 5.3: Results estimation women

	Dependent variable: Indicator $\mathbb{1}(ADL_t = 1)$			
	Women: $DI_{t-1} = 1$		Women: $DI_{t-2} = 1$	
	1) APE	2) APE	3) APE	4) APE
FRA reached (ATI)	−0.034 (0.033)		−0.010 (0.036)	
FRA reached (AYI)		−0.015 (0.032)		−0.041 (0.042)
Age	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes
Education Dummies	Yes	Yes	Yes	Yes
Married	Yes	Yes	Yes	Yes
Age first DP	Yes	Yes	Yes	Yes
Observations	1039	1039	695	695

Note: Results Probit estimation. Average partial effects (APE) are reported. Standard errors are in brackets. Interviewed individuals are aged between 58 and FRA+2. Standard errors are clustered at individual level. $^{*}p < 0.1$. $^{**}p < 0.05$. $^{***}p < 0.01$.

Robustness

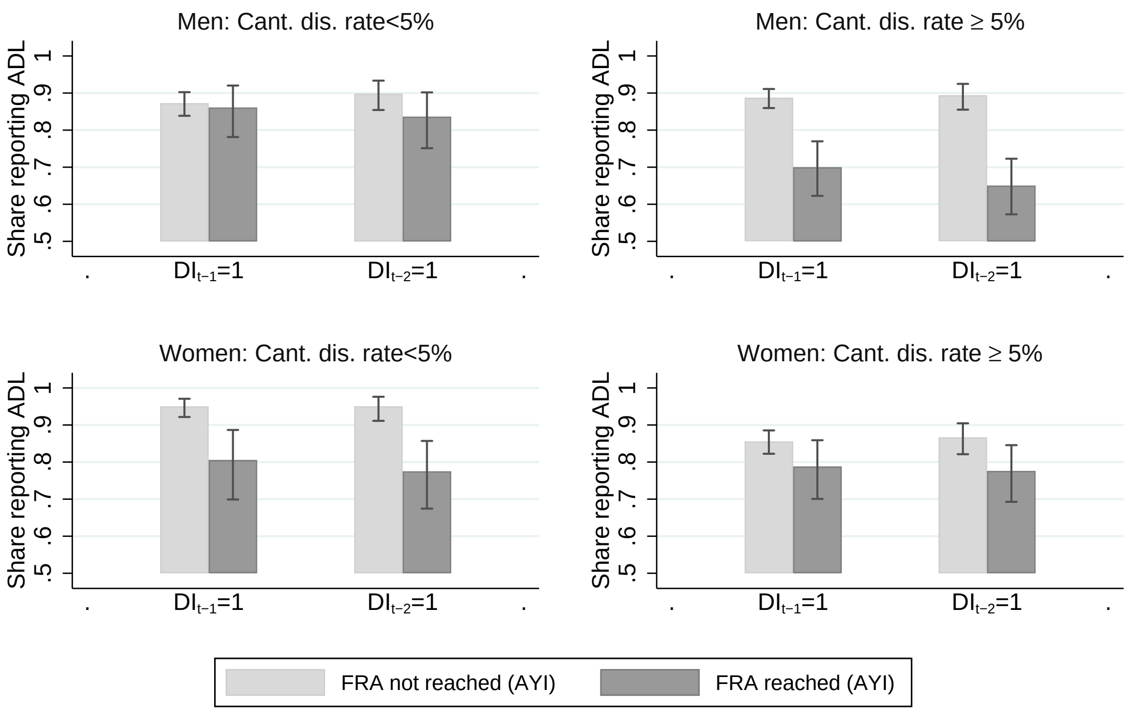
A potential concern is that the results are driven by individuals who got their first disability pension at older ages. In Appendix 5.A, I analysed whether the results are sensitive to the inclusion of DI beneficiaries who got their first disability pension after the age of 60. I estimated the effect of reaching FRA for the sample of individuals who got their first disability pension before the age of 60. Results are displayed in Table 5.7 and in Table 5.8 in Appendix 5.A. The results are very similar in both sign and magnitude. I find no evidence that the extent of the justification bias is driven by individuals who got their first disability pension at older ages.

