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Pension incentives and early retirement☆

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ABSTRACT

In this paper we exploit a cohort-specific pension reform to estimate the labour market effects of changes in the financial incentives to retire. In particular, we analyse the effects of the introduction of cohort-specific deductions for early retirement on female retirement, employment and unemployment. For the empirical analysis we use high-quality administrative data from the German pension insurance. We present evidence for sizeable labour market effects. In addition to direct effects on women older than 60 we find important anticipation effects before reaching the pension eligibility age. Overall we document that the pension reform leads to a postponement of retirement, an increase in employment and a shifting in unemployment over age rather than a substitution into unemployment.

1. Introduction

Ageing populations present significant challenges for public pension systems. Therefore, most OECD countries have revised their retirement policies since the 1990s in order to encourage longer working lives, thus alleviating the decline of the working age population (OECD, 2006, 2011). Reforms include tighter qualifying conditions and increases in the pension eligibility age, the introduction of actuarial deductions for early retirement, increases in the normal retirement age (NRA), i.e. the age at which people can first draw full benefits without actuarial deductions,[1] increases in the statutory retirement age, or a combination of these policies.

The effectiveness of pension reforms strongly depends on the induced labour market effects, in particular the impact on employment and retirement. Therefore, it is crucial to empirically evaluate these policies and to quantify their labour market effects. It is the aim of this paper to provide novel insights on this important issue. More specifically, we estimate the labour market effects of a pension reform that introduced actuarial deductions for early retirement in combination with an increase in the NRA. We quantify the impact on employment, retirement, and the take-up of disability or unemployment benefits. A pension reform induces direct labour market effects for individuals who reach the pension eligibility age. In addition, pension reform might lead to anticipation effects for individuals before reaching that age. For example, individuals might increase employment prior to the age of pension eligibility in order to compensate for the reduced generosity of the pension system. Moreover, there is convincing empirical evidence that individuals use unemployment benefits or disability pensions as a substitution for, or a bridge into, retirement (e.g., Duggan et al., 2007, Coe and Haverstick, 2010, Grogger and Wunsch, 2012, Giesecke and Kind, 2013, Staubli and Zweimüller, 2013, Atalay and Barrett, 2015 or Inderbitzin et al., 2016). Therefore, in order to capture the full labour market effects of the pension reform, in this paper we analyse both the labour market effects before ("anticipation effect") and after ("direct effect") reaching the pension eligibility age.

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[1] This definition of the NRA is equal to the OECD definition of the "pensionable age" (OECD, 2011, p. 20). In contrast to the NRA, the statutory retirement age is not necessarily the first age at which an individual receives full pensions. For example, in this paper we analyse a reform that increased the NRA for women in Germany from 60 to 65, while the statutory retirement age remained constant at 65.

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The identification of the effects of the pension system on the labour market is challenging. One central problem is that decisions on the labour market are likely to be influenced by unobserved individual factors that are correlated with the financial incentives of the pension system (e.g. Chan and Stevens, 2004 or Hanel and Riphahn, 2012). For example, individual social security wealth, which is a measure of financial retirement incentives, depends on the working and earnings history of each individual. Therefore, the interpretation of estimated employment effects obtained in commonly used regressions that use cross-sectional variation in the social security wealth requires strong assumptions (Gruber and Wise, 2004).

In this paper, we propose a different estimation strategy and directly exploit exogenous cohort-specific variation in the introduction of actuarial deductions for early retirement. Specifically, we focus on the 1992 pension reform in Germany that increased the NRA and introduced deductions for early retirement for women born after December 1939. The estimation is based on high-quality administrative data from the German public pension insurance. For the identification, we exploit the following variation: women born before January 1940 could retire without deduction from age 60 onwards, while for women born in subsequent months through December 1944 deductions were gradually introduced by month of birth. Thus, all cohorts born between January 1940 and December 1944 were affected by the reform in different ways. In addition, the NRA was gradually increased from the age of 60 to the age of 65, while both the pension eligibility age (60) and the statutory retirement age (65) remained constant.[2]

This specific design allows us to estimate the direct effect and the anticipation effect (behavioural reaction before reaching age 60, i.e. the age of pension eligibility) of the pension reform. First, in order to estimate the direct effect of the pension reform on labour market outcomes, we exploit the cohort-specific age pattern of the deductions and estimate the effects of deductions on retirement, employment, and unemployment. Second, in order to account for both the direct effect and the anticipation effect, we focus on the impact of the reform on the retirement age as well as the time spent in employment and unemployment (duration) between 55 and 65 years of age. These outcomes include the behaviour of individuals before and after reaching the pension eligibility age. For the identification of the overall effect, we follow the estimation approach proposed by Mastrobuoni (2009).

Our approach follows several studies that rely on exogenous cohort-specific variation in pension reforms to estimate the labour market effects of pension reforms. For example, Mastrobuoni (2009) focuses on the increase of the NRA in the US to estimate the effect on retirement age. Since the reform was introduced in different steps, it affected adjacent cohorts differently. Similarly, Staubli and Zweimüller (2013) use cohort-specific variation in the implementation of an increase in the pension eligibility age in Austria to estimate the employment and fiscal effects of this reform. They find a modest increase in employment and a substantial increase in registered unemployment for both men and women. They do not find large effects on disability take-up. Manoli and Weber (2016), analysing the same reform, show that employment effects are mainly explained by individuals who keep their pre-retirement jobs longer. Atalay and Barrett (2015) analyse a reform in Australia that gradually increased the pension eligibility age for women from 60 to 65. Since the Australian pension system follows a non-contributory scheme, they are able to identify the effect of the reduction in social security wealth on employment behaviour. Hanel (2012) analyse a Swiss reform that increased the NRA for women. They find relatively large effects on employment comparable to the findings in Mastrobuoni (2009) for the US (for the Swiss reform, see also Lalive and Staubli (2015)). Our paper is also related to another strand of literature that focuses on programme substitution effects, e.g. between unemployment insurance, disability, and retirement if the attractiveness of one of these programmes changes in comparison to the other programmes (e.g. Duggan et al., 2007; Karlström et al., 2008; Li and Maestas, 2008; Coe and Haverstick, 2010; Staubli, 2011; Borghans et al., 2014).

