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The effect of raising the retirement age on retirement decisions in the Netherlands

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Abstract

The goal of this research is to identify how the labor supply decisions and social insurance usage of older individuals are affected by changes in the official retirement age (the AOW age) in the Netherlands. In the period 2013 to 2017, the AOW age increased stepwise from 65 years to 65 years and 9 months. As a result, individuals were subjected to different AOW ages depending on their date of birth. This setting provides an opportunity to employ a Regression Discontinuity Design. Using administrative data, I find a decrease in the retirement rate of 29.1–51.8 percentage points in the period before treated individuals reach the new AOW age. Individuals seem to finance this period in which they normally would have retired by retaining their original work state. As a result, the employment rate, unemployment rate and the share disabled increase by 4.1–16.4, 1.1–3.4 and 8.4–10.4 percentage points, respectively. Of the proceeds of the reform in terms of additional income tax revenue and decrease in AOW benefits paid approximately 18.5 percent is lost to the increase in unemployment and disability benefits paid.

* Written as part of a thesis internship at the Netherlands Bureau for Economic Policy Analysis (CPB).

Acknowledgments

This thesis follows from a project I worked on as an intern at the Netherlands Bureau of Policy Analysis (CPB). Throughout the internship I co-authored a discussion paper in which a similar study of the effect of the changes in the AOW age was done using a different empirical strategy. During this process, my tasks included writing parts of the paper as well as performing some of the analyses. For my thesis I recycled part of the writings I had produced for the discussion paper and set up a new methodology. Furthermore, I include in this thesis the main results from the original paper and discuss them in relation to the main results of my own analysis. The topic and data used to write this thesis were provided through the internship.

On a final note, I would like to take a moment here to thank Egbert Jongen, Simon Rabaté and Marcel Lever for giving me the opportunity to apply what I have learned during my studies to do policy relevant research, as well as their feedback and the pleasant co-operation throughout my internship. Furthermore, I would like to thank my supervisor professor Dinand Webbink for his helpful feedback throughout the process.

1 Introduction

Due to aging populations and lower fertility rates, the sustainability of public finances has become a major concern for many countries. In the Netherlands, these phenomena are expected to increase the age-dependency ratio from 32 percent in the year 2018 to 51.2 percent by 2040 (CBS, 2019a,b). To alleviate the financial pressure such developments exert on the pension system, the Dutch government implemented numerous policies over the past decades. An example is the reform of the Dutch official retirement age, referred to as the *AOW age* from here on. While the AOW age was fixed at 65 up until 2012, it increased gradually from 2013 onwards. With this reform, the government intended to make the Dutch pension system more durable by reducing expenditures on social security and increasing income tax receipts from higher employment rates of older individuals. Yet the implementation of such a reform can also bring about adverse effects. For example, older individuals tend to have weaker employment opportunities, which may lead to higher unemployment and lower labor force participation rates. Moreover, workers that would normally have retired at the old AOW age may substitute toward other social security programs (Staubli & Zweimüller, 2013). Both occurances would counteract the purpose of the reform.

Given this potential for opposing forces, I investigate the recent changes in the AOW age and quantify how they affect labor supply decisions and the use of different types of social insurance of older individuals. Specifically, I evaluate the effect of an increase in the AOW age on the respective shares of individuals employed, retired, on unemployment insurance (UI) or on disability insurance (DI). These four categories that individuals can fall under will be referred to as 'states' from here onward. I perform this evaluation by making use of the fact that the reforms generate variation in at which age individuals start receiving retirement benefits. More precisely, each birth cohort born after 1947 is subjected to a higher retirement age than the cohort that precedes it. This setup allows for the implementation of a Regression Discontinuity Design (RDD). Using monthly administrative data from Statistics Netherlands (CBS) over the period 2002 to 2017, I compute the difference in participation rates between two consecutive cohorts for individuals at the AOW age of the older cohort. I calculate this difference for each change in the AOW age and for each possible state separately. Additionally, using a similar methodology, I evaluate the effect of the reform on the government budget, substitution toward other work states as well as heterogeneity in the treatment effect across certain subgroups.

The main findings are as follows. First, the share of individuals that are retired decreases by 28.1–51.8 percentage points.[1] Second, the employment rate increases by 4.1–16.4 percentage points. Third, although the shares in UI and DI increase as well, I find that individuals subjected to a higher AOW age remain in their initial state to finance

[1] Coefficients are expressed as a range as the discontinuities differ in size across different changes in the AOW age.

the additional month(s) in which they do not receive the AOW benefits[2]. In other words, individuals do not actively substitute toward other social insurance programs, such as UI or DI. Finally, approximately 18.5 percent of the proceeds of the reform, in terms of additional income tax revenue and decrease in AOW benefits paid, is lost to the increase in unemployment and disability benefits paid.

These results relate to the growing body of literature about the relationship between shifts in the retirement age and the participation of older individuals. Although most existing literature finds a negative relationship for retirement, a positive relationship for employment, and very small to no spillover effects to other social security programs as well, the magnitude of these effects is quite volatile across studies (Atalay & Barrett, 2015, Behaghel & Blau, 2012, Cribb et al., 2014, Geyer et al., 2018, Geyer & Welteke, 2019, Mastrobuoni, 2009, Rabaté & Rochut, 2019, Staubli & Zweimüller, 2013).[3] Consequently, the size of the effects found in this research are difficult to compare to existing literature. These differences between estimations are likely driven by differences in preferences and country or reform specific factors. For example, many countries have Early Retirement Age (ERA) and Full Retirement Age (FRA) systems.[4] While the Dutch AOW age is something that shares characteristics with both types of retirement ages, it is not identical to either of the two; individuals can choose to retire before the AOW age and can still increase their retirement benefits by working after having reached the AOW age. Such differences in pension systems and reforms may result in different incentives for workers.[5] Thus, to gain insight on the effects of the Dutch reform and alike, it is important to do the assessment for such a reform specifically. Other reasons for the discrepanties between studies could be related to methodological aspects such as sample selection, the definition of the outcome variables or type of data used. For example, although this specific reform was previously studied by De Vos et al. (2018), they estimate the effect on employment only and do not include an analysis of the fiscal effects. Furthermore, De Vos et al. (2018)) make use of survey data, employ a different empirical strategy and focus on the earliest cohorts affected by the reforms only. Thus, this research will expand on the work done by De Vos et al. (2018), as well as provide more precise estimates of the effect of the Dutch reform using administrative data.

The remainder of this paper is organized as follows. In section 2, I present an overview of the institutional context and the relevant reforms. Subsequently, to illustrate the theoretical effects of the reform, I introduce a model of retirement in section 3. Section 4 contains an explanation of the empirical strategy. The data used are described in section 5. In section 6, the results are presented. Then, I provide results of some sensitivity

[2]The initial state being the state of an individual in the month before reaching the AOW age of the control group.

[3]Appendix Table C.1 presents an overview of the results for employment of some relevant studies.

[4]The ERA is the earliest age at which individuals can take up retirement benefits, whereas the FRA is the age at which individuals can take up full retirment benefits without reductions.

[5]In many countries early retirement (retirement before ERA or FRA) is associated with penalties, partial benefits or dependent on past earnings, which induce different financial incentives (Atalay & Barrett, 2015, De Vos et al., 2018, Manoli & Weber, 2018)

analyses in section 7. Finally, in section 8, conclusions are drawn.

2 Institutional context

This section contains an overview of the Dutch pension system and a discussion of the AOW age reform. Additionally, some alternative routes to retirement and relevant reforms therein are described.

2.1 The pension system

The Dutch pension system consists of three pillars. The first pillar, which consists of the old age pension (*Algemene Ouderdomswet (AOW)*), forms the base of the income of retired individuals. Per year of residence in the Netherlands, individuals accumulate 2 percent of the full first pillar benefits. Additional to years of residency, the size of these benefits is determined by the minimum wage and partnership status. Assuming 100 percent of the benefits are accumulated through residency, depending on the other factors the monthly amount received from july 2019 onward ranges from 637,94 to 1.256,25 euros (SVB, 2019). These benefits are financed through a pay-as-you-go system.[6] The benefits become available to individuals once they have reached the AOW age and, thus, cannot be accessed beforehand. Furthermore, at the AOW age, employment contracts end by law and need to be renewed if an individual prefers to continue to work. In addition, individuals are no longer eligible for benefits from other social security programs.

The second and the third pillar are subsidiaries to the first: based on past earnings and savings, an individual can increase their retirement income through these two channels. In the second pillar, individuals build up pension benefits for each additional year spent in employment through firm- and sector-specific occupational pension schemes. These additional benefits can go up to 100 percent of the average wage earned over the life course of an individual. How much individuals save up through this channel depends on how much they earn and the type of pension arrangement that is provided by the employer. Employees and employers pay monthly premiums to the pension fund of the respective sector. Using these premiums, the pension fund makes investments.[7] From the returns on these investments, second pillar benefits are payed out to retired individuals. Using second pillar benefits, individuals can decide to retire early, before the AOW age. However, this comes at the cost of an actuarially fair reduction in the monthly second pillar benefits. The last and third pillar of the Dutch pension system consists of any actions taken by the individual to insure him- or herself. This can be either personal savings or private insurances.

[6] Under a pay-as-you-go system benefits are paid out using the current income of the government.

[7] The premiums payed are determined by annual earnings minus a franchise (income threshold). These net of franchise annual earnings over which an individual can accumulate benefits are capped.

Table 2.1: Reforms in eligibility age for retirement benefits in the Netherlands

Year	2011 reform	2012 reform	AOW age	Affected birth cohort
2012	-	-	65	Before 01-01-1948
2013	1 month	1 month	65+1 month	After 31-12-1947 and before 01-12-1948
2014	1 month	1 month	65+2 months	After 30-11-1948 and before 01-11-1949
2015	1 month	1 month	65+3 months	After 31-10-1949 and before 01-10-1950
2016	2 months	3 months	65+6 months	After 30-09-1950 and before 01-07-1951
2017	2 months	3 months	65+9 months	After 30-06-1951 and before 01-04-1952
2018	2 months	3 months	66	After 31-04-1952 and before 01-01-1953
2019	3 months	4 months	66+4 months	After 31-12-1952 and before 01-09-1953
2020	3 months	4 months	66+8 months	After 31-08-1953 and before 01-05-1954
2021	3 months	4 months	67	After 30-04-1954 and before 01-01-1955

Source: Tweede Kamer der Staten-Generaal (2012, 2014).

2.1.1 Reforms

In 2011, the Dutch government announced a reform that issued an increase in the first pillar AOW age, which had been fixed at 65 up untill that point. The second column of Table 2.1 shows the yearly increases that would take place. In 2012 this reform was amended to allow the AOW age to increase at a faster pace from 2015 onward, as shown in the third column. These changes in the AOW age will be the key ingredient of the empirical strategy presented in section 4.

Reforms in early retirement (ER) and second pillar pensions are relevant within the context of this research as well. These are presented in the third column of Table 2.2. An important event to consider is the 2006 reform through which the ER scheme was abolished. Under this scheme, which was financed through a pay-as-you-go system, individuals could retire and receive benefits several years before the AOW age. Individuals that reach the AOW age before 2015 were offered a transitional scheme in return, while individuals that reach this age after 2015 were not. As a result, the individuals that were affected by the AOW changes that occured in 2013 and 2014 are not directly comparable to the individuals that were affected by the changes from 2015 onward. Furthermore, reforms occured in the Life Course Saving scheme and the Deferred Pension Bonus. However, as these reforms were implemented in the years before the changes in the AOW age took place and do not affect the birth cohorts differently, they should not pose a problem for this research.