5.5.3 Heterogeneity

I analyse whether the effect depends on the share of DI beneficiaries in the canton the individual has his or her residence. There are large differences in disability enrolment rates between cantons, see Figure 5.5 in Appendix 5.A. According to Spycher et al. (2003), only part of the difference can be explained by differences in the demographic structure

across cantons. A non-conclusive list for complementary explanations include difference in assessment standards, salience, and differences in reintegration measures.
I created a dummy which takes the value one if the respondent lives in a canton where the share of disability beneficiaries is above 5% (men and women combined) of the insured population, and zero otherwise.[15] Graphical evidence for men and women using treatment status definition based on *age in year of interview* is displayed in Figure 5.4. The effect of reaching FRA on the probability of reporting ADL is small and statistically insignificant for male DI recipients living in cantons with a disability enrolment rate below 5%. By contrast, the effect is large and statistically significant for male DI recipients living in cantons with disability enrolment rates above 5%.

Figure 5.4: ADL by FRA status (AYI) and cantonal DI enrolment rate



Share of DI beneficiaries reporting ADL by gender, FRA status, and cantonal DI enrolment rate. Individuals aged between 58 and 2 years after reaching FRA are included. DI beneficiaries with positive earnings are excluded. Source: Own calculations based on SESAM, FSO (2003-2009).

Estimation results for men are presented in table 5.4. In column 1) and column 2) of Table 5.4, the results for the sample drawing a disability pension in period $t-1$ are presented. In column 3) and column 4) of Table 5.4, the results for the sample drawing a disability pension in period $t-2$ are presented. I use DI beneficiaries who live in a canton with a DI enrolment rate below 5% and have not yet reached FRA as the

[15]The insured population encompasses all individuals aged 20 to FRA. 5% represents approximately the average share of DI beneficiaries in Switzerland for the time period between 2003 and 2009.

reference group. The estimate for the cantonal disability enrolment dummy is small and statistically insignificant.[16] This result suggests that the effect of living in a canton with high DI enrolment rates on the share reporting ADL is small before FRA is reached. The estimate for the FRA is small and statistically insignificant for both treatment status definitions and both samples. By contrast, the estimate for the interaction term is large and statistically significant. This result suggests that the drop in the share reporting ADL is mainly driven by respondents coming from canton with high DI enrolment rates.

Table 5.4: Results men: Heterogeneity by canton

	Dependent variable: Indicator $\mathbb{1}(ADL_t = 1)$			
	Men: $DI_{t-1} = 1$		Men: $DI_{t-2} = 1$	
	1)	2)	3)	4)
CDR >5%	0.005 (0.021)	0.020 (0.021)	−0.028 (0.027)	−0.001 (0.025)
FRA reached (ATI)	0.051 (0.039)		−0.042 (0.051)	
FRA reached (AYI)		0.010 (0.040)		−0.070 (0.054)
FRA reached (ATI) x CDR > 5%	−0.171*** (0.062)		−0.125* (0.064)	
FRA reached (AYI) x CDR > 5%		−0.169*** (0.051)		−0.185*** (0.059)
Age	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes
Education Dummies	Yes	Yes	Yes	Yes
Married	Yes	Yes	Yes	Yes
Age first DP	Yes	Yes	Yes	Yes
Observations	1337	1337	846	846

Note: Results Probit estimation. Average partial effects (APE) are reported. Standard errors are in brackets. CDR: Cantonal DI enrolment rate. Reference group: FRA not reached, living in a canton with DI enrolment rate < 5%. Interviewed individuals are aged between 58 and FRA+2. Standard errors are clustered at individual level. $^{*}p < 0.1$. $^{**}p < 0.05$. $^{***}p < 0.01$.

Estimation results for women are presented in table 5.5. In column 1) and column 2) of Table 5.5, the results for the sample drawing a disability pension in period $t-1$ are presented. In column 3) and column 4) of Table 5.5, the results for the sample drawing a disability pension in period $t-2$ are presented. I use female DI beneficiaries who live in a canton with a DI enrolment rate below 5% and have not yet reached FRA as the reference group. The estimate for the cantonal disability enrolment dummy is negative

[16] See equation (5.4) in Appendix 5.B.

and statistically significant. Therefore, women who have not yet reached FRA, have a smaller probability of reporting ADL when living in a canton with a higher DI enrolment rate. In contrast to men, the estimate for the interaction term is positive, though it is only statistically significant for the treatment definition using *age in year of interview*. Adding the estimate for the cantonal dummy to the interaction term provides weak evidence that women from cantons with low disability enrolment rates change their ADL reporting behavior when reaching FRA, whereas women from canton with high disability enrolment rates do not change their reporting behavior.