The empirical results provide evidence for sizeable labour market effects. In particular, for women older than 60 years who are directly affected by the pension reform we find that an increase in the deductions by one percentage point reduces the average retirement rate by about 1.9 percentage points, increases employment by about 1 percentage point, and leads to substitution effects into unemployment of about 0.9 percentage points. The results also show that the effect of deductions on retirement is non-linear and follows a concave function; specifically, we find that the introduction of modest deductions already has an important effect. Furthermore, the results document that anticipation effects are important. First, we show that the anticipation effect reinforces the direct effect on retirement and employment; we find that due to the pension reform, employment prior to the age of 60 years increases whereas during the same period retirement is reduced. Moreover, when additionally including women younger than 60, the substitution effects into unemployment show an interesting pattern. We find that prior to the age of 60 unemployment is reduced whereas after the age of 60 unemployment increases. Thus, the effect of the pension reform is close to zero over the full period between the ages 55 and 65. Hence, our results suggest that the pension reform induces a shifting in unemployment periods before retirement rather than a stronger substitution into unemployment. This shifting is consistent with previous empirical evidence that unemployment is often used as a bridge into retirement. Finally, our analysis documents interesting effect heterogeneity. The size of the reform effects differ by East and West Germany, by the previous employment history, and by the presence of children.

The paper is structured as follows. In Section 2 we describe the institutional background and the pension reform of 1992. We present the data and provide descriptive statistics in Section 3. The empirical models are presented in Section 4. Section 5 provides estimation results. Section 6 concludes.

2. Institutional background

In this section, we provide a brief overview of the German pension system and discuss in detail how the 1992 pension reform affected the different cohorts over time. Moreover, we provide evidence how the pension system interacts with other social security programmes and highlight potential substitution patterns between the different programmes.

2.1. Germany's pension system

The statutory public pension system covers all private and public sector employees. It provides old-age pensions, disability pensions, and survivors benefits. Depending on the number of years of contributions and other qualifying conditions, the pensionable age is between 60 and 65 for the cohorts under study (1938–1944).[3] In addition, people who are not able to work due to severe health conditions can retire before

[2] Several studies use this specific pension reform as additional variation in the context of option-value models (e.g. Hanel, 2010). The identification of these models still partly relies on cross-sectional variation and requires structural assumptions. Moreover, some studies used option-value models to evaluate this reform *ex ante*, e.g. Siddiqui (1997), Börsch-Supan (2000), Berkel and Börsch-Supan (2004).

[3] This is different for later birth cohorts. In 1999, the pension for women was abolished for cohorts born after 1951 (see Geyer and Welteke, 2017, for an analysis of that reform). Since 2012, the statutory retirement age has gradually increased from 65 to 67 due to a reform in 2007.

Table 1
Example of variation in deductions by retirement age and cohort.

	Born in November...						Born in December...					
Ret. age	1939	1940	1941	1942	1943	1944	1939	1940	1941	1942	1943	1944
60	0	3.3	6.9	10.5	14.1	17.7	0	3.6	7.2	10.8	14.4	18
61	0	0	3.3	6.9	10.5	14.1	0	0	3.6	7.2	10.8	14.4
62	0	0	0	3.3	6.9	10.5	0	0	0	3.6	7.2	10.8
63	0	0	0	0	3.3	6.9	0	0	0	0	3.6	7.2
64	0	0	0	0	0	3.3	0	0	0	0	0	3.6
65	0	0	0	0	0	0	0	0	0	0	0	0

Note: The table shows the variation in D from Eq. (2) (multiplied by 100) by retirement age, year of birth and month of birth. For example, if a woman was born in November 1941 and retires at 60, her pension is permanently reduced by 6.9%. If she was born in December, the deduction would be at 7.2%.

the age of 60 (disability pension).[4] In Appendix A we provide a detailed overview of the different pathways to retirement and discuss the eligibility rules.

In this paper, we focus on the most important path to retirement for women, namely the women's pension. This pension allows women to retire at the age of 60.[5] Eligibility for this pension requires 15 years of contributions, of which at least 10 years must be after the age of 40. According to the data, about 50% of all women were eligible for this programme at the age of 55, (see Table 2). Women with a shorter employment history could enter retirement only at the age of 65 or via other pathways to retirement, e.g. via disability pension.

2.2. Pension benefits before and after the 1992 pension reform

The calculation of pension benefits is based on a point system and takes into account the complete earnings history of an individual. A year's contribution at the average earnings of contributors earns one pension point. Earnings are only insurable up to a certain earnings ceiling; therefore there is an upper limit to the obtainable annual pension points, which amounts to roughly two points. Moreover, pension points can be acquired during other insurance periods (e.g. unemployment, for periods caring for children, and during the provision of informal care). There is no explicit limit to the sum of pension points and the system does not feature an individual minimum pension.[6]

Before the 1992 reform, the old-age pension benefit was the product of the sum of pension points at retirement and the money value of a pension point in year t (pension-point value). Accordingly, the old-age pension in year t was calculated as:

$$\text{Pension}_t^{pre92} = \left(\sum_{a=age}^{\text{ret.age}} \text{pensionpoint}_a\right) \times \text{pension-pointvalue}_t \quad (1)$$

The pension-point value is indexed to average earnings and is adjusted annually. If an individual was eligible for early retirement, e.g. through the pension for women, she could claim full pension benefits before reaching the statutory retirement age of 65 without actuarial deductions for early retirement.

The 1992 reform reduced incentives for early retirement through the women's pension by introducing actuarial deductions. The pension eligibility age remained at age 60, as did the statutory retirement age of 65. However the NRA, the age at which a full pension without deductions is available, gradually shifted from age 60 to 65, depending on the month and year of birth of the individual. Deductions for the pension for women started with the cohort born in January 1940 and were fully phased-in for women born in December 1944 or later. The pension formula was supplemented by an access factor D that reduces the pension benefit by 0.3% per month if a person retires before reaching the NRA[7]:

$$\text{Pension}_t^{post92} = \sum_{a=age}^{\text{ret.age}} \text{pensionpoint}_a \times \text{pension-pointvalue}_t \times (1 - D_{c,ret.\ age}) \quad (2)$$

D depends on the month of birth c and the retirement age. As explained above, the NRA (pension for women) varies across cohorts born between 1940 and 1944. For example, if a woman born in November 1941 retired at the age of 61 in November 2002, D equals 0.033 and her pension would be permanently reduced by 3.3%. If she retired six month earlier, D would be 0.051. For a women born one month later in December 1941 the deductions at age 61 equal 3.6%, retiring six months earlier results in a deduction of 5.4%. The maximum deduction (retiring at age 60) reaches 18% for women born in December 1944 and all following cohorts. Deductions are reduced when entering retirement after the age of 60 and the NRA, when $D = 0$, is at the age of 65. As an example, we show this variation for selected retirement ages and different months of birth in Table 1.[8] This is the variation exploited in the empirical analysis.