Table 2.2: Timeline of related reforms

Year	AOW age	Second pillar / Early Retirement	Unemployment Insurance	Disability Insurance
2006		ER tax exemptions abolished, Life Course Saving Scheme introduced	Reduction of maximum benefit duration	Stricter distinction between partially, fully and permanently disabled
2008				Experience rating abolished
2009		introduction Deferred Pension Bonus		
2012		Life Course Saving Scheme abolished		
2013	Gradual yearly increase		Revised calculation of employment period	
2015	Accelerated gradual yearly increase			
2016			Gradual shortening of benefit period	

Source: De Vos et al. (2018) and Jongen (2016).

2.2 Alternative pathways

Although AOW benefits can only be obtained from the AOW age onward, individuals can exit the labor force before this age using alternative pathways. A change in the AOW age could, therefore, lead to substitution toward other social security programs (OECD, 2019). In most cases these benefits stop once the AOW age is reached. They may, however, affect labor supply behavior of individuals before this age. Thus, it is important to take these spillover effects into account when assessing the effectiveness of an increase in the AOW age.

In the Netherlands, the two main options to substitute toward are unemployment insurance (UI) and disability insurance (DI).[8] Unemployed individuals can temporarily

[8] Although welfare is also a largely used social security programme in the Netherlands, this is not included as an outcome in this analysis.

take up unemployment benefits if they worked at least 26 weeks in the last 36 weeks of employment. If this requirement is met, an individual can receive unemployment benefits for at least three months based on the previously earned wage. The replacement rate is approximately 75 percent in the first two months, after which it drops to 70 percent (UWV, 2019). Furthermore, an individual is eligible for disability benefits if they are forced to work less due to a disability or illness. The length and benefit of the disability insurance depends on the length and degree of the disability.

2.2.1 Reforms

Column four and five of Table 2.2 present an overview of the most important changes in UI and DI in the Netherlands. These reforms all provide financial incentives that make it more attractive to remain in the labor force. The reforms that took place before 2016 do not affect the different cohorts differently and, therefore, are not expected to be problematic for this research. In 2016, however, a gradual shortening of the unemployment benefit period was implemented, which could result in differences between the birth cohorts that were affected by the 2016 and 2017 changes in the AOW age. This may lead to an overestimation of the effect of the AOW age increase that occured between 2016 and 2017. This potential for bias will be taken into account when interpreting the effect of the AOW age change between these two cohorts.

3 Theoretical framework

The previous section forms an overview of the institutional framework of the Dutch pension system. In this section, I introduce a simple model of lifetime income based on the Dutch context. Using this model, I formulate an expectation of the financial and behavioral effects of changing the AOW age.

3.1 A static lifetime utility model

The life cycle model presented in this section is obtained by adapting the model constructed by Manoli & Weber (2018) to the Dutch pension system. In this model, individuals decide when to retire by maximizing their lifetime utility, $U(C, R)$, subjected to their lifetime budget constraint (LBC), as shown in equation (1). When an individual retires, he or she stops supplying labor, which corresponds to a drop in labor income. The choice of when to retire is, therefore, led by a trade-off between consumption of goods, C, and consumption of leisure (implicit in R): an increase in the retirement age, R, coincides with an increase in utility from consumption of goods, facilitated by an increase in labor earnings, and a drop in utility from the decrease in the consumption of leisure.

$$
\begin{aligned}
\max_{R} \quad & U(C,R) = u(C) - \theta(R) \\
\text{s.t.} \quad & C = wR + \underbrace{[T - \text{AOW}] \times b_1}_{\text{first pillar}} + \underbrace{[T - R] \times b_2(R,w)}_{\text{second pillar}}
\end{aligned}
\tag{1}
$$

The lifetime budget constraint in this model is made up of two elements, namely labor income and retirement benefits. In this budget constraint, w is net-of-tax annual labor income (here assumed to be constant over time), b_1 is the annual first pillar pension benefit, AOW stands for the AOW age, and b_2 is the annual benefit from the second pillar. The total benefit from the first pillar equals the product of the annual benefit and the years lived from eligibility age onward, $[T - \text{AOW}]$. The total benefits from the second pillar, on the other hand, equal the product of the annual benefit and the years lived after retirement, $[T - R]$. In this model, we abstract away from third pillar income, as its relationship with retirement is less straightforward. The budget constraint thus states that lifetime consumption, C, will equal lifetime earnings before retirement and the total retirement benefits after the eligibility age. Figure 3.1 shows what the lifetime budget constraint of a Dutch individual could look like, starting from the arbitrarily chosen age of 54.

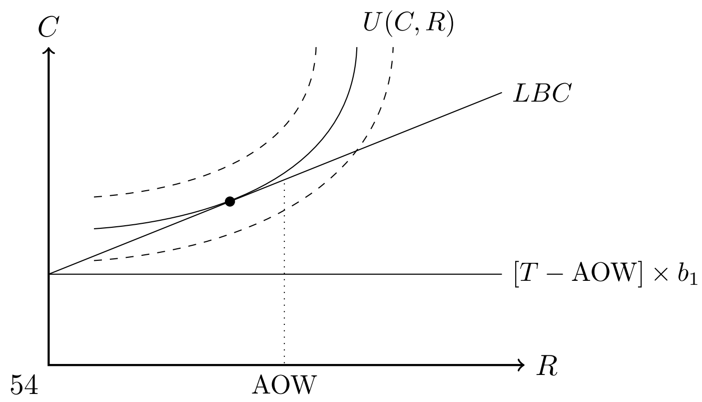
The decision to retire at $R+1$ instead of at R can affect the lifetime budget constraint through several channels in this model. On the one hand, the individual gains one additional period of labor income, w. On the other hand, the total retirement benefits received can change. As can be deduced from the budget constraint above, the first pillar benefits are independent from the retirement age. In other words, choosing a different retirement age does not affect the total first pillar benefits an individual will receive. However, retiring one year later could affect the total benefits that can be obtained through the second pillar, as this benefit increases in the years worked and the wage earned. In the Dutch case these benefits are not earnings tested. Furthermore, wages are assumed to be constant over time and the Dutch pension system is assumed to be actuarially fair. As a result, the relative cost of retiring at R in terms of retiring at $R + 1$ is constant. Therefore, within this model, I do not expect the second pillar benefits to induce a change in the slope (e.g. a kink) of the lifetime budget constraint at a specific age, which would push individuals to retire at this age.[9]

3.2 Including reference dependence and loss aversion

Existing literature shows that financial incentives and wealth effects are not sufficient to explain retirement behavior. For example, while the lifetime budget constraint as drawn up above suggest no specific age at which it might be more attractive for an individual to retire, empirically, retirement tends to spike around institutional ages. This suggest that a more complete interpretation of the impact of reforms in these institutional ages should

[9] This may not hold true at the official second pillar retirement age, which is equal to 68 in the Netherlands. As this is past the AOW age, it is not included in the analysis.

Figure 3.1: Optimal retirement age subject to lifetime budget constraint



include the effect of non-financial determinants as well (Van Erp et al., 2014).

Such non-financial effects can arise due to reference dependence or loss aversion of individuals.[10] These effects are captured not in the lifetime budget constraint, but in the utility function. Following Seibold (2017), we can express the utility functions under reference dependence and loss aversion as shown in equation (2) and (3), where $\hat{R}$ and $\hat{C}$ are the reference levels of the retirement age and consumption of goods, respectively.

$$U(C,R) = u(C) - \theta(R) - \lambda_C(\hat{C} - C) \cdot \mathbb{1}(C \leq \hat{C}) \tag{2}$$

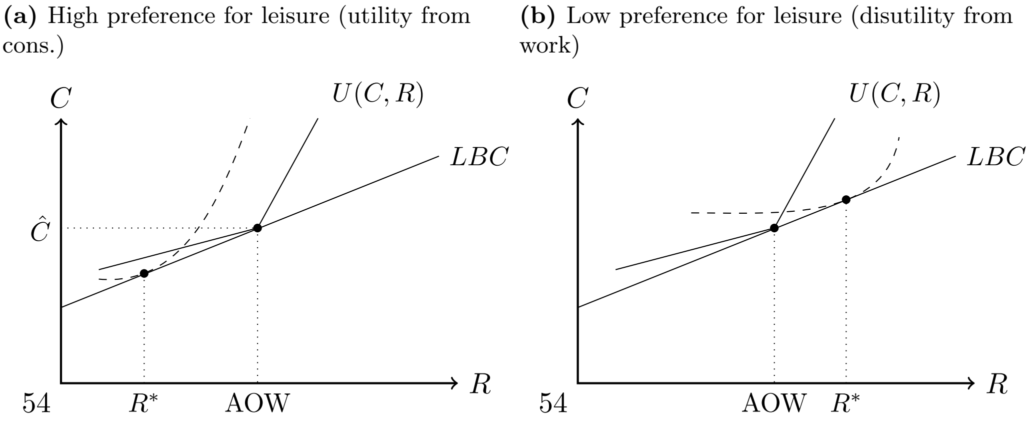
$$U(C,R) = u(C) - \theta(R) - \lambda_R(R - \hat{R}) \cdot \mathbb{1}(R \geq \hat{R}) \tag{3}$$

If reference dependence or loss aversion is present, a unit of consumption or leisure lost as a result of a change in the retirement age away from the reference point is valued more heavily than a unit gained. The lambda's in the equations above represent these additional utility losses. More specifically, equation (2) shows that, under loss aversion and reference dependence, decreasing consumption below the reference level, $(C \leq \hat{C})$, coincides with a larger decrease in utility, as an individual suffers an additional utility loss of λ_C, compared to if consumption is decreased at a level above the reference point. Similarly, for a decrease in consumption of leisure due to an increase of the retirement age above the reference point, $(R \geq \hat{R})$, an individual suffers an additional loss in utility of λ_R. As a result, if individuals are loss averse or reference dependent, they are more likely to reach optimal utility at the reference point (Behaghel & Blau, 2012). Altogether these factors result in a kink in the indifference curve at the reference point (Seibold, 2017).

The optimal retirement age also depends on the preference for leisure: if individuals attach a high value to leisure units, they are more likely to retire earlier, whereas individuals that value leisure less are more likely to retire later (Behaghel & Blau, 2012). For individuals that would choose to retire earlier without a reference point the indifference

[10]Under reference dependence moving away from a reference point affects how gains and losses are valued (Van Erp et al., 2014). Examples are interpretation of the AOW age as an endorsement by the government or as the age at which you retire according to social norms.

Figure 3.2: Optimal retirement age under reference dependence



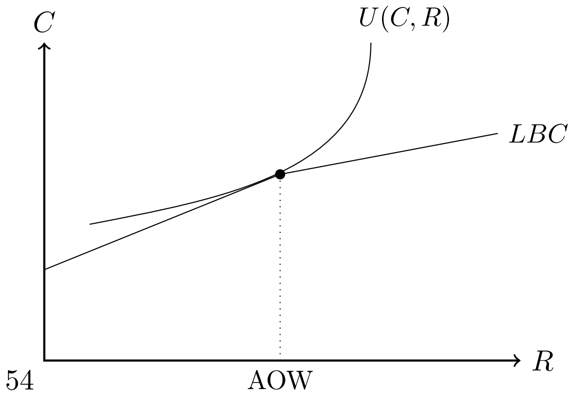
Note: Source: Seibold (2017). The dashed utility functions represent the situation before the inclusion of reference dependence and loss aversion, whereas the full line utility functions represent the situation after reference dependence and loss aversion and, therefore, the kink and rotation are included. The AOW age is the reference retirement age ($\hat{R}$), and $\hat{C}$ is its respective reference level of consumption of goods.

curve rotates clockwise when they are subjected to a reference point, given the dominating increase in utility from consumption. For individuals that initially retire later, on the other hand, the indifference curve rotates counter-clockwise under the introduction of a reference point as a result of the dominating reduction in disutility from working less. As a result of the rotation and the previously mentioned kink, the introduction of a reference points induces the reference point to be the optimal bundle, which makes bunching at the reference point a plausible outcome, as shown in Figure 3.2 (Seibold, 2017). Based on the Dutch context, in this figure, the AOW age is the reference retirement age ($\hat{R}$), and $\hat{C}$ is the corresponding reference level of consumption of goods.