Table 5.5: Results women: Heterogeneity by canton

	Dependent variable: Indicator $\mathbb{1}(ADL_t = 1)$			
	Women: $DI_{t-1} = 1$		Women: $DI_{t-2} = 1$	
	1)	2)	3)	4)
CDR >5%	−0.091***	−0.106***	−0.095***	−0.112***
	(0.020)	(0.022)	(0.029)	(0.031)
FRA reached (ATI)	−0.074		−0.050	
	(0.055)		(0.047)	
FRA reached (AYI)		−0.067		−0.094*
		(0.041)		(0.050)
FRA reached (ATI) x CDR > 5%	0.070		0.079	
	(0.069)		(0.056)	
FRA reached (AYI) x CDR > 5%		0.095**		0.107**
		(0.048)		(0.054)
Age	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes
Education Dummies	Yes	Yes	Yes	Yes
Married	Yes	Yes	Yes	Yes
Age first DP	Yes	Yes	Yes	Yes
Observations	1039	1039	695	695

Note: Results Probit estimation. Average partial effects (APE) are reported. Standard errors are in brackets. CDR: Cantonal DI enrolment rate. Reference group: FRA not reached, living in a canton with DI enrolment rate < 5%. Interviewed individuals are aged between 58 and FRA+2. Standard errors are clustered at individual level. $^{*}p < 0.1$. $^{**}p < 0.05$. $^{***}p < 0.01$.

5.6 Conclusion

For male DI beneficiaries, I find that the share reporting ADL sharply drops at FRA. I attribute this drop to the presence of a justification bias. For women, the estimate for the justification bias is smaller and statistically insignificant. The presence of a justification bias among female disability beneficiaries, however, cannot be ruled out.

In the heterogeneity analysis, I find that the justification bias among male DI beneficiaries is mainly driven by individuals living in cantons with above average DI enrolment rates. This result raises interesting questions for future research. Are cantons with lower disability rates better at integrating individuals with a disability? Or are individuals in cantons with lower disability rates reluctant to apply for disability benefits due to social pressure?

5.7 Bibliography

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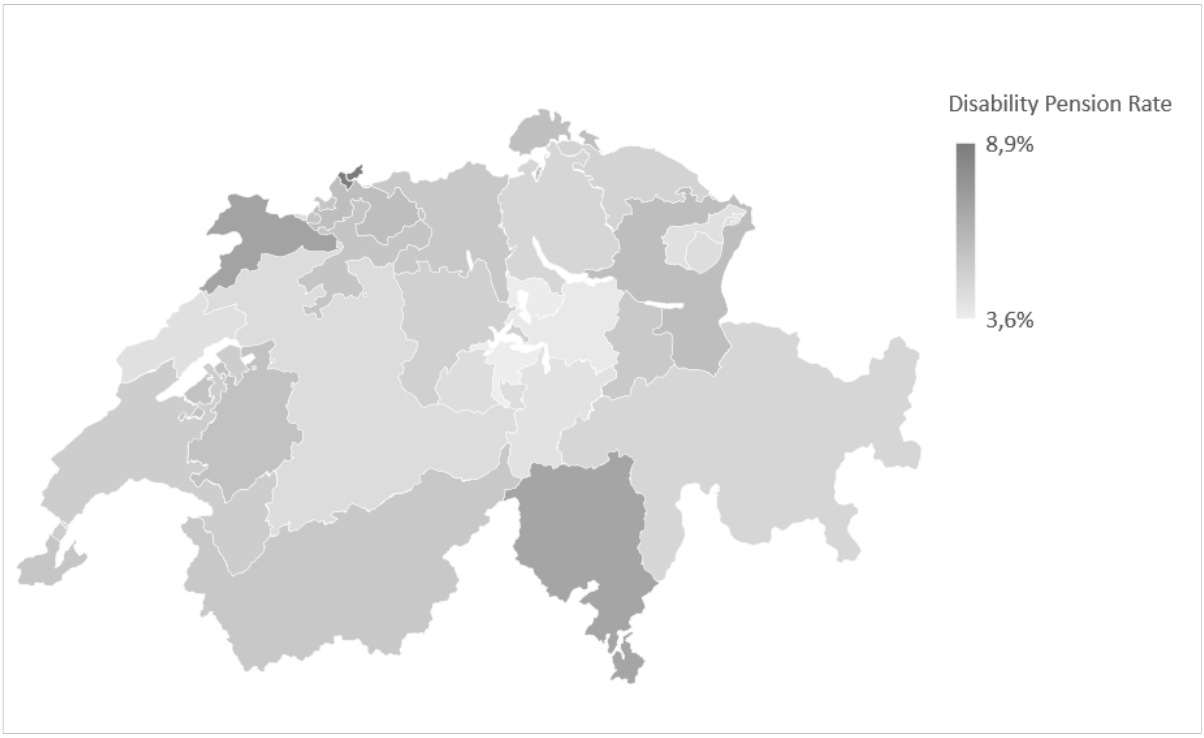
Appendix 5.A Additional tables and figures