2.3. Disability pensions and unemployment benefits

Previous literature provides convincing evidence that due to pension reforms, other benefit programmes, in particular unemployment insurance and disability pensions, become more attractive and, therefore, individuals enter these other programmes instead of retirement. In the following, we briefly describe the design of unemployment and disability benefits in Germany and discuss the potential for substitution effects.

[4] Note that the German pension system provides two different types of pensions due to impaired health. The disability pension ("Erwerbsminderungsrente") is similar to disability benefits in the US. Eligibility for full benefits requires that an individual is unable to work more than 3hours a day for at least six months. Eligibility for partial disability benefits require that the individual is unable to work more than 6 hours a day. Eligibility requires 5 years of contributions. It is the only pension available before the age of 60. In addition, there is a second type of old-age pension that is available from age 60 for people with severe disability status under German law. We refer to this pension type as "disability pension II". Severe disability status requires a degree of disability of 50% or more and does not require work incapacity.

[5] In principle, it is possible to continue working after early retirement. However, for early retirees who continue working, pension benefits are withdrawn at relatively high rates. Only a negligible fraction of women work while receiving a pension.

[6] The German pension system offers survivors' pensions. Survivor pensions amount to 60% (after 2001, 55%) of the partner's pension for spouses who are age 45 and over or if children are in the household; otherwise 25%. Unfortunately, we cannot observe if women receive a widow's pension in our data. Therefore we cannot account for the rules in our analysis. However, there is no systematic variation in survivor's pension that coincides with the variation induced by the 1992 pension reform.

[7] D equals −0.005 for each month retiring after the age of 65 (i.e. a bonus of 6% per year). However, retiring after age 65 is very uncommon in Germany.

[8] Fig. A.4 in Appendix A shows graphically deductions as a function of retirement age and month-of-birth cohort for selected cohorts.

Unemployment benefits. Unemployment benefits in Germany replace about 60% of previous net earnings and increase pension entitlements.[9] The eligibility and entitlement period depend on the age and the previous working history. The maximum entitlement period for unemployment benefits changed during our observation period. Specifically, the maximum entitlement period for individuals above the age of 57 was up to 32 months until January 2006. Between February 2006 and December 2007 it was reduced to 18 months and again increased in 2008 to 24 months. In the empirical specification, we control for these reforms by including the age and time-specific maximum entitlement period. In general there is a strong interdependence between unemployment benefits and pensions for older individuals. As documented in Grogger and Wunsch (2012), a large share of older individuals uses unemployment benefits as a bridge into retirement. In particular, there is clear evidence that unemployed individuals exhaust their full entitlement period for unemployment benefits before entering retirement. The design of the institution provides strong incentives for this behaviour; unemployment benefits are relatively generous – often similar to pension benefits, periods in unemployment increase pension entitlements and finally search requirements for unemployed persons close to retirement are very low. Therefore, an increase in the NRA is likely to affect the take-up of unemployment benefits. In particular, individuals have an increased incentive to postpone entry into unemployment to smooth the transition into retirement at the NRA without actuarial deductions.

Disability pension. Disability pensions are the only pathway to retirement before the age of 60. Therefore, when we discuss retirement effects before the age of 60 in the following analysis, we always refer to the effects on disability pensions. A pension reform changed the disability pension scheme in 2001. Cohorts born between 1938 and 1944 were mainly affected by the earlier regime. Before 2001, eligibility for disability benefits depended on one of two earnings capacity tests. Full benefits were granted if the individual had a general and significant limitation in their ability to work. That is, full benefits required an earnings capacity of 15% or less of average gross earnings (Erwerbsunfähigkeitsrente). In addition, a second scheme provided partial disability benefits (66% of full benefits) related to the individual occupation. This less strict eligibility test was passed if the worker could not find a job matching his specific job profile and faced a substantial reduction in earnings (at least 50%) when changing to a different job (Berufsunfähigkeitsrente).[10]

The disability pension scheme was reformed in 2001. The occupation-related scheme was abolished and the earnings criterion was replaced with two working hours thresholds. Eligibility requires the long-term (at least six months) inability to perform an activity under normal labour market conditions for at least six hours (partial disability pension) or at least three hours (full disability pension) per day (Erwerbsminderungsrente). In both schemes, the pension is calculated according to the previous insurance biography. It amounts to a pension that would be paid if the individual continued to work until the age of 60 (55 in the old regime). When reaching the statutory retirement age, the disability pension is converted into an old-age pension, usually of the same level.[11] In the empirical analysis we control for the 2001 reform.

In Germany, health-related eligibility criteria for disability pensions are relatively strict, especially since the 2001 reform. About 50% of all applications are rejected. Therefore, using disability pensions as a pathway to regular old-age pensions is difficult and often not an attractive option. Moreover, since 2001 actuarial deductions apply to this type of pension as well. The reference age for deductions is 63 and deductions amount to a maximum of 10.8%. Nearly 100% of these pensions are reduced by maximum deductions since most people claim this pension before turning 60 (Deutsche Rentenversicherung, 2015, p.83).

Thus, overall disability pensions became less attractive after 2001. However, the average share of women entering retirement through disability remained relatively constant at about 15% across cohorts (Table A.10).

3. Data and descriptive evidence

3.1. Public pension insurance accounts

We use high-quality administrative data from the German pension insurance. The scientific use file is a 5% random sample of all German citizens with a statutory pension insurance account between the ages of 30 and 67 (*Versicherungskontenstichprobe*, SUFVSKT).[12] The data are available since 2002 (though wave 2003 is missing). The data mainly include characteristics that are relevant for pension insurance: we obtain detailed information about the individual employment history including monthly employment status and accumulated pension contributions, i.e. pension points. Moreover the data include information on the number and age of children as well as place of residence.[13]

3.2. Sample

Our analysis focuses on women born between 1938 and 1944 for whom we observe the complete employment history, including the date of retirement, i.e. the date of claiming pension benefits. We exclude women with special pension schemes who were not affected by the pension reform (miners, civil servants, and self-employed), women with pensions according to the Foreign Pension Law (*Fremdrentengesetz*), and women with partial pensions. Overall, our population covers 84% of all women born in the cohorts of interest. For more details about the sample and the number of observations, see Appendix B.

As explained in Section 2.1, not all women were eligible for the pension for women. The data allow identifying eligibility for this pension type: women must be at least 60 years old, fulfil a 15-year waiting period, and must have accumulated more than 120 months of compulsory contributions after their 40th birthday. Furthermore, we include women only if they fulfil the eligibility criteria at age of 55, since we are interested in their employment behaviour from age 55 onward.[14] In the main analysis, we focus only on women who fulfil these criteria. In addition we present the results of the main specifications (direct reform effects) for the full sample including women who are not eligible in Appendix D.