3.3 Automatic job termination

Another reason for a spike at the AOW age can be found in institutions and regulations, such as the collective labor agreement (CAO). According to the CAO employment contracts end by law at the AOW age. As a result, employers in the Netherlands are enabled to let workers go once they reach this age (De Hek & van Erp, 2009). This mechanism limits the employment and income possibilities of individuals after the AOW age. In other words, this increases the likelihood that an individual will be rendered unemployed or may choose to withdraw from the labor force due to an hourly wage that is most likely lower. If the hourly wage an individual faces from the AOW age onward is indeed lower as a result of the CAO, the slope of the LBC is smaller after the AOW age. In other words, there would be a kink in the LBC at the AOW age, as shown in Figure 3.3, making it more likely that individuals retire at this age.

Figure 3.3: Optimal retirement age under automatic job termination



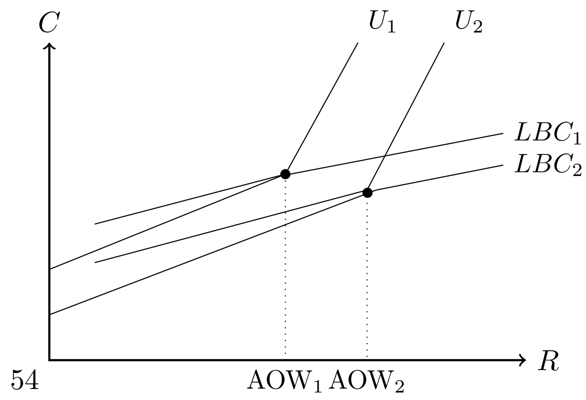
3.4 Predicted effects of the reform

Using the model presented above, we can deduce the effect of an increase in the AOW age on the optimization problem described above. In the Dutch case, the AOW benefit eligibility only depends on the age of an individual. The size of the benefit, b_1, depends on years of residence in the Netherlands. However, as the starting age moves in lock-step with the AOW age, the years of residence needed to obtain the maximum benefit remains constant. A change in the AOW age thus affects the lifetime budget constraint of an individual through the total retirement benefit, or the pension wealth, an individual will be able to take up in the first pillar. More specifically, if the AOW age increases by one month, affected individuals forgo the benefits that could have been taken up in that month. Consequently, an increase in the eligibility age entails a permanent reduction in lifetime income and, therefore a downward shift of the lifetime budget constraint 3.4.

How will such a shift affect the labor supply of individuals? First, individuals become more poor in general. In theory, this wealth (or income) effect should reduce both the consumption of goods and consumption of leisure, thereby increasing the retirement age. Important to note is that this reform is related to the fact that individuals are facing increasing life expectancy. Therefore, the size of the shift is dependent on the ratio between the increase of the AOW age and the increase in life expectancy. As a result, wealth effects are not expected to be the main drivers of the results. Second, an increase in the AOW age alleviates limitations that result from automatic job termination for the period by which it extends employment contracts. Thus, the increase in the AOW age also shifts the kink in the LBC that results from automatic job termination. As a result, the relative price of retirement in terms of consumption, or the slope of the LBC, in between the two AOW ages is different for the individuals that are affected by the reform. This implies in a price effect: it becomes more expensive to retire at said ages, leading to a higher employment rate and lower retirement rate for affected individuals between the old and the new AOW age.

Lastly, reference dependence and loss aversion also induce individuals to locate at the

Figure 3.4: The effects of an increase in the AOW age



AOW age. The spike in retirement at the AOW age that results from this can be expected to move with the reference point, as locating at a point before or beyond the new reference point would result in larger losses of utility due to reference dependence and loss aversion.

Altogether these effects point to an increase in labor supply of older workers as a result of an increase in the AOW age.

3.4.1 Other possible forces

There are a couple of other factors that may result from changing the AOW age. First, it is important to note that retirement benefits and employment are not the only two possible sources of income that play a role in the optimization problem of individuals. Other social security programs, such as unemployment and disability schemes, are potential substitutes of the pension system (Rabaté & Rochut, 2019, Staubli & Zweimüller, 2013). As discussed above, when individuals are faced with an increase in the AOW age, their budget constraint shifts downward, making their initial level of utility unattainable. Using benefits from other social security programs, an individual could expand the possibilities, enabling them to choose a bundle of consumption and retirement which yields a utility level that is closer to the one that would have been attained prior to the change in the AOW age. If this holds true, eligible individuals can choose to retire through the alternative programs, reducing the potential positive employment effects.

Second, changes in the AOW age may also affect the employment of individuals at ages before the AOW age. There are multiple reasons why such upstream effects are likely to take place. First, individuals that prefer to retire before the AOW age are restricted in their options to finance such an early retirement. For example, even if it would be possible for an individual to take up unemployment benefits, these benefits have a limited duration. Second, some individuals prefer to take up retirement jointly with their (older) partner. The effect of an increase in the AOW age would then take place before the AOW age for the younger partner. Third, the increase in the retirement age will increase the horizon of any investment in the human capital and, therefore, make them more valuable.

As a result, individuals are incentivized to invest in their human capital and to increase their labor supply before retirement. An increase in the AOW age could also increase the incentives for employers to invest in the human capital of their older workers. Lastly, it could increase the incentives for unemployed individuals to find a new job (Hairault et al., 2010).

Finally, a change in the AOW age may affect subgroups of the population differently. First pillar benefits are an important source of post-retirement income for especially lower educated and lower paid individuals. As a result, they are expected to be affected more heavily by a change in the AOW age, while their employment decisions are more restricted. Furthermore, older cohorts have less time to adapt their consumption and savings decisions to such changes. Therefore, they might be affected more than younger generations, who knew beforehand what changes would take place (Bolhaar et al., 2017). Finally, it is likely that different categories in health, marital status and gender may experience different effects of a reform in the AOW age (Van Erp et al., 2014).

4 Methodology

The numerous factors that play a role in retirement decisions can make it more difficult to obtain a clear-cut identification of such decisions at the AOW age. For instance, preferences differ across individuals and trends in labor supply behavior change over time (Atalay & Barrett, 2015, Staubli & Zweimüller, 2013). Furthermore, related reforms that take place at the same time may bias the estimated effect (Rabaté & Rochut, 2019). Finally, as they cannot retire through the mainstream pathway before the AOW age, individuals may substitute toward other social security insurances, which would not be inlcuded by just looking at employment and retirement (Staubli & Zweimüller, 2013).

By evaluating retirement decisions using the previously discussed reforms in the AOW age as sources of exogenous variation in treatment of individuals, I mitigate some of these issues. Treatment is defined as an increase in the AOW age within this context. Given the design of the reforms, the date of birth of an individual determines whether or not he or she is treated, which generates variation in the AOW age that neighboring birth cohorts are subjected to. This set up provides an opportunity to employ a Regression Discontinuity Design (RDD) to estimate the effect of the reform.

Crucial to the RDD is the existence of a cutoff. A running (or forcing) variable on the domain of which this cutoff lies, pushes individuals in and out of treatment. More specifically, individuals that are positioned before this cutoff are not treated, while individuals positioned beyond the cutoff are. In the context of the changes in the AOW age the cutoff is the first month of birth from which onward the new AOW age applies. As all individuals receive the AOW benefits they have accumulated once they surpass this cutoff, the set up calls for a sharp RDD. The date of birth is the running variable on the basis of which individuals are assigned an AOW age. The identifying assumption of this approach is that the month in which individuals are born is random and, therefore, individuals around the cutoff are similar to the extent that their retirement decisions should be comparable. In essence, the only thing that is expected to differ between these individuals is the AOW age that they are subjected to. As a result, any discontinuity in the outcome variable at the cutoff is attributed to being treated.

This discontinuity can be estimated using equation (4). The outcome y_{ijt} represents the state an individual i at age t is in, which can be either employed, retired, unemployed or disabled. As these are all binary variables and the specification will be estimated for each outcome separately, equation (4) represents a linear probability model. Furthermore, equation (4) simultaneously estimates the treatment effects on a specific outcome variable for four different instances of an increase in the AOW age, denoted by j. More specifically, the θ_j represents four dummy variables that each take on value one for observations that pertain the treated and untreated individuals that are part of a certain increase in the AOW age. Table 4.1 contains an overview of what the treatment and control groups are for an AOW age increase that occurred in a specific year. To avoid bias caused by the differential treatment of individuals that reach the retirement age before and after 2015 due to the abolishment of the early retirement schemes, the AOW increase of 2015 is not included in the analysis.

Table 4.1 also shows that neither the date of birth, Z_{ij}, nor the cutoff, c_j, overlap for different increases in the AOW age. To still be able to estimate the treatment effects simultaneously, $f(Z_{ij} - c_j)$ is used as the running variable, which represents the distance (in months) between the date of birth of individual i to the cutoff that applies to the individuals that are part of RD j. This distance variable takes on value zero at the cutoff. For values of the distance variable greater than or equal to zero, the treatment indicator T_{ij} takes on value 1, indicating the treated individuals. For values below zero T_{ij} equals zero. Moreover, the slope coefficients of the left and right side of the cutoff are represented by the γ_j and δ_j coefficients, respectively.

$$y_{ijt} = \sum_{j=1}^{4} \theta_j \big[1 + \beta_j T_{ij} + \gamma_j f(Z_{ij} - c_j) + \delta_j f(Z_{ij} - c_j) T_{ij} \big] + \eta X_{it} + \epsilon_{ijt} \tag{4}$$

The β_j coefficients are the estimated local average treatment effects. Important to note is that individuals are only compared at ages on which they would have received first pillar benefits in the absence of the reform. As a result, the β_j coefficients can be interpreted as the percentage point difference in the outcome variable between the treatment and control groups *between the AOW age of the control and treatment groups.* For example, for the increase in the AOW age that occurred in 2013, individuals of the treatment and control groups are compared at the age of 65. The estimated treatment effect for this group then represents the share of individuals that would have retired at 65 if the AOW age had not increased to 65 and one month. Lastly, X_it is a vector of individual level control variables and the ϵ_{ijt} indicates the error term. The estimation is performed with standard errors

Table 4.1: Treated and untreated cohorts by RD

RD	Year	Control	AOW age	Treated	AOW age
θ_1	2013	After 31-12-1946 and before 01-01-1948	65	After 31-12-1947 and before 01-12-1948	65 + 1 month
θ_2	2014	After 31-12-1947 and before 01-12-1948	65 + 1 month	After 30-11-1948 and before 01-11-1949	65 + 2 months
θ_3	2016	After 31-10-1949 and before 01-10-1950	65 + 3 months	After 30-09-1950 and before 01-07-1951	65 + 6 months
θ_4	2017	After 30-09-1950 and before 01-07-1951	65 + 6 months	After 30-06-1951 and before 01-04-1952	65 + 9 months

clustered at the date of birth (a combination of month and year) level, to account for the fact that individuals born at a specific time are subjected to similar macroeconomic developments over time that may result in correlation between their standard errors.