Table 5.6: Variable definitions

Variable	Definition	Data source
Dependent Variable		
ADL	= 1 if a disability that limits activities of daily living is reported = 0 if no ADL is reported	SLFS
Labor market status		
Disabled	= 1 if disability pension recipient and no earnings, = 0 otherwise	Admin
Disabled and working	= 1 if disability pension recipient and positive earnings, = 0 otherwise	Admin
Unemployed	= 1 if unemployment benefits recipient, = 0 otherwise	Admin
Employed	= 1 positive earnings and no disability pension, = 0 otherwise	Admin
Inactive	= 1 no earnings, no disability pension, and no unemployment benefits	Admin
Socio-economic variables		
Age at time of interview (ATI)	= age in years at time of the interview	SLFS
Age in year of interview (AYI)	= age in years in year of interview	SLFS
FRA reached (ATI)	= 1 if individual has reached FRA at time of interview, = 0 otherwise	SLFS
FRA reached (AYI)	= 1 if individual reaches or has reached FRA in year of interview, = 0 otherwise	SLFS
Age 1st disability pension	= *age* in years at which 1st disability pension was drawn	Admin
Married	= 1 if married, = 0 otherwise	SLFS
Secondary education	= 1 if highest degree of education is secondary, = 0 otherwise	SLFS
Tertiary education	= 1 if highest degree of education is tertiary, = 0 otherwise	SLFS
Further variables		
Cant. dis. rate>5%	= 1 if respondent is living in year of interview in a canton with disability enrolment rate >5%, = 0 otherwise	FSIO

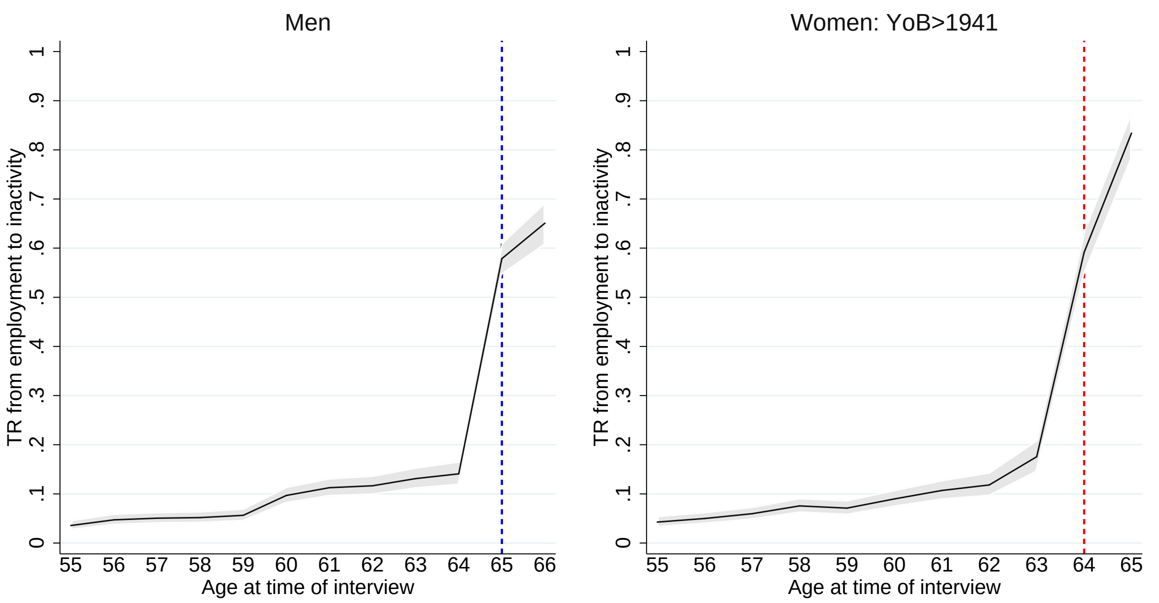
Classification into labor market states based on status in month of the interview. SLFS: Swiss labor force survey, Admin: Administrative social security records, FSIO: Federal social insurance office.