3.3. Descriptive statistics

Before we turn to the multivariate analysis, we provide descriptive statistics on the women born in different cohorts. In Table 2, we present information about employment behaviour at different points over the life cycle and about the key explanatory variables. The statistics are calculated based only on those women eligible for the

[9] People receiving unemployment benefits acquire pension entitlements as if they earned 80% of their previous gross earnings.

[10] For more details, see Börsch-Supan and Wilke (2004).

[11] The level of the old-age pension cannot fall below the level of the previous disability pension. In rare cases, the old-age pension benefit can be higher than the disability pension.

[12] A pension insurance account is opened conditional on at least one episode over the life-course that constitutes rights in the pension insurance. Pension entitlements result, e.g., from employment subject to social security contributions, unemployment, from childcare, and during the provision of informal care.

[13] A detailed description of the data is in Stegmann et al. (2005) and Himmelreicher and Stegmann (2008). Panel mortality is negligible (Fachinger and Himmelreicher, 2006).

[14] About 10% of all women who fulfil the eligibility criteria at a later age fail to fulfil these criteria at age 55.

Table 2
Descriptive statistics by cohort.

Cohort	No. of children	West	Pension points age 55	Retirement entry at 60	Retirement entry at 65	Share of eligible women
1938	2.1	0.74	28.4	0.65	0.02	0.52
1939	1.9	0.73	28.1	0.65	0.03	0.52
1940	1.9	0.80	28.1	0.43	0.04	0.52
1941	1.9	0.75	28.6	0.36	0.03	0.50
1942	1.9	0.76	28.3	0.35	0.03	0.52
1943	1.8	0.76	28.4	0.35	0.05	0.53
1944	1.9	0.79	27.9	0.34	0.08	0.53

Notes: The last column denotes the share of women eligible for the pension for women at age 55. The two columns "retired at 60" and "retired at 65" denote the share of women who enter retirement (claiming benefits) at that age.
Source: FDZ-RV – SUFVSKT 2004–2012, own calculations.

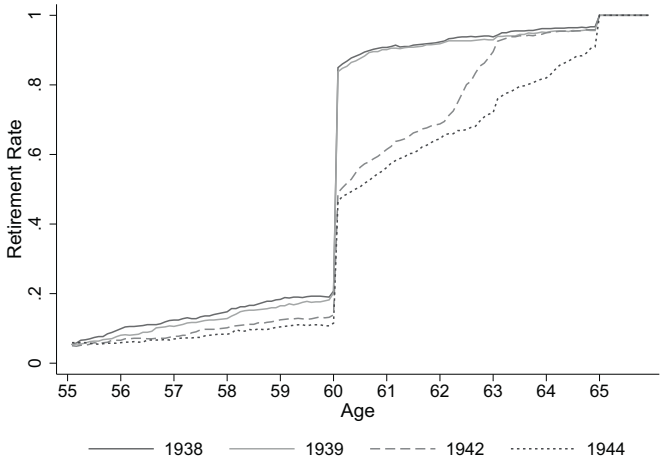

Fig. 1. Retirement rates by age and cohort. Notes: the figure shows the share of retired women by age (monthly data) among women eligible for the pension for women. Source: FDZ-RV – SUFVSKT2004–2012, own calculations.

women's pension. In the last column, we present the cohort-specific share of women who qualify for that pension; overall the share is constant across the different cohorts at about 52%.

In the first two columns of Table 2, we describe the key demographic variables for our analysis and show how these differ between cohorts. The number of children is relatively stable over the cohorts; at the same time the share of women born in West Germany increases. In the regressions, we account for these cohort-specific differences. Furthermore, we show in Column 3 that the number of pension points accumulated over the working life until the age of 55 is fairly constant over the cohorts. This suggests that for the adjacent cohorts there is no trend or cohort-specific effect on employment and earnings prior to age of 55. In contrast, the retirement entry rates at age 60 and 65 differ markedly between the cohorts, and these differences are consistent with the incentives of the pension reform. Several points are remarkable: First, the share of women entering retirement at age 60 amounts to 65% for the pre-reform cohorts that could enter retirement at this age without deductions. This share drops markedly for the cohorts born after 1939. Second, despite deductions, a remarkable share of women affected by the reform still enters retirement at the age of 60 (e.g. 34% of women born in 1944). Finally, the fraction of women entering retirement at the age of 65 remains fairly low. It increases only slightly for the later cohorts for which the NRA gets closer to 65.

In order to obtain further information about the labour market effects of the pension reform, we focus on the central labour market outcomes for relevant cohorts and ages. Specifically, we present the

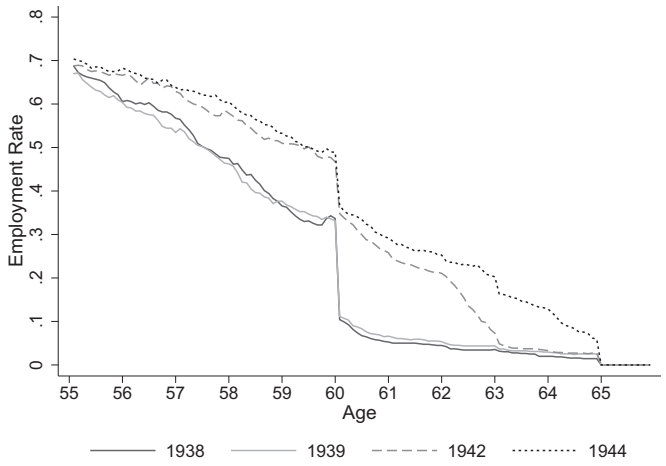

Fig. 2. Employment rates by age and cohort. Notes: the figure shows the share of employed women by age (monthly data) among women eligible for the pension for women. Source: FDZ-RV – SUFVSKT2004–2012, own calculations.

outcomes for the cohorts 1938 and 1939, i.e. cohorts not affected by the reform, for cohort 1942 for which the reform was partly implemented, and for cohort 1944 which is nearly fully affected by the reform.[15]

Fig. 1 shows remarkably similar age-specific retirement patterns of the two pre-reform cohorts that face the same pension rules. For women born in 1938 or 1939 retirement rates increase at age 60 by about 60 percentage points, whereas retirement rates increase by only about 30 percentage points for the younger cohorts. Second, in line with the incentives induced by the pension reform, retirement rates after the age of 60 increase faster for women born in 1942 than for women born in 1944: we observe a steep increase between age 62 and 63 for cohort 1942, i.e. the age at which women born in 1942 reach their cohort-specific NRA. Women born in 1944 enter retirement later: more than 10% of the women only retire at the age of 65. Third, before the age of 60 retirement rates are relatively low for all cohorts. As discussed above, retirement before the age of 60 is only possible through disability pensions. The rates are slightly lower for the cohorts affected by the reform, which might be related to anticipation effects.