For the baseline estimations, the bandwidth of each RD is determined by the size of the birth cohorts that belong to the control and the treatment group. For example, under the 2013 increase in the AOW age, individuals born up to twelve months before the cutoff belong to the control group, whereas individuals born up to twelve months after the cutoff are assigned to the treatment group. Thus, the bandwidth of the first RD is twelve months on both sides of the cutoff. This differs per RD, as the size differs by birth cohort. Furthermore, the functional form of the baseline estimations will include a fist order polynomial and will allow for different slope coefficients on either side of the cutoff. In section 7, I perform the analysis using different bandwidths and funcitonal forms to assess the sensitivity of the results to such changes.

Active vs. passive substitution The β_j coefficients that result from estimating equation (4) give a notion of the substitution effect of the increase in the AOW age. However, this effect includes both the individuals that remain in a specific state as a result of the reforms (passive substitution) as well as the individuals that switch to the relevant outcome state from a different initial state as a result of the reform (active substitution). To distinguish between these two effects, the equation will also be estimated by conditioning on different initial states. The initial state in this context is the state an individual is in, in the month preceding observation. For unemployment as the outcome state and employment as the initial state, for example, β_j can be interpreted as the percentage point change in the probability of being unemployed in period t for individuals that were employed in t-1 as a result of the change in the AOW age, which can be interpreted as active substitution toward unemployment. Alternatively, by estimating the equation for the same variable as the outcome and initial state condition, persistence in or passive substitution to a particular state is assessed. This estimation would indicate the share of individuals that just remain in their original state.

Subgroup analysis Equation 4 pools the treatment effect for different subgroups within the population. To evaluate the presence of heterogeneity in the treatment effect across different subgroups, equation (4) is estimated separately by gender, partnership status, migration background and income level. For the analysis of heterogenous treatment effects between different income levels, the average total income is computed for each individual.[11] Based on this, individuals are split up into quartiles, after which the equation is estimated for each quartile separately.

Fiscal effects Finally, to quantify the short run effect of the change in the AOW age on the government budget, equation (4) can be estimated with monthly income from different sources as the y_{ijt} variable. The β_j coefficients can then be interpreted as the difference in the average monthly amount received from different sources between treated and untreated individuals around the threshold. Using the average tax rate to compute income tax revenues and by weighting and summing the β_j coefficients, the short run effect of the reform on the government budget can be computed.

5 Data

To perform the analysis I use administrative data that can be accessed only through the CBS remote access environment. The dataset contains information on the state and earnings trajectories of the population of the Netherlands. The initial data set pertains to over 1.2 million individuals that were born between 1946 and 1951 and are observed monthly from 2002 to 2017. For the one month increases, only the observations at the AOW age of the control group are kept for each individual. For the three month increases, the observations at the AOW age of the control group until but not including the observation at the AOW age of the treatment group are kept.[12] In other words, there is one observation per individual for the first two RDs and three observations per individual for the last two RDs.

The y_{ijt} variables of equation (4) are constructed for each individual using the Socio-Economic Category (SECM) variables, which indicate the monthly income individuals obtain from different sources: labor earnings, other types of work-relations (e.g profits from self-employment), pension benefits (both AOW and private), and benefits from social security programs (e.g. disability, unemployment). The state of an individual in a specific period is determined by evaluating which of these sources of income is dominant within that period. For example, if the largest source of income of an individual within a period is unemployment benefits, this individual is classified as unemployed in that period. In this

[11] Income from all possible sources of income is summed within each month. The average monthly income is computed over ages 62 to 66 for each individual.

[12] Although they are part of the treatment group of the last RD, individuals born in 1952 are not included as these individuals do not reach the age of 65 + 6 months in the observed period.

Table 5.1: Balance check by RD

	θ_1		θ_2		θ_3		θ_4	
	Control	T - C	Control	T - C	Control	T - C	Control	T - C
Age	65.00	0.000	65.08	0.000	65.25	0.000	65.50	0.000
Share single	0.092	-0.001	0.091	0.000	0.092	0.002	0.094	0.000
Share migration backgr.	0.088	0.011	0.099	0.004	0.112	-0.014	0.098	0.003
Share female	0.505	-0.002	0.503	0.000	0.504	-0.000	0.504	0.002
Share employment	0.070	0.069***	0.093	0.072***	0.165	0.122***	0.177	0.113***
Share retired	0.893	-0.325***	0.816	-0.295***	0.730	-0.400***	0.715	-0.395***
Share in unemployment	0.003	0.011***	0.005	0.009***	0.012	0.025***	0.014	0.025***
Share in disability	0.015	0.099***	0.052	0.066***	0.051	0.073***	0.052	0.073***
	Control	Treatment	Control	Treatment	Control	Treatment	Control	Treatment
Individuals	203,306	176,646	176,477	172,517	154,022	134,380	133,969	89,271

This table contains the mean value of certain background and outcome variables of the control group as well as the difference in means between control (C) and treatment (T) groups for each RD. These values and their statistical significance are computed by regressing each variable on a dummy variable that equals one for the treatment group and zero for the control group.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

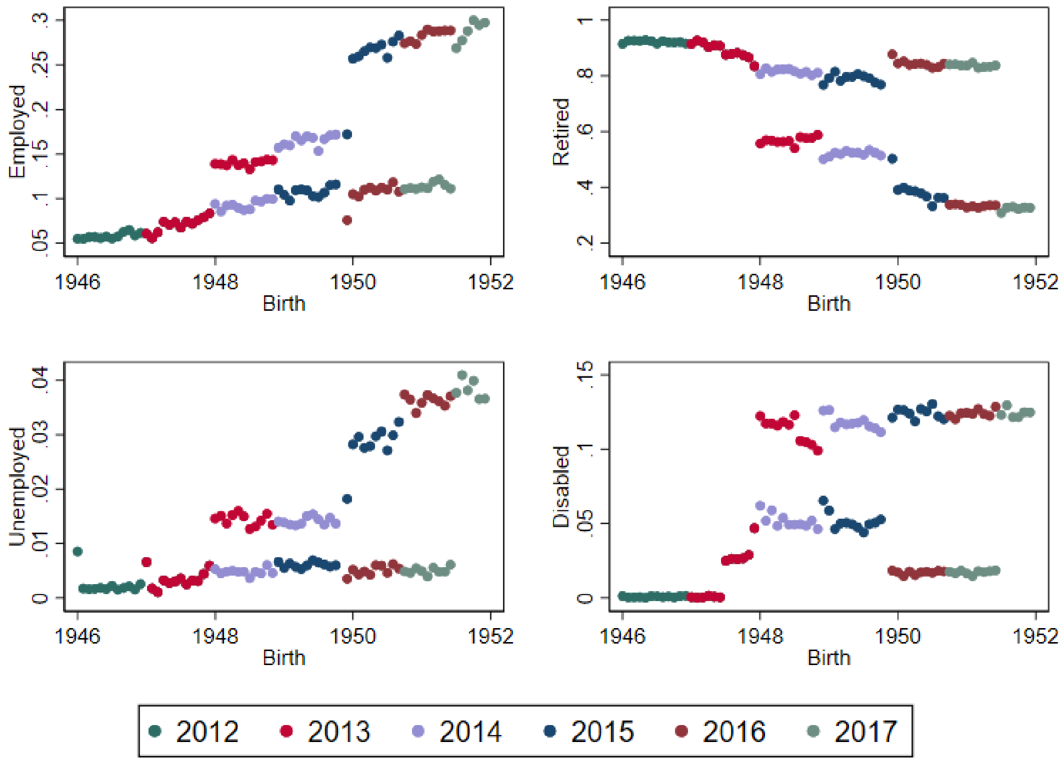
way, several dummy variables are created which indicate the main state of an individual. The most important variables for this research are the indicators of whether an individual is employed, retired, unemployed or disabled. For the right hand side of equation (4), data on the date of birth and a specific cutoff per cohort will be used. Furthermore, the variables gender, migration background and household position of individuals are included.

Descriptive statistics by RD for individuals when they are at the AOW age of the control group are presented in Table 5.1. An important assumption of the RD approach is that it is random on which side of the cutoff an individual ends up and, therefore, which individuals get treated and which individuals do not. As a result, the generated treatment and control groups should be similar in composition. To evaluate this, the differences in the means of all outcome and background variables between treatment (T) and control (C) groups are presented in the T - C columns of Table 5.1. Reassuring is that the differences are statistically insignificant for the available background characteristics.

The differences in the outcome variables between treatment and control groups give an initial indication of the treatment effect at the AOW age. These differences are also shown in Figure 5.1. The signs of the differences in Table 5.1 and the scatterplots in Figure 5.1 imply that employment rates, unemployment rates and disability rates are larger in the treated cohorts at the AOW age of the untreated, whereas the retirement rates are lower. Furthermore, the figure shows that in most cases the discontinuitiy is quite clear-cut.

To assess whether these outcome variables would have been continuous in the absence of the reform, the estimation of equation (4) can be performed at a placebo cutoff. The β_A

Figure 5.1: Plots of shares of outcomes by date of birth (in months)

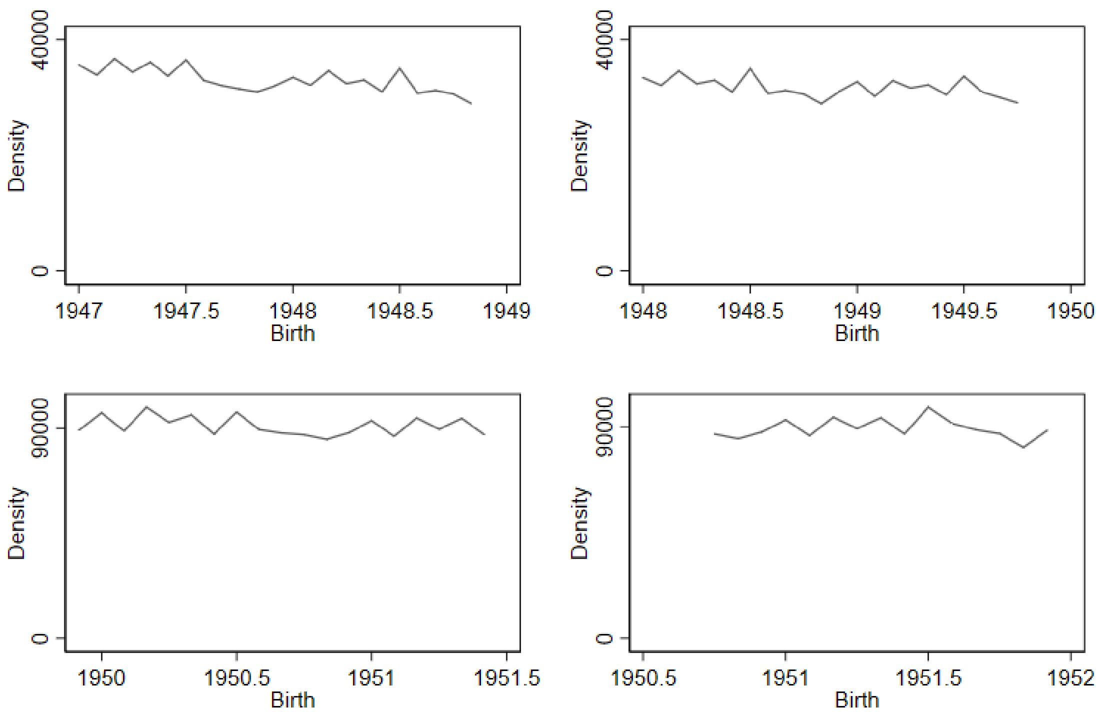


Note: Each color indicates a different control and treatment group combination.

coefficients in Table A.1 show the results of such an estimation. Here, the control group comprising of individuals born in 1946 is compared to the 'treatment' group formed by individuals born in 1947. The cutoff that is used is January 1947. As neither of these groups were subjected to a change in the AOW age, no discontinuities should occur at the placebo cutoff. Although the coefficients for retirement and disability are significant at the 5 percent level, the 'jumps' are quite small in magnitude. The coefficients of employment and unemployment, on the other hand, are not significantly different from zero. The β_B coefficients in the same table pertain to the estimation of the same equation using December 1946 as a cutoff instead. None of these estimates are significant. The difference between the two months in whether or not some coefficients are significant may be a result of seasonality in when individuals move between states. To correct for such seasonality, month dummies can be added to the equation so that the effect of fixed spikes or downturns in participation rates for specific months can be filtered out.