Figure 5.5: DI enrolment rate by canton



Share receiving disability benefits by canton. Average values for time period between 2003 and 2009. Source: Own illustration based on data from Federal Social Insurance Office.

Figure 5.6: Transition rates from employment to inactivity.



Transition rates from employment to inactivity by gender. Only women born in 1942 or earlier are included (FRA 64). Dotted lines represent FRA for men (FRA 65) and women (FRA 64). Shaded grey areas represent 95% confidence interval for mean estimate. Source: Own calculations based on SESAM, FSO (2003-2009).

Table 5.7: Men Robustness: Age first DI benefit < 60

	Dependent variable: Indicator $\mathbb{1}(ADL_t = 1)$			
	Men: $DI_{t-1} = 1$		Men: $DI_{t-2} = 1$	
	1) APE	2) APE	3) APE	4) APE
FRA reached (ATI)	-0.067^{*}		-0.119^{***}	
	(0.036)		(0.037)	
FRA reached (AYI)		-0.104^{***}		-0.168^{***}
		(0.033)		(0.043)
Age	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes
Education Dummies	Yes	Yes	Yes	Yes
Married	Yes	Yes	Yes	Yes
Age first DP	Yes	Yes	Yes	Yes
Observations	1165	1165	747	747

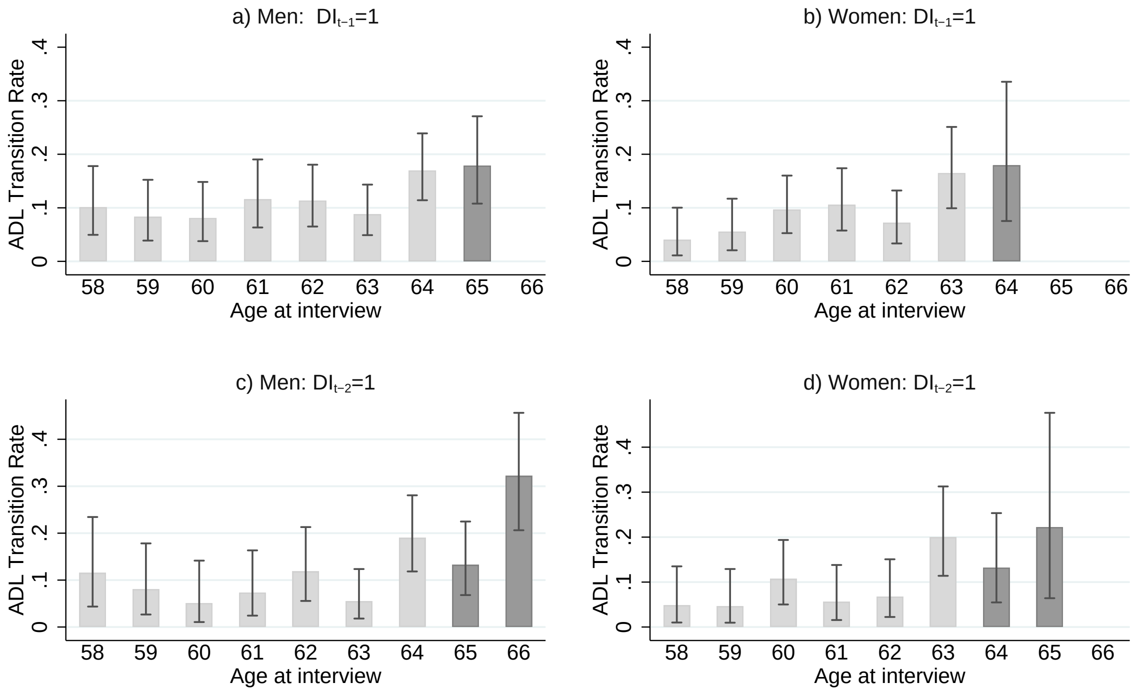
Note: Results Probit Estimation. Average partial effects are reported (APE). Interviewed individuals are aged between 58 and FRA+2. DI beneficiaries with positive earnings are excluded. Standard errors are clustered at individual level. $^{*}p < 0.1$. $^{**}p < 0.05$. $^{***}p < 0.01$.