Turning to age-specific employment rates (Fig. 2), we find a similar development, yet with one important exception. The pattern of the employment rates for the 1938 and 1939 cohorts are again remarkably similar. Most importantly, there is a sizeable drop in the employment rate at the age of 60 for the two pre-reform cohorts. The pattern is different for cohorts affected by the pension reform. Consistent with the incentives induced by the deductions, the drop at the age of 60 is smaller and the employment rates remain higher beyond the age of 60 for the 1944 cohort, even up to the age of 65. However, in contrast to the retirement rates, we find sizeable differences between the pre- and post-reform cohorts even before the age of 60. Specifically, at the age of 55 we observe similar employment rates across all cohorts. However, after the age of 55 employment rates for women born in 1938 and 1939 decrease much faster than for women born in 1942 or 1944. At 55, employment rates are about 70% for all cohorts, yet at age 57 it has decreased by about 15 percentage points for women born in 1938 and 1939 and by about 5 percentage points for the latter two cohorts. Just before the age of 60, the employment rate of the pre-reform cohorts amounts only to 33%, while the two younger cohorts have an employment rate of about 50%. The large differences in the employment rates for the pre- and post-reform cohorts before the age of 60 are consistent with sizeable anticipation effects of the pension reform that are

[15] Note, in the econometric specification, we stratify by month of birth in order to make use of all cohorts between January 1939 and December 1944.

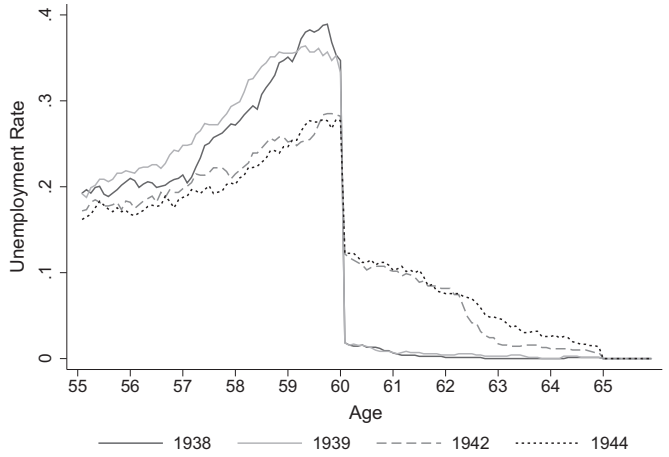

Fig. 3. Unemployment rates by age and cohort. Notes: the figure shows the share of unemployed women by age (monthly data) among women eligible for the pension for women. Source: FDZ-RV – SUFVSKT2004–2012, own calculations.

documented for similar pension reforms in several studies (e.g. Staubli and Zweimüller, 2013).

The cohort-specific pattern of the unemployment rates (Fig. 3) again suggests sizeable anticipation effects. For all cohorts, unemployment rates increase strongly before the age of 60, but the increase is much lower for cohorts affected by the reform. After age 60, however, the unemployment rate of cohorts 1938 and 1939 drops almost to zero while it remains high for the other two cohorts. As discussed in Section 2.3, unemployment is often used as a bridge into retirement, i.e. individuals exhaust their entitlement period for unemployment benefits before entering retirement. For women of the 1938 and 1939 cohorts, this effect is particularly strong between the ages of 55 and 60. For younger cohorts, transitioning from unemployment into retirement is less attractive at the age of 60 because they face deductions for early retirement. Thus, the observed shift of the unemployment rate of younger cohorts is consistent with an anticipation of the financial incentives induced by the pension reform.

In summary, the descriptive statistics provide several pieces of evidence that are crucial for the following analysis. First, we show that the age-specific retirement, employment, and unemployment rates for the cohorts that were not affected by the reform are very similar. This is supportive evidence for the identifying assumption of the empirical model. As discussed below, we need to assume that in the absence of cohort-specific changes in pension rules, the cohort-specific retirement behaviour does not differ across cohorts. Second, we find strong differences in the labour market outcomes for the cohorts affected by the reform in comparison to the pre-reform cohorts, thus consistent with the incentives induced by the pension reform. Finally, we provide evidence for sizeable anticipation effects in employment and unemployment, as well as, to a lesser extent, in retirement.[16]

In the following multivariate analysis, we exploit the described variation to estimate the labour market effects of the pension reform and to quantify the impact of financial incentives on employment, unemployment, and retirement.

4. Empirical analysis

In order to identify the effect of the pension reform on labour market outcomes, we propose two different estimation approaches. First, we concentrate on the direct effects of the pension reform and estimate the effect of the introduction of the deductions on retirement, employment, and unemployment for women who have reached the pension eligibility age of 60. In the second approach, we focus on the effect of the pension reform on the retirement age as well as on employment and unemployment durations between the ages of 55 and 65. The second approach allows studying the overall effect of the reform, including both the direct effects and the anticipation effects. Crucially, both empirical strategies exploit the cohort-specific pattern of the deductions described above to estimate the causal effects of the reform. In the following, we present the two approaches and discuss the identifying variation.

4.1. Direct effects on labour market outcomes

The individual retirement decision can be described as an optimal stopping problem (see, e.g. Rust and Phelan, 1997). In this framework, for example, at each age individuals decide if they will continue to work or if they will stop working and enter retirement. Among other things, the retirement decision depends on the financial incentives of the pension system, which can be expressed through a function of the individual's security wealth, e.g. through the option value (see, e.g. Gruber and Wise, 2004). As mentioned above, social security wealth depends strongly on the working and earnings history of an individual and, thus, estimated employment effects obtained in regressions that directly use the variation in the social security wealth are likely to be biased. Thus, previous studies have exploited pension reforms as an instrument for the social security wealth or they have used pension reforms directly in a reduced form approach to estimate the employment effects (e.g., Hanel and Riphahn, 2012; Atalay and Barrett, 2015; Lalive and Staubli, 2015; Cribb et al., 2016; Geyer and Welteke, 2017). We follow this approach: instead of using the social security wealth directly, we exploit the cohort-specific introduction of the pension reform and construct a variable, D_{it}, that captures the changes in the deductions for early retirement.