From the assumption that individuals before and after the cutoff are similar follows that individuals should have imperfect control over on which side of the threshold they are positioned and that there should not be any sorting around the cutoff. As date of birth cannot be influenced by individuals themselves this is not expected to be a problem. To show that there is no sorting of birth in specific months, Figure 5.2 presents a line graph

Figure 5.2: Number of individuals by month of birth and RD



Note: The upper two graphs relate to the control and treatment groups of the first two RDs, whereas the bottom two graphs relate to the last two RD's

of the densities of birth in each possible month by RD. These densities appear relatively constant across months within each control and treatment group pair and therefore give no reason to doubt that this assumption holds.

6 Results

In this section, the results of all the analyses described above will be discussed. The tables that are included in this section only present the most important coefficient of the estimations, namely the treatment effect for each outcome and each AOW age increase separately.

6.1 Main results

Table 6.1 contains the estimates of equation (4). All coefficients are statistically significant at the 0.1 percent level. For individuals that have been subjected to a higher AOW age the retirement rate has decreased while the employment, unemployment and disability rates have increased. More specifically, the share of retired individuals is 28.1–51.8 percentage points higher past the threshold. The share of individuals that are employed increases by 4.1–16.4 percentage points. Put differently, 14.6–31.7 percent of individuals that do not retire as a result of the reform are now employed instead.[13] A graphical representation

[13]Computed in the following way: $\frac{\beta_{Employment}}{\beta_{Retirement}} * 100\%$

Table 6.1: Regression results of the effect of an increase in the AOW age by state outcome

	(1) Employed	(2) Retired	(3) Unemployed	(4) Disabled
β_1	0.041***	-0.281***	0.011***	0.084***
	(0.005)	(0.009)	(0.001)	(0.004)
β_2	0.054***	-0.290***	0.009***	0.079***
	(0.005)	(0.009)	(0.001)	(0.003)
β_3	0.152***	-0.486***	0.029***	0.105***
	(0.005)	(0.006)	(0.001)	(0.002)
β_4	0.164***	-0.518***	0.034***	0.104***
	(0.003)	(0.005)	(0.001)	(0.003)
Avg.	0.168	0.614	0.015	0.078
Obs.	2235251	2235251	2235251	2235251

Regression results of the RDD for the outcomes employed, retired, unemployed and disabled. Beta one to four each refer to a different instance of an AOW age increase. Included are controls and standard errors clustered on the date of birth level. Avg. refers to the average level of each outcome for the untreated individuals, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

of the discontinuities in the outcomes retired and employed for the second and the last increase in the AOW age is shown in Figure 6.1. The increases in UI and DI usage in terms of the reduction of retirement are 3.1–6.6 percent and 20.0–29.9 percent, respectively.[14]

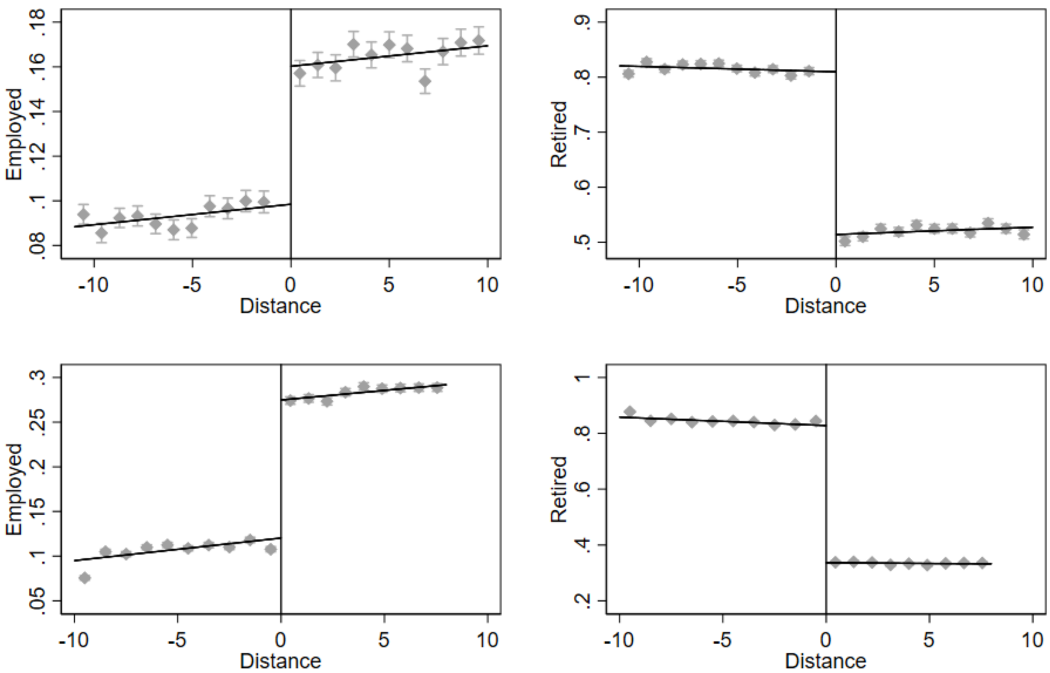
Although the β_2 coefficients are comparable in magnitude to the β_2 coefficients, the β_3 and β_4 coefficents are much larger than the former two. This can be explained by the fact that the first two changes in the AOW age are one-month increases, whereas the latter two concern a three-month increases in the AOW age, yieling a larger effect. Table A.2 in Appendix A shows the results of same estimation, now including interaction terms to differentiate between the effect by age in months for the latter two increases in the AOW age. The coefficients of the interaction terms are small in magnitude, showing that size of change in the outcome variables does not differ much by each additional month. Lastly, the somewhat larger β_4 coefficients for employed and retired compared to the β_3 coefficients could be due to the 2016 reform in UI, though the fact that β_4 is also larger for unemployed compared to β_3 contradicts this explanation.

6.2 Additional analyses

In the paragraphs below I discuss the results of the additional analyses. Almost all coefficients of these additional analyses are statistically significant at the 0.1 percent level at

[14] $\frac{\beta_{State}}{\beta_{Retirement}} * 100\%$

Figure 6.1: Plots of relationship between running variable and shares employed or retired



Note: Plots of the discontinutities in the outcomes employed and retired. Distance refers to the distance between the date of birth of individiduals and the threshold that applied to them. The upper two graphs concern the development in the shares of employed and retired for the second RD, whereas the latter to pertain to the last RD.

least. Furthermore, these coefficients mostly carry the same signs by outcome as the signs found in the main estimation. Notable divergents are mentioned below.

Fiscal effects Table 6.2 contains the coefficients for the fiscal analysis on the individual level. Each coefficient gives the average individual effect of the increases in the AOW age. In line with the main estimations, these coefficients imply that income from employment, UI and DI have increased on average, whereas income from retirement benefits have decreased.

To be able to compute the effect on the government budget, the income tax revenues from the increased income from employment must be computed and the coefficients must be weighted by the number of individuals in the treatment group. The number of individuals in the treatment group are shown in Table 5.1. The average increase in tax revenue is computed by using an average tax rate of 39.9%, 39.1%, 37.7% and 38.6% for the AOW age changes that took place in 2013, 2014, 2016 and 2017, respectively (CBS, 2019c). After weighting the coefficients, the short run fiscal effect is computed by summing the positive budget effects (decrease in retirement benefits payed and increase in income tax revenue) and deducting from this the sum of the negative budgets effects caused by

Table 6.2: Regression results for budgetary effect of the AOW increases

	(1) Income from employment	(2) Retirement benefits	(3) Unemployment benefits	(4) Disability benefits
β_1	-29.92	-1325.8***	19.17***	131.3***
	(24.59)	(38.26)	(4.455)	(15.00)
β_2	84.45***	-1069.9***	20.64***	186.0***
	(23.57)	(29.55)	(3.244)	(11.05)
β_3	465.2***	-1081.8***	75.10***	234.5***
	(17.08)	(26.02)	(3.906)	(11.43)
β_4	545.8***	-1035.1***	87.45***	209.3***
	(16.74)	(22.86)	(2.626)	(10.39)
Obs.	2,235,251	2,235,251	2,235,251	2,235,251

Regression results of the RDD with the monthly amount received from employment, retirement, unemployment and disability as outcomes. Beta one to four each refer to a different instance of an AOW age increase. Included are controls and standard errors clustered on the date of birth level. Avg. refers to the average level of each outcome for the untreated individuals, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

increased spending on social security benefits.[15] Finally, the amounts that result for each separate RD are summed to arrive at the total net budget effect. The resulting effect of increasing the AOW age by is equal to approximately 574 milion euros (on average 144 million euros per increase). This effect is mainly driven by the large reduction in spendings on the retirement benefits. On average, 18.5 percent of the short term increase in the government budget due to the increases in the AOW age were spent on the increased expenditures on unemployment benefits and disability benefits.

Active vs. passive substitution Table 6.3 shows the estimates for equation (4) after conditioning on employment as the initial state of an individual and Appendix Table A.6 shows the estimates of equation (4) after conditioning on unemployment or disability as the initial state. The coefficients for retired are large and negative for all initial states, which implies that individuals who used to be in a different state in the preceding month are less likely to be retired before the AOW age if they are subjected to a higher AOW age.

Interestingly, for each initial state considered, the increase in the probability to be in that same state increases by almost the same amount as the probability to retire decreases. Thus, the drops in retirement before the AOW age seem to be induced by persistence in the previous state instead of substitution toward other states. In other words, although people retire at a later age, only individuals that were initially employed remain employed.

[15]The β_1 coefficient for employed is treated as zero.

Table 6.3: Regression results for individuals that were employed in t-1

	(1) Employed	(2) Retired	(3) Unemployed	(4) Disabled
β_1	0.229***	-0.224***	0.002*	0.005**
	(0.034)	(0.022)	(0.001)	(0.001)
β_2	0.263***	-0.257***	0.001	0.004
	(0.040)	(0.026)	(0.000)	(0.002)
β_3	0.402***	-0.391***	0.000	-0.000
	(0.017)	(0.011)	(0.001)	(0.001)
β_4	0.399***	-0.387***	0.001**	0.000
	(0.017)	(0.013)	(0.000)	(0.001)
Obs.	461,815	461,815	461,815	461,815

Regression results of the RDD for the outcomes employed, retired, unemployed and disabled for individuals that were employed in the month preceding the observation. Beta one to four each refer to a different instance of an AOW age increase. Included are controls and standard errors clustered on the date of birth level. Avg. refers to the average level of each outcome for the untreated individuals, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Individuals that previously were unemployed or disabled continue their use of these social security programs as their main source of income. Although many of the other estimates are also significant, these coefficients are all very close to zero. Hence, in the short run, there appears to be no economically significant direct substitution effect induced by the reform.

Subgroup analysis The results of estimating equation (4) by gender are presented in Table 6.4. The coefficients show that men and women are affected quite differently by the reform. Women witness a substantially larger decrease in the share that is retired. Furthermore, while women witness a larger increase in employment than men for the first two changes in the AOW age, the effect is larger for men when looking at the last two changes in the AOW age. The shares in unemployment and disability increase more for men.