Table 5.8: Women Robustness: Age first DI benefit < 60

	Dependent variable: Indicator $\mathbb{1}(ADL_t = 1)$			
	Men: $DI_{t-1} = 1$		Men: $DI_{t-2} = 1$	
	1) APE	2) APE	3) APE	4) APE
FRA reached (ATI)	-0.028		0.006	
	(0.037)		(0.037)	
FRA reached (AYI)		0.003		-0.034
		(0.033)		(0.041)
Age	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes
Education Dummies	Yes	Yes	Yes	Yes
Married	Yes	Yes	Yes	Yes
Age first DP	Yes	Yes	Yes	Yes
Observations	972	972	639	639

Note: Results Probit Estimation. Average partial effects are reported (APE). Interviewed individuals are aged between 58 and FRA+2. DI beneficiaries with positive earnings are excluded. Standard errors are clustered at individual level. $^{*}p < 0.1$. $^{**}p < 0.05$. $^{***}p < 0.01$.

Figure 5.7: Transition rates in ADL status by *age at time of interview* (ATI) and gender



Probability of reporting no ADL in period t conditional on reporting ADL in $t-1$ by gender and *age at time of the interview* (ATI). Dark grey shared bars indicate that FRA is reached in year of the interview. Only women born in 1942 or later are included. DI beneficiaries with positive earnings are excluded. Source: Own calculations based on SESAM, FSO (2003-2009).

Appendix 5.B Partial effect with interaction terms

For the interaction effects in section 5.5.3, I estimate a probit of the following form

$$P(ADL_{it} = 1|T_{it}, \mathbf{X_{it}}) = \Phi(\beta_0 + \beta_1 T_{it} + \beta_2 Z_{it} + \beta_3 T_{it} \times Z_{it}) \tag{5.2}$$

where the dummy Z_{it} denotes the interaction variable to be studied (dummy for disability enrolment rate in canton). For illustration purposes, I dropped the additional controls I use in the estimation. Following Ai and Norton (2003), the partial effect of the interaction term is given by the following double difference

$$\begin{aligned}\frac{\Delta^2 E[ADL_{it}|T_{it}, Z_{it}]}{\Delta T_{it} \Delta Z_{it}} &= E[ADL_{it}|T_{it} = 1, Z_{it} = 1] - E[ADL_{it}|T_{it} = 0, Z_{it} = 1] \qquad (5.3)\\ &- (E[ADL_{it}|T_{it} = 1, Z_{it} = 0] - E[ADL_{it}|T_{it} = 0, Z_{it} = 0])\end{aligned}$$

Moreover, I calculate the partial effect of treatment variable T_{it} for $Z_{it} = 0$ by

$$\frac{\Delta E[ADL_{it}|T_{it}, Z_{it} = 0]}{\Delta T_{it}} = E[ADL_{it}|T_{it} = 1, Z_{it} = 0] - E[ADL_{it}|T_{it} = 0, Z_{it} = 0] \tag{5.4}$$

Last, I compute the average partial effect of the variable Z_{it} for $T_{it} = 0$ as follows

$$\frac{\Delta E[ADL_{it}|T_{it} = 0, Z_{it}]}{\Delta Z_{it}} = E[ADL_{it}|T_{it} = 0, Z_{it} = 1] - E[ADL_{it}|T_{it} = 0, Z_{it} = 0] \tag{5.5}$$