As presented in Table 1, deductions vary across women by month of birth and by age. This allows controlling for age and cohort fixed effects when estimating the direct effect of deductions on different labour market outcomes. Thus, for the identification of the effect of deductions, we need to assume that the age-specific effects on retirement, employment, and unemployment do not change between the 1938 and 1944 cohorts. Note, this assumption is weaker than assuming that there are no general labour market differences between the cohorts since the cohort specific effects would control for these differences. However, the descriptive evidence presented in Section 3.3 suggests that labour market behaviour of the adjacent cohorts is fairly similar, absent the changes due to the pension reform.

We propose the following equation:

$$y_{it} = \alpha + \theta_{it} + \lambda_c + \gamma D_{it} + \beta_x X_{it} + \epsilon_{it} \quad (3)$$

where y_{it} is an indicator variable for different labour market outcomes, namely retirement, employment and unemployment. D_{it} is the variable of central interest, measuring the deductions for early retirement. Furthermore, we include monthly age fixed effects (θ_{it}), monthly cohort fixed effects (λ_c), and individual variables including the number of children, region, changes in the legislation for disability pensions, and in the entitlement rules for unemployment insurance (X_{it}).

4.2. Overall effects on labour market outcomes

Deductions directly affect the incentives to retire for women older than 60 when they have reached the pension eligibility age. By definition there are no deductions for women before turning 60; i.e. for this group $D_{it} = 0$ independent of the cohort. However, as discussed above and presented in Section 3, the reform might induce anticipation effects at earlier ages. In order to capture these anticipation effects, in the following, we focus on the 55 to 65 years of age interval, including

[16] Figs. C.5–C.7 in Appendix C show the same statistics as the figures in this section for the sample of non-eligible women. We do not find any indication that these women reacted to the pension reform.

Table 3
Regression results: direct effects on labour market behaviour.

	Retirement			Employment			Unemployment		
	I	II	III	IV	V	VI	VII	VIII	IX
Penalty in %	−0.020**	−0.019**		0.011**	0.010**		0.009**	0.009**	
	(0.001)	(0.001)		(0.001)	(0.001)		(0.001)	(0.001)	
No penalty			base			base			base
0.3–3.6			−0.154**			0.083**			0.069**
			(0.007)			(0.006)			(0.005)
3.9–7.2			−0.194**			0.108**			0.084**
			(0.009)			(0.008)			(0.007)
7.5–10.8			−0.225**			0.127**			0.102**
			(0.012)			(0.010)			(0.010)
11.1–14.4			−0.247**			0.127**			0.116**
			(0.015)			(0.013)			(0.013)
14.7–18.0			−0.232**			0.116**			0.110**
			(0.018)			(0.016)			(0.016)
West Germany		−0.079**	−0.079**		0.181**	0.181**		−0.111**	−0.111**
		(0.007)	(0.007)		(0.008)	(0.008)		(0.006)	(0.006)
Children		−0.000	−0.000		−0.005	−0.005		−0.001	−0.001
		(0.003)	(0.003)		(0.003)	(0.003)		(0.002)	(0.002)
Pension points		0.002**	0.002**		0.000	0.000		0.001†	0.001†
		(0.000)	(0.000)		(0.000)	(0.000)		(0.000)	(0.000)
Observations	601,680	601,680	601,680	601,680	601,680	601,680	601,680	601,680	601,680
Cohort Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
X Variables	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Pre-reform mean	0.521			0.275			0.140		

Notes: Columns III, VI and IX show results with a non-linear specification of the deduction variable based on the range specific indicator functions. Reading example: given a penalty of 7.2% we estimate a reduction of the retirement rate by 7.2 × 0.019 = 13.68 percentage points (column II). When we use a non-linear dummy specification (column III), we estimate the retirement rate to be 19.4 percentage points lower than the retirement rate of the base category (no deductions). In addition to the reported variables we control in Specifications II, III, V, VI, VIII and IX, for changes in the legislation for disability pensions and in the entitlement rules for unemployment insurance. Standard errors in parentheses are clustered on the individual level; Significance levels: †p < 0.10, * p < 0.05, ** p < 0.01. The mean is calculated for pre-reform cohorts 1938 and 1939. The estimated model is described in Section 4.1. Source: FDZ-RV – SUFVSKT 2004–2012, own calculations.

individuals before they have reached pension eligibility. Since we cannot include the deduction variable D_{it} directly, we follow the approach by Mastrobuoni (2009) and specify a model based on cohort-specific age profiles. Specifically, we estimate age profiles of the retirement age, and for different measures of time spent in employment, retirement, and unemployment for the different cohorts. The cohort specific differences of the age profiles then allow us to derive results about the overall effect of the pension reform. The assumptions of this identification strategy are stronger than for the Model derived in Eq. (3): we need to assume that cohort specific differences are only a function of the pension reform. The descriptive evidence presented in Section 3.3 strongly supports this assumption as it shows that labour market behaviour of the adjacent cohorts is fairly similar absent the changes due to the pension reform. Still, in order to relax the identifying assumption, we follow Mastrobuoni (2009) and include cohort specific characteristics in the main specification.

More formally, in the main model we propose the following equation:

$$y_{i,j} = \sum_{a=55}^{65} \mathbb{1}(A_i = a) \times \left(\alpha_{a,j} + \sum_{c=1940}^{1944} \beta_{a,c,j} \times \mathbb{1}(C_i^* = c) \right) + \omega_j' X_{i,j} + \epsilon_{i,j} \quad (4)$$

where $y_{i,j}$ is a binary variable that denotes one of the different labour market statuses j, and $X_{i,j}$ are individual and cohort specific variables such as number of children, region, as well as changes in the legislation for disability pensions and in the entitlement rules for unemployment insurance. We do not include a constant term and omit the 1939 cohort. That implies, $\beta_{a,c,j}$ measures the average difference in $y_{i,j}$ at age a between cohort c and the baseline cohort 1939. Aggregate results for different cohorts can easily be derived from the sum of the estimated β-coefficients. For example, if $y_{i,j}$ denotes the retirement status, the sum of $\beta_{a,c,j}$-coefficients ($\Delta_{c,j}$) equals the difference in the average retirement age of cohort c and cohort 1939 (Mastrobuoni, 2009):

$$\begin{aligned} \Delta_{c,j} &= \sum_{a=55}^{66} a\left[\text{Prob}_{a,c,j}\left(y_j = 1\right) - \text{Prob}_{a,1939,j}\left(y_j = 1\right) \right] \\ &= \sum_{a=55}^{66} a\left(\beta_{a,c,j} - \beta_{a-1,c,j}\right) \\ &= 55\left(\beta_{55,c,j} - 0\right) + 56\left(\beta_{56,c,j} - \beta_{55,c,j}\right) + \dots \\ &+ 66\left(0 - \beta_{65,c,j}\right) \\ &= -\sum_{a=55}^{66} \beta_{a,c,j} \end{aligned} \quad (5)$$

where $\text{Prob}_{a,c,j}\left(y_j = 1\right)$ denotes the percentage of women of cohort c at age a in status j. In the Section 5, we report the sum of coefficients as our basic specification and we show the average change in the outcome variables for an increase of the NRA by one year and deductions by 3.6%.