Table 6.5 and Appendix Table A.3 contain the estimates by partnership status and migration background. Here, the differences found were much more subtle than the differences between genders. Individuals with a migration background appear to be affected by increases in the AOW age more than individuals without a migration background, with the exception of the last change in the AOW age. The estimations by partnership status show that, compared to couples, singles are affected less by the first two AOW age increases and are affected more by the latter two in terms of the outcomes employed and

Table 6.4: Heterogeneity analysis: results by gender

	Men				*Women*			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Emp.	Ret.	Unemp.	Dis.	Emp.	Ret.	Unemp.	Dis.
β_1	0.031***	-0.181***	0.013***	0.098***	0.052***	-0.381***	0.008***	0.071***
	(0.007)	(0.010)	(0.002)	(0.004)	(0.004)	(0.010)	(0.001)	(0.005)
β_2	0.043***	-0.193***	0.009***	0.093***	0.065***	-0.386***	0.009***	0.066***
	(0.008)	(0.012)	(0.001)	(0.004)	(0.004)	(0.007)	(0.001)	(0.002)
β_3	0.182***	-0.391***	0.033***	0.116***	0.131***	-0.587***	0.027***	0.096***
	(0.007)	(0.007)	(0.001)	(0.003)	(0.004)	(0.006)	(0.001)	(0.002)
β_4	0.201***	-0.432***	0.039***	0.113***	0.136***	-0.610***	0.032***	0.096***
	(0.005)	(0.008)	(0.001)	(0.003)	(0.004)	(0.004)	(0.001)	(0.003)
Avg.	0.138	0.806	0.006	0.025	0.064	0.886	0.003	0.019
Obs.	1,109,331	1,109,331	1,109,331	1,109,331	1,125,920	1,125,920	1,125,920	1,125,920

Regression results of the RDD for the outcomes employed, retired, unemployed and disabled by gender. Beta one to four each refer to a different instance of an AOW age increase. Included are controls and standard errors clustered on the date of birth level. Avg. refers to the average level of each outcome for the untreated individuals, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

retired. Furthermore, singled are affected more in terms of the outcome disabled, while the coefficients are quite similar for the outcome unemployed.

Part of the found differences may be caused by compositional differences at the relevant ages between subgroups. Given the results of the substitution analysis, this is probably the main driver of the differences in the outcomes employed, unemployed and disabled. For example, women could be more likely to be unemployed or disabled at these specific ages than men. The explanation for the differences in the coefficients for retirement between subgroups is less straightforward. An explanation could be that more heavily affected subgroups are more likely to have a lower income and, therefore, cannot retire. The differences between genders, on the other hand, may be related to joint retirement decisions of partners based on for example income or occupational differences between men and women.

Finally, an assessment is made by income level. The results are presented in Appendix Table A.7 and A.8. The magnitude of the effect on the share that is retired seems to decrease in income. In other words, individuals with a higher average monthly income are affected less by the reform, which is in line with the expectations formed in section 3. Similarly, the magnitude of the effect on the share that makes use of disability insurance decreases in income from the second quartile onward. The magnitude of the effect on

Table 6.5: Heterogeneity analysis migration background and marital status for outcomes employed and retired

	No MB		*MB*		*Couple*		*Single*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Emp.	Ret.	Emp.	Ret.	Emp.	Ret.	Emp.	Ret.
β_1	0.040***	-0.275***	0.050***	-0.336***	0.042***	-0.278***	0.034***	-0.275***
	(0.004)	(0.009)	(0.011)	(0.022)	(0.005)	(0.009)	(0.008)	(0.019)
β_2	0.052***	-0.288***	0.069***	-0.314***	0.052***	-0.288***	0.046***	-0.275***
	(0.005)	(0.010)	(0.015)	(0.033)	(0.005)	(0.009)	(0.010)	(0.015)
β_3	0.155***	-0.487***	0.157***	-0.524***	0.154***	-0.485***	0.162***	-0.510***
	(0.005)	(0.006)	(0.013)	(0.023)	(0.005)	(0.006)	(0.008)	(0.010)
β_4	0.170***	-0.515***	0.147***	-0.574***	0.166***	-0.516***	0.176***	-0.529***
	(0.003)	(0.004)	(0.007)	(0.030)	(0.003)	(0.006)	(0.006)	(0.008)
Obs.	2,021,818	2,021,818	213,433	213,433	1,870,647	1,870,647	190,871	190,871
Avg.	0.102	0.856	0.089	0.756	0.105	0.862	0.093	0.826

Regression results of the RDD for the outcomes employed and retired for individuals without a migration background (no MB), with a migration background (MB), singles and couples separately. Beta one to four each refer to a different instance of an AOW age increase. Includes controls and standard errors clustered on the date of birth level. Avg. refers to the average level of each outcome for the untreated individuals, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

employment, on the other hand, increases in income for all quartiles except for the fourth, where the effect is in fact the smallest. A reason could be that individuals in the highest quartile of income will have built up larger second pillar benefits and possibly third pillar benefits, which allows them to retire earlier. The effect on unemployment is substantially smaller for the first quartile compared to the others, where it is relatively stable across income groups. An explanation for this might be that individuals in the lowest income group are eligible for general welfare benefits (*bijstand*).

7 Sensitivity analyses

In this section, I discuss the results of several robustness checks that I performed to assess the sensitivity of the results to using different functional forms, bandwidths, definitions of retirement and empirical strategy to estimate the effect of the reform.

The estimations presented in the previous section all assumed a linear relationship between distance and the outcome variables. Table 7.1 presents the results for the outcomes employed and retired of the estimation of equation (4) including second and third order

Table 7.1: Regression results assuming different functional forms for outcomes employed and retired

	First order (Baseline)		*Second order*		*Third order*	
	(1)	(2)	(3)	(4)	(5)	(6)
	Employed	Retired	Employed	Retired	Employed	Retired
β_1	0.041***	-0.281***	0.010	-0.205***	0.049***	-0.263***
	(0.005)	(0.009)	(0.010)	(0.007)	(0.006)	(0.013)
β_2	0.054***	-0.290***	0.042***	-0.272***	0.052***	-0.294***
	(0.005)	(0.009)	(0.008)	(0.011)	(0.005)	(0.010)
β_3	0.152***	-0.486***	0.164***	-0.493***	0.166***	-0.510***
	(0.005)	(0.006)	(0.006)	(0.007)	(0.004)	(0.005)
β_4	0.164***	-0.518***	0.178***	-0.532***	0.160***	-0.516***
	(0.003)	(0.005)	(0.006)	(0.007)	(0.004)	(0.006)
Obs.	2,235,251	2,235,251	2,235,251	2,235,251	2,235,251	2,235,251

Regression results of the RDD for the outcomes employed and retired. Beta one to four each refer to a different instance of an AOW age increase adding polynomials of the second and third order. IIncluded are controls and standard errors clustered on the date of birth level. Avg. refers to the average level of each outcome for the untreated individuals, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

polynomials of the running variable. The coefficients seem to be slightly lower, but still quite close to the original estimates. Only the estimates for the first RD decrease somewhat when a second order polynomial of distance is included. The same interpretation applies to the estimates of the outcomes unemployed and disabled, which are presented in Table A.4 of Appendix A.

Furthermore, for the initial estimations the bandwidth that was used was determined by the months of birth that were part of an AOW age cohort. Table 7.2 contains the estimations for the outcome employed and retired using three different, smaller bandwidths. Specifically, the estimations are done using nine, six and three months on either side of the cutoff. The coefficients are fairly similar across the estimations. Although slight changes are present, there is no clear pattern in how the estimates change. The same interpretation applies to the estimates of the outcomes unemployed and disabled, which are presented in Table A.5 of Appendix A.

Next, the robustness of the estimation towards changing the definition of retirement is evaluated. For the initial estimations, an individual was deemed retired at a specific observation point if the main source of income within the relevant month was pension benefits. Table 7.3 shows the coefficients for the outcome retirement for two other definitions as well. The first column shows the coefficients for the original definition, the second column

Table 7.2: Regression results using different bandwidths for outcome employed and retired

	9 months		*6 months*		*3 months*	
	(1)	(2)	(3)	(4)	(5)	(6)
	Employed	Retired	Employed	Retired	Employed	Retired
β_1	0.051***	-0.283***	0.047***	-0.272***	0.044***	-0.254***
	(0.003)	(0.008)	(0.005)	(0.011)	(0.002)	(0.004)
β_2	0.055***	-0.293***	0.055***	-0.288***	0.062***	-0.313***
	(0.003)	(0.006)	(0.004)	(0.007)	(0.001)	(0.004)
β_3	0.157***	-0.498***	0.163***	-0.499***	0.164***	-0.488***
	(0.005)	(0.005)	(0.007)	(0.005)	(0.004)	(0.008)
β_4	0.164***	-0.519***	0.158***	-0.514***	0.113***	-0.486***
	(0.003)	(0.004)	(0.004)	(0.006)	(0.007)	(0.013)
Obs.	2,077,746	2,077,746	1,525,999	1,525,999	844,038	844,038

Regression results of the RDD for the outcomes employed and retired for three different bandwidths of the running variable (in terms of distance in months on either side of the cutoff). Beta one to four each refer to a different instance of an AOW age increase. Included are controls and standard errors clustered on the date of birth level. Avg. refers to the average level of each outcome for the untreated individuals, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

shows the estimates that result when retirement is defined as receiving pension benefits, and the third column shows the coefficients for the estimation where retirement equals having pension benefits as a main source of income for four consecutive months after the first occurrence of it.[16] The coefficients of the second definition are are somewhat lower for the first two AOW age changes, whereas they are larger for the latter two. The coefficients of the third definition are slightly smaller. Still, there are no drastic changes in the sign, significance or magnitude of the coefficients. Important to note, however, is that all of these additional definitions of retirement are based on benefit claiming and not on, for example, whether an individual stops working, which may explain the similar results. [17]

Finally, a different empirical strategy is employed to assess the effects under different assumptions underlying inference. The set-up of the reform allows for the implementation of a difference-in-differences (DD) approach as well as an RDD. Although the RDD is relatively precise and credible in its assumptions, it only allows for the estimation of the

[16] An individual is deemed to receive retirment benefits if income from pension benefits within a month is higher or equal to 100. The amount 100 was chosen as deeming an individual retired for very low values of claiming did not seem realistic.

[17] Although a definition based on hours worked was initially also considered, this definition is much harder to implement as most individuals do not stop working completely. As a result, equating retirement to working zero hours, for example, showed no clear relationship.

Table 7.3: Regression results for different definitions of retirement

	(1) Main source	(2) Claiming only	(3) Main source spell
β_1	-0.281***	-0.226***	-0.272***
	(0.009)	(0.005)	(0.010)
β_2	-0.290***	-0.236***	-0.287***
	(0.009)	(0.008)	(0.011)
β_3	-0.491***	-0.437***	-0.478***
	(0.006)	(0.006)	(0.007)
β_4	-0.522***	-0.487***	-0.512***
	(0.005)	(0.006)	(0.006)
Obs.	2,235,251	2,235,251	2,235,251

Regression results of the RDD for three different definitions of retirement. Beta one to four each refer to a different instance of an AOW age increase. Included are controls and standard errors clustered on the date of on on the date of birth level. Avg. refers to the average level of each outcome for the untreated individuals, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

local average treatment effect on individuals at a specific age, as only the behavior of individuals around the thresholds is evaluated. Therefore, the external validity of such an approach is considerably weaker as the conclusions that are drawn might not apply to individuals born in other months than the ones included in the analysis or are at an age other than the one considered. A DD approach on the other hand can be used to compare the treatment effect across several different cohorts, exploit information about the same individual at different ages and compare it to what individuals of different cohorts were doing at these ages. The exact methodology for the DD that is implemented and whether the identifying assumption is likely to hold, is elaborated upon in Appendix B.