Moreover, we propose an augmented specification to account for potential cohort specific trends. In more detail, in the augmented model we additionally include the effect of non-eligible women who are not affected by the pension reform to control for potential cohort specific trends.[17] Therefore, in a second step, we augment the specification by subtracting the trend for the non-eligible group of

[17] Mastrobuoni (2009) applies a similar strategy; he exploits variation of several pre-reform cohorts that were not affected by the reform method to calculate an overall cohort trend. In our data, we do not have sufficient information on pre-reform cohort, therefore we rely on the variation of the women not affected by the reform.

Table 4
Heterogeneity of the direct effect of deductions on labour market behaviour.

Dep. variable	West	East	High	Low	Children	No children
Retirement	−0.021**	−0.014*	−0.020**	−0.016**	−0.020**	−0.015**
	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.003)
Employment	0.013**	0.003	0.009**	0.013**	0.011**	0.003
	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.003)
Unemployment	0.008**	0.009**	0.010**	0.005*	0.008**	0.013**
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)
	457,200	144,480	451,320	150,360	534,360	67,320

Notes: High is defined above the 75th percentile of accumulated pension points. Standard errors in parentheses; Significance levels: †p < 0.10, * p < 0.05, ** p < 0.01. The last row denotes the number of observations.
Source: FDZ-RV – SUFVSKT 2004–2012, own calculations.

women. That is, we use Eq. (4) and estimate Δ_{cj} for both women who are eligible (E) for the pension for women and for those who do not meet the qualifying conditions (NE) and take the difference.

5. Results

In the following, we discuss the estimation results. We first focus on the direct labour market effects and present heterogenous effects. Then, we turn the results for the outcome variables, which include both the direct effects and the anticipation effects.

5.1. Direct effects on labour market outcomes

In Table 3, we present the estimation results for the direct effects of the pension reform; the standard errors in parentheses are clustered on the individual level. We consider the effects on retirement, employment and unemployment, which are measured in percent. The variable of interest is the deduction variable which captures the relative deductions of the pension benefits as defined in Table 1. For all outcomes, we focus on three specifications in which we all control for age- and cohort-specific effects. In the first specifications (columns I, IV and VII), we only include the deduction variable with age- and cohort-specific effects. In the second specifications (columns II, V and VIII), we add individual-specific variables such as region, accumulated pension points at age 55 (which are a function of the full employment and earnings history), and number of children, as well as time-varying variables capturing age and time-specific changes of the entitlement period for unemployment benefits and changes of rules for disability benefits. Finally, in the last specifications (columns III, VI and IX), we allow for potential non-linearities in the deduction variable. Therefore we slightly change Eq. (3) and instead of imposing a linear effect of the deduction variables D_{it}, we include indicator variables for different ranges of the deduction variable.

In all specifications, we include observations of women eligible for the women's pension aged between 55 and 65. This results in about 600,000 person-months observations.[18] In Appendix D (Table D.13) we present results for the estimation with the full sample including women who are not eligible for this pathway. We briefly comment on these results at the end of this section.

First, we discuss the effects on retirement. The results in the basic specification and with additional co-variates (columns I and II) are very similar: we find that an increase in deductions by 1 percentage point reduces the average retirement rate by about 2 percentage points. The effects of the individual-specific variables suggest that West German women aged 55 to 65 have lower retirement rates than East German women (about 8%). We find that children have no significant effect while the effect of accumulated pension points at the age of 55 is positive. The regional difference can be explained by the longer working history of East German women. Due to their longer working history, they can afford to enter retirement earlier. The same reasoning applies to the positive effect of pension points at the age of 55. Specification III shows that the effect of deductions on retirement is non-linear and follows a concave function with a particularly large effect of modest deductions. In more detail, in this specification we introduce indicator variables for different ranges of the deduction variable. We find that relative to the base line, i.e. relative to women facing no deductions, retirement rates for women with deductions with up to 3.6% are about 15 percentage points lower; moreover, the results indicate that the effects are only slightly stronger for women facing deductions between 3.6% and 7.2% (19 percentage points). Further increases in the deductions only marginally affect retirement rates: for women facing deductions up to 18 percentage points, the retirement rate decreases by about 23 percentage points relative to the baseline.

The effects of financial incentives on employment (Columns IV to VI) are smaller than the effects on retirement. In particular, the linear specification including cohort effects (IV) and the specification with further control variables (V) show that an increase in deductions by 1 percentage point increases the average employment rate of about 30% by slightly more than 1 percentage point. The non-linear specification (VI) shows again that deductions up to 3.6% cause large employment effects; relative to the baseline, employment rates for women with deductions between 0.3% and 3.6% increase by about 8 percentage points. Larger increases in deductions lead to further moderate employment effects: according to the estimation results the employment rates of women facing the full deductions increase by about 11 percentage points.

The difference between the changes in employment and retirement can be explained by the effects of deductions on unemployment (Columns VII to IX). In the linear specifications, we find that an increase in deductions by 1 percentage point increases the average unemployment rate of about 14% by 0.9 percentage points. In the non-linear specification, we find approximately a concave relationship of the effect of deductions on the unemployment rate.

As mentioned above, in Table D.13 (Appendix D), we present results for the same specifications with the full sample including women who are not eligible for this pathway. Note again, that according to our definition about 50% of the women are not affected by the reform. Therefore, by definition the overall effects are lower. We find that all point estimates in the full sample are roughly half the size of the effects in the sample with only eligible women; for example an increase in deductions by 1 percentage point reduces the average retirement rate of all women by about 1 percentage points. Moreover the pattern of the findings is very similar. This suggests that the pension reform did not affect the behaviour of the women not eligible for the women's pension at the age of 55.[19]

5.2. Heterogenous effects

The estimation results presented in Table 3 provide information about

[18] Note that women younger than 60 do not contribute to the identification of the coefficient of the deduction variable but provide identifying variation for the coefficients associated with the individual specific covariates and the cohort effects.