Table B.1 in the Appendix contains the results. All estimates shown in this table are statistically significant at the 0.1 percent level. Overall, the share of individuals that retire before the AOW age decreases by 50.6 percentage points, compared to cohorts that are subject a lower AOW age. This decrease in retirement again translates into an increase of participation in other states. The employment rate increases by 16 percentage points below the AOW age. Unemployment, on the other hand, increases by only 2.8 percentage points. Furthermore, the share of individuals that make use of disability insurance increases by 11.1 percentage points. Similar to what was found through the RDD, 32.0 percent of the decrease in retirement translates in increase in employment, 5.6 percent in unemployment and 22.2 percent in disability.[18]

The coefficients of the DD estimation have the same signs as the RDD estimation. For

[18] Again, computed in the following way: $\frac{\beta_{State}}{\beta_{Retirement}} * 100\%$

the DD estimation only three-month increases were considered. Comparing the coefficients of the DD to the β_3 and β_4 of the RDD shows that the estimates are similar in magnitude. The slight differences are likely driven by the fact that the DD estimates the effect for the multiple increases in the AOW age at once.

8 Conclusion

In this paper I have evaluated the effect of the Dutch state pension age reform on the employment decisions and social security insurance usage of older individuals. This effect was estimated by applying an RDD to Dutch administrative data. The results indicate that an increase in the AOW age induces older workers to retire later. In stead of substituting towards other social security programs, individuals remain in their initial state to finance this delay in retirement. Furthermore, the evaluation points to heterogeneity in the treatment effect by different subgroups and to positive government budget effects in the short run. Finally, the sensitivity analyses did not raise any suspision toward the credibility of the found effects. Overall, the results confirm the expectations that were formed earlier: increasing the AOW age seems to lead to an increase in the labor supply of older workers. Whether these decisions are driven by the wealth effect, the price effect or reference dependece, however, does not follow from the analysis.

Several policy implications can be derived from these results. So far, it seems that the increases in the AOW age have been beneficial for problems in terms of age dependency as described in the introduction. However, these results may hold true only up until a certain age. Even though life expectancy of individuals is increasing, after a certain point individuals may simply not be able to work due to, for example, health related reasons. Additionally, the fact that individuals can take up their second pillar benefits after the age of 68 may induce different effects beyond this age. Moreover, although individuals that first worked remain employed, individuals that were initially unemployed or disabled remain in these states longer too. This may lead to higher spendings on social security for the government or, given the limited period for which some of these social security benefits can be taken up, this may yield (more) financial complications for certain households. All in all, although the results point to positive budget effects as a result of further increasing the AOW age, it is difficult to say on the basis of these results whether this is a desirable course of action.

A number of limitations should be pointed out about the approach taken in this study. First of all, the data does not contain information about when individuals actually retire. The state measures based on the dominant source of income is a good proxy, but may not capture the exact moment of retirement. Besides, the reform relates to the timing of a sudden addition (AOW benefits) to the monthly income from pension benefits, which may drive part of the results due to how the outcome variable is defined. Furthermore, in the Netherlands, welfare (*bijstand*) benefits are widely used as a source of income, more so than unemployment benefits. These were not included in the analysis as the relationship between the outcomes and the changes in the AOW age were less clear and less credible at the cutoff. However, including this in the analysis may have resulted in considerably smaller positive budget effects. Finally, as the amount of time that has passed since the implementation of the reforms is fairly short, the long term effects of these changes in the AOW age could not be analyzed.

Future research could focus on circumventing these issues. In addition, further research could touch upon other interesting topics that were outside of the scope of this particular study. For example, interesting questions would be how labor market opportunities of younger workers are affected by these reforms and what the repercussions are for intergenerational redistribution. Moreover, the effects on the productivity of the individuals that remain in the workforce and the long term budget effects of the reform could be explored. Altogether these additions would create a more complete image on whether further increasing the retirement age is a desirable method, in terms of equity and efficiency, to improve the sustainability of the Dutch pension system.

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Appendix A: Additional results and full tables

Table A.1: Regression results at the placebo cutoff

	(1) Employed	(2) Retired	(3) Unemployed	(4) Disability
β_A	-0.002	0.007	0.002	-0.005
	(0.003)	(0.006)	(0.002)	(0.003)
β_B	-0.002	0.014 *	0.002	-0.008 *
	(0.003)	(0.006)	(0.002)	(0.003)
Obs.	409,029	409,029	409,029	409,029

Regression results of the RDD for the outcomes employed, retired, unemployed and disabled at placebo cutoffs in December and (A) January (B) of 1946 including controls and clustered on the date of birth level. Standard errors in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table A.2: Regression results for work state outcomes including interactions for AOW increases with multiple months

	(1) Employment	(2) Retirement	(3) Unemployment	(4) Disability
β_1	0.041***	-0.281***	0.011***	0.084***
	(0.005)	(0.009)	(0.001)	(0.004)
β_2	0.054***	-0.290***	0.009***	0.079***
	(0.005)	(0.009)	(0.001)	(0.003)
β_3	0.152***	-0.486***	0.029***	0.105***
	(0.005)	(0.006)	(0.001)	(0.002)
$\beta_3 \times \theta_3 \times A_{65.25}$	0.007***	-0.009***	0.002***	0.000 *
	(0.000)	(0.001)	(0.000)	(0.000)
$\beta_3 \times \theta_3 \times A_{65.33}$	0.004***	-0.005***	0.001***	0.000 *
	(0.000)	(0.000)	(0.000)	(0.000)
β_4	0.164***	-0.518***	0.034***	0.104***
	(0.003)	(0.005)	(0.001)	(0.003)
$\beta_4 \times \theta_4 \times A_{65.5}$	0.006***	-0.008***	0.003***	0.000
	(0.001)	(0.001)	(0.000)	(0.000)
$\beta_4 \times \theta_4 \times A_{65.58}$	0.003***	-0.004***	0.001***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
Avg.	0.168	0.614	0.015	0.078
Obs.	2,235,251	2,235,251	2,235,251	2,235,251

Regression results of the RDD for the outcomes employed, retired, unemployed and disabled including interactions for age in months dummies (A) for the three-month AOW age increases,. Beta one to four each refer to a different instance of an AOW age increase. Included are controls and standard errors clustered on the date of birth level. Avg. refers to the average level of each outcome for the untreated individuals, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table A.3: Heterogeneity analysis: by migration background and marital status for outcomes unemployed and disabled

	No MB		*MB*		*Couple*		*Single*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Unemp.	Dis.	Unemp.	Dis.	Unemp.	Dis.	Unemp.	Dis.
β_1	0.010^{***}	0.082^{***}	0.016^{***}	0.107^{***}	0.011^{***}	0.079^{***}	0.010^{**}	0.119^{***}
	(0.001)	(0.004)	(0.003)	(0.012)	(0.001)	(0.004)	(0.003)	(0.010)
β_2	0.009^{***}	0.076^{***}	0.014^{***}	0.105^{***}	0.009^{***}	0.073^{***}	0.007^{**}	0.118^{***}
	(0.001)	(0.003)	(0.002)	(0.019)	(0.001)	(0.003)	(0.002)	(0.008)
β_3	0.030^{***}	0.101^{***}	0.030^{***}	0.139^{***}	0.030^{***}	0.100^{***}	0.034^{***}	0.159^{***}
	(0.001)	(0.003)	(0.002)	(0.012)	(0.001)	(0.002)	(0.003)	(0.008)
β_4	0.037^{***}	0.107^{***}	0.024^{***}	0.089^{***}	0.035^{***}	0.100^{***}	0.037^{***}	0.153^{***}
	(0.001)	(0.002)	(0.002)	(0.012)	(0.001)	(0.003)	(0.003)	(0.006)
Obs.	2,021,818	2,021,818	213,433	213,433	1,870,647	1,870,647	190,871	190,871
Avg.	0.005	0.021	0.005	0.027	0.005	0.020	0.005	0.034

Regression results of the RDD for the outcomes unemployed and disabled for individuals without a migration background (no MB), with a migration background (MB), singles and couples separately. Beta one to four each refer to a different instance of an AOW age increase. Includes controls and standard errors clustered on the date of birth level. Avg. refers to the average level of each outcome for the untreated individuals, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table A.4: Regression results assuming different functional forms for outcomes unemployed and disabled

	Second order		*Third order*	
	(1)	(2)	(3)	(4)
	Unemp.	Disabled	Unemp.	Disabled
β_1	0.002	0.071***	0.007***	0.067***
	(0.002)	(0.011)	(0.001)	(0.004)
β_2	0.007***	0.069***	0.008***	0.073***
	(0.002)	(0.009)	(0.001)	(0.004)
β_3	0.029***	0.100***	0.031***	0.109***
	(0.002)	(0.004)	(0.001)	(0.003)
β_4	0.031***	0.097***	0.035***	0.103***
	(0.001)	(0.005)	(0.001)	(0.003)
Obs.	2,235,251	2,235,251	2,235,251	2,235,251

Regression results of the RDD for the outcomes unemployed and disabled. Beta one to four each refer to a different instance of an AOW age increase adding polynomials of the second and third order. Included are controls and standard errors clustered on the date of birth level. Avg. refers to the average level of each outcome for the untreated individuals, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table A.5: Regression results using different bandwidths for outcomes unemployed and disabled

	9 months		*6 monts*		*3 months*	
	(1)	(2)	(3)	(4)	(5)	(6)
	Unemp.	Disabled	Unemp.	Disabled	Unemp.	Disabled
β_1	0.010 ***	0.078 ***	0.008 ***	0.077 ***	0.004 ***	0.069 ***
	(0.001)	(0.004)	(0.002)	(0.006)	(0.000)	(0.002)
β_2	0.009 ***	0.078 ***	0.009 ***	0.073 ***	0.012 ***	0.077 ***
	(0.001)	(0.003)	(0.001)	(0.003)	(0.000)	(0.002)
β_3	0.0301***	0.108 ***	0.032 ***	0.106 ***	0.031 ***	0.106 ***
	(0.001)	(0.003)	(0.001)	(0.003)	(0.001)	(0.002)
β_4	0.035 ***	0.105 ***	0.036 ***	0.106 ***	0.020 ***	0.129 ***
	(0.001)	(0.003)	(0.001)	(0.002)	(0.001)	(0.006)
Obs.	2,077,746	2,077,746	1,525,999	1,525,999	844,038	844,038

Regression results of the RDD for the outcomes unemployed and disabled for three different bandwidths of the running variable (in terms of distance in months on either side of the cutoff). Beta one to four each refer to a different instance of an AOW age increase. Included are controls and standard errors clustered on the date of birth level. Avg. refers to the average level of each outcome for the untreated individuals, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table A.6: Regression results for individuals that were unemployed or disabled in t-1

		(1) Employed	(2) Retired	(3) Unemployed	(4) Disabled
Unemployed in t-1					
	β_1	0.013*	-0.619***	0.586 ***	0.005 **
		(0.005)	(0.071)	(0.075)	(0.002)
	β_2	0.006	-0.467***	0.427 ***	0.012*
		(0.005)	(0.025)	(0.028)	(0.005)
	β_3	-0.005	-0.544***	0.564 ***	0.002
		(0.003)	(0.023)	(0.028)	(0.001)
	β_4	-0.009***	-0.640***	0.677 ***	0.002
		(0.003)	(0.033)	(0.019)	(0.002)
Obs.		49,881	49,881	49,881	49,881
Disabled in t-1					
	β_1	0.002	-0.636***	0.001*	0.633 ***
		(0.001)	(0.038)	(0.001)	(0.038)
	β_2	-0.000	-0.572***	0.000	0.573 ***
		(0.002)	(0.025)	(0.000)	(0.026)
	β_3	-0.005***	-0.664***	-0.000	0.671 ***
		(0.001)	(0.018)	(0.000)	(0.018)
	β_4	-0.004***	-0.659***	0.000	0.665 ***
		(0.001)	(0.018)	(0.000)	(0.019)
Obs.		220,945	220,945	220,945	220,945

Regression results of the RDD for the outcomes employed, retired, unemployed and disabled for individuals that were unemployed or disabled in the month preceding the observation. Beta one to four each refer to a different instance of an AOW age increase. Included are controls and standard errors clustered on the date of birth level. Avg. refers to the average level of each outcome for the untreated individuals, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table A.7: Regression results for first two income quartiles

		(1) Employed	(2) Retired	(3) Unemployed	(4) Disabled
Q1					
	β_1	0.040***	-0.542***	0.001	0.044***
		(0.004)	(0.011)	(0.001)	(0.004)
	β_2	0.041***	-0.588***	0.002*	0.040***
		(0.003)	(0.013)	(0.001)	(0.002)
	β_3	0.060***	-0.750***	0.003**	0.040***
		(0.002)	(0.010)	(0.001)	(0.002)
	β_4	0.069***	-0.757***	0.006***	0.039***
		(0.003)	(0.006)	(0.000)	(0.002)
Obs.		509353	509353	509353	509353
Avg.		0.012	0.916	0.000	0.006
Q2					
	β_1	0.061***	-0.343***	0.014***	0.161***
		(0.006)	(0.016)	(0.002)	(0.009)
	β_2	0.070***	-0.308***	0.012***	0.147***
		(0.007)	(0.011)	(0.001)	(0.007)
	β_3	0.142***	-0.566***	0.034*	0.204***
		(0.007)	(0.008)	(0.002)	(0.007)
	β_4	0.146***	-0.604***	0.041***	0.198***
		(0.005)	(0.006)	(0.002)	(0.006)
Obs.		557170	557170	557170	557170
Avg.		0.070	0.843	0.004	0.047

Regression results of the RDD for the outcomes employed, retired, unemployed and disabled for the first two income quartiles (Q1 and Q2). Beta one to four each refer to a different instance of an AOW age increase. Included are controls and standard errors clustered on the date of birth level. Avg. refers to the average level of each outcome for the untreated individuals, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table A.8: Regression results for last two income quartiles

		(1) Employed	(2) Retired	(3) Unemployed	(4) Disabled
Q3					
	β_1	0.054***	-0.187***	0.019***	0.096***
		(0.008)	(0.011)	(0.002)	(0.005)
	β_2	0.069***	-0.217***	0.019***	0.096***
		(0.008)	(0.013)	(0.002)	(0.004)
	β_3	0.215***	-0.425***	0.045***	0.140***
		(0.007)	(0.007)	(0.002)	(0.005)
	β_4	0.230***	-0.473***	0.051***	0.149***
		(0.006)	(0.006)	(0.002)	(0.003)
Obs.		552381	552381	552381	552381
Avg.		0.113	0.847	0.008	0.029
Q4					
	β_1	0.013	-0.060***	0.007**	0.029***
		(0.008)	(0.010)	(0.002)	(0.002)
	β_2	0.032**	-0.073***	0.004*	0.030***
		(0.010)	(0.011)	(0.001)	(0.003)
	β_3	0.193***	-0.278***	0.035***	0.039***
		(0.011)	(0.010)	(0.002)	(0.002)
	β_4	0.219***	-0.314***	0.041***	0.046***
		(0.008)	(0.007)	(0.002)	(0.001)
Obs.		613513	613513	613513	613513
Avg.		0.199	0.785	0.006	0.006

Regression results of the RDD for the outcomes employed, retired, unemployed and disabled for the last two income quartiles (Q3 and Q4). Beta one to four each refer to a different instance of an AOW age increase. Included are controls and standard errors clustered on the date of birth level. Avg. refers to the average level of each outcome for the untreated individuals, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Appendix B: Difference-in-differences estimation

Following Staubli & Zweimüller (2013), a baseline difference-in-differences (DD) model is specified in equation (B.1).

$$y_{iact} = \alpha_0 + \delta_c + \theta_{at} + \alpha_1 \mathrm{I}(\mathrm{age} < \mathrm{AOW})_{iact} + \alpha_2 X_{iat} + \epsilon_{iact} \tag{B.1}$$

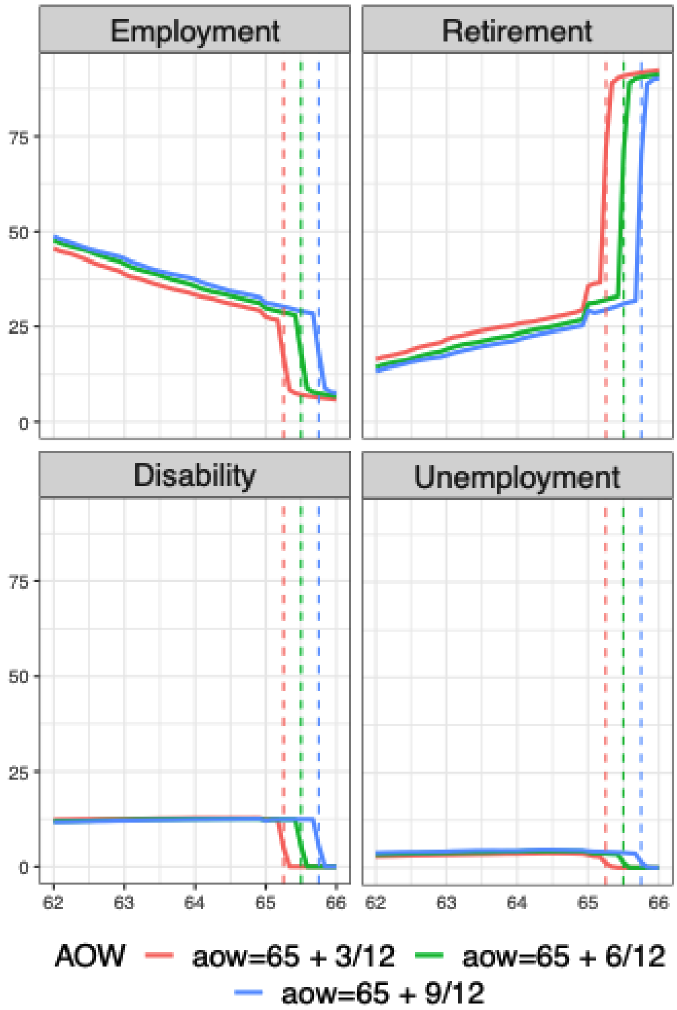
In this specification, δ_c and θ_{at} are cohort and age (in month t) dummies, respectively, and X_{iat} is a vector of macro-level and individual-specific controls. The cohorts are formed by the AOW age reform, as individuals were subjected to a different AOW age depending on their birth date. The effect of interest is α_1, which indicates the difference in the outcome variable before and after individuals reach the AOW age, between different cohorts. This parameter can be estimated by including a dummy variable that indicates the interaction between the age of an individual and the AOW age cohort that he or she belongs to. In equation (B.1), the $\mathrm{I}(\mathrm{age} < \mathrm{AOW})_{iact}$ variable represents this interaction. This dummy variable equals one for individuals below the AOW age that is applicable within their cohort, and zero for individuals that have reached this age. As individuals are affected by the reform at different ages depending on the cohort, the value of the variable changes over cohorts as well as over time. Thus, with equation (B.1) the employment decisions of individuals that are affected by the reform in different degrees are compared to identify its effect on the labor supply of older individuals.

The left hand side of equation (B.1) contains outcome variable y_{iact}. The outcomes for which the equation is estimated are again employed, retired, unemployed and disabled. Again, equation (B.1) forms a linear probability model. Thus, similar to the RDD estimates, α_1 can be interpreted as percentage point difference in the *probability* that an individual is employed, retired, unemployed or disabled before and after reaching the AOW age compared to cohorts that are subjected to a different AOW age as a result of the reform.

The identifying assumption of employing the difference-in-differences strategy in this context is that, conditional on cohort effects, age effects and control variables, in the absence of the reform the trend in the outcomes over the age variable would be similar across affected and unaffected AOW age cohorts. If this assumption holds, α_1 can be interpreted causally. To circumvent the violation of this assumption by reforms in the second pillar pension (see section 2), the analysis is limited to the changes in the AOW age of 2015 and after. Thus, three cohorts are compared. For these three cohorts, the evolution of the trends in the outcome variables across ages appears quite stable across ages.

Results additional analyses for DD

Figure B.1: Evolution of the trend in outcomes employed, retired, unemployed and disabled across age



Note: The participation share on the y-axis and age on the x-axis. The colors each indicate different AOW age cohorts, denoted in the legend.

Source: Original CPB discussion paper

Table B.1: Regression results for the difference-in-differences approach

	(1) Employed	(2) Retired	(3) Unemployed	(4) Disability
Before AOW age	0.160 ***	-0.500 ***	0.028 ***	0.111 ***
	(0.001)	(0.001)	(0.000)	(0.001)
Average	0.395	0.215	0.042	0.123
Observations	17,761,820	17,761,820	17,761,820	17,761,820
Indindividuals	375,271	375,271	375,271	375,271

Regression results of the DD for the outcomes employed, retired, unemployed and disabled. Beta one to four each refer to a different instance of an AOW age increase. Included are controls and standard errors clustered on the date of birth level. Avg. refers to the average level of each outcome for the untreated individuals, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Appendix C: Existing research

Table C.1: Overview of results of previous research on changes in the retirement age

Study	Type	Reform	Country	Method	Treated	Outcome	Before	TE
Geyer et al. (2018) (survey data)	ERA	60 → 63 for women in 1999	GER	RDD	Women born 1952 onward	Employment rate	42 %	8.4 ppt
Geyer & Welteke (2019) (admin. data)	ERA	60 → 63 in 1999	GER	RDD	Women born 1952 onward	Employment rate	44.1 %	13.5 ppt
Staubli & Zweimüller (2013)	ERA	60 → 62 for men and 55 to 58.25 for women between 2001 and 2010	AUT	DD	Women born after Sept. 1945 and men born after Sept. 1940	Employment rate	♀: 67 % ♂: 36 %	♀: 11 ppt ♂: 9.75 ppt
Rabaté & Rochut (2019)	ERA	60 → 62 between 2010 and 2015	FR	DD	Birth cohorts 1951 to 1955	Employment rate	51 %	21 ppt
Cribb et al. (2013)	NRA	60 → 61 between 2010 and 2011 (♀)	UK	DD	Women born April 1950 to 1953	Employment rate	58 %	7.3 ppt
Atalay & Barrett (2015)	NRA	60 → 65 between 1995 and 2017 (♀)	AUS	DD	Women born June 1935 to 1952	labor force participation dummy	42 %	12 ppt
De Vos et al. (2018) (survey data)	AOW	65 → 65 between 2013 and 2016	NL	DD	Birth cohorts 1948 to June 1951	Employment rate	37 %	10 ppt
This paper (admin. data)	AOW	65 → 67 between 2013 and 2017	NL	RDD	Birth cohorts 1948 to April 1952	Employment rate	20.5	4.1-16.4 ppt

Note: DD and ppt stand for differences-in-difference and percentage points, respectively. Column (9) contains the average (over cohorts and gender) value of the outcome variable before the reform. Colum (10) and (11) contain the treatment effect (TE) (approximate and rounded) and percentage point (approximate and rounded) and percentage change in the outcome variable, respectively.