[19] If we change the eligibility criteria to the age of 60 we find the same result.

Table 5
Estimated effects on retirement by cohort (in months).

	55–65		55–59		60–65	
Cohort	Basic	Augmented	Basic	Augmented	Basic	Augmented
1940	4.10**	2.17	1.17	0.06	2.93**	−2.11†
	(1.18)	(1.82)	(0.84)	(1.09)	(0.74)	(1.13)
1941	7.53**	5.75**	2.15**	1.59	5.39**	4.16**
	(1.17)	(1.86)	(0.83)	(1.11)	(0.73)	(1.12)
1942	10.92**	10.83**	1.84*	1.25	9.08**	9.58**
	(1.30)	(2.03)	(0.86)	(1.18)	(0.83)	(1.24)
1943	13.84**	13.06**	2.10*	1.69	11.74**	11.37**
	(1.40)	(2.05)	(0.88)	(1.17)	(0.93)	(1.30)
1944	17.36**	14.33**	2.73**	0.81	14.63**	13.52**
	(1.48)	(2.12)	(0.88)	(1.18)	(1.05)	(1.40)
Observations	601,680					

Notes: The cohorts represent the sum of the coefficients on the age dummies (Δ_c multiplied by 12) of a given cohort (see Eqs. (4) and (6)). The augmented specification deducts the sum of the coefficients of the women not eligibile for the pension for women ($\Delta_c^E - \Delta_c^{NE}$). We control in all specifications for the number of children, region, pension entitlements, for changes in the legislation for disability pensions and in the entitlement rules for unemployment insurance. Standard errors clustered by individuals in parentheses. Significance levels: †p < 0.10, * p < 0.05, ** p < 0.01.
Source: FDZ-RV – SUFVSKT 2004–2012, own calculations.

the labour market effects for the average of the population. However, the effects might potentially differ between subgroups. In order to study the heterogeneous effects, we split the sample and separately estimate Eq. (3) for women in West and East Germany, for women with accumulated pension points below and above the 25%-percentile, as well as for women without and with children.

The sample split is mainly motivated by the different employment histories of the different groups. Related to the different political and cultural environment before the reunification, East German women have, on average, a longer working history than women in West Germany. For example, in our sample about 90% of all women in East Germany qualify for the pension for women, while only about 48% in West Germany. Moreover, the average accumulated pension points are higher for East German women. Similarly, women with children tend to have longer career interruptions and, therefore, lower pension claims than women without children. Obviously, there are other differences between women in East and West Germany, as well as between women with and without children, that are not related to the employment history. Therefore, we additionally focus directly on the heterogeneous effects by accumulated pension points at the age of 55. *Ex-ante*, it is not clear if, and how, the heterogeneous effects might differ. On the one hand, women with a longer employment history and, therefore, higher pension entitlements are more likely to not change their behaviour or to substitute retirement with unemployment. On the other hand, these women might have a greater preference for work and, therefore, they react stronger to the financial incentives by increasing employment.

In Table 4 we present the estimation results of the linear specification including cohort fixed effects and additional co-variates. In addition we present the heterogeneous effects of the specification with the non-linear effect of the deduction variable in Appendix D. The non-linear pattern discussed above is present for all sub groups. The estimation results show sizeable effect heterogeneity. Specifically, West German women respond to deductions with sizeable changes in retirement and employment. However, for East German women there is no employment effect, rather a strong and significant substitution effect into unemployment. For women with and without children, the effects differ, especially with respect to employment and unemployment. We find no significant effect on employment, but a strong substitution effect into unemployment for women without children. For women with children, we find a sizeable employment effect and a significant effect on unemployment. Finally, the results show that women with low accumulated pension points tend to increase employment, whereas women with higher accumulated pension points are more likely

Table 6
Estimated effects on employment by cohort (in months).

	55–65		55–59		60–65	
Cohort	Basic	Augmented	Basic	Augmented	Basic	Augmented
1940	4.19**	2.89†	2.74*	2.14	1.45*	0.74
	(1.55)	(1.75)	(1.22)	(1.33)	(0.64)	(0.76)
1941	5.85**	4.32*	3.06*	2.39†	2.79**	1.93**
	(1.55)	(1.75)	(1.23)	(1.34)	(0.61)	(0.74)
1942	12.20**	10.36**	5.86**	4.72**	6.35**	5.64**
	(1.70)	(1.90)	(1.26)	(1.39)	(0.74)	(0.85)
1943	13.06**	12.27**	4.70**	4.24**	8.35**	8.03**
	(1.81)	(1.97)	(1.29)	(1.39)	(0.83)	(0.92)
1944	17.37**	15.90**	7.06**	6.15**	10.31**	9.75**
	(1.95)	(2.16)	(1.33)	(1.45)	(0.96)	(1.06)
Observations	601,680					

Notes: The cohorts represent the sum of the coefficients on the age dummies (Δ_c multiplied by 12) of a given cohort (see Eqs. (4) and (6)). The augmented specification deducts the sum of the coefficients of the women not eligibile for the pension for women ($\Delta_c^E - \Delta_c^{NE}$). We control in all specifications for the number of children, region, pension entitlements, for changes in the legislation for disability pensions and in the entitlement rules for unemployment insurance. Standard errors clustered by individuals in parentheses. Significance levels: †p < 0.10, * p < 0.05, ** p < 0.01.
Source: FDZ-RV – SUFVSKT 2004–2012, own calculations.

Table 7
Estimated effects on unemployment by cohort (in months).

	55–65		55–59		60–65	
Cohort	Basic	Augmented	Basic	Augmented	Basic	Augmented
1940	−0.07	−0.02	−1.30	−1.38	1.23**	1.36**
	(1.06)	(1.20)	(1.04)	(1.11)	(0.26)	(0.35)
1941	1.88†	1.89	−0.39	−0.08	2.27**	1.98**
	(1.12)	(1.23)	(1.06)	(1.12)	(0.33)	(0.43)
1942	−0.54	−2.44†	−3.55**	−3.93**	3.01**	1.50**
	(1.12)	(1.32)	(1.04)	(1.13)	(0.38)	(0.55)
1943	0.71	−0.87	−2.62*	−3.00**	3.33**	2.13**
	(1.17)	(1.37)	(1.07)	(1.16)	(0.42)	(0.61)
1944	−0.01	−2.66†	−3.95**	−4.67**	3.94**	2.01**
	(1.19)	(1.45)	(1.08)	(1.18)	(0.46)	(0.70)
Observations	601,680					

Notes: The cohorts represent the sum of the coefficients on the age dummies (Δ_c multiplied by 12) of a given cohort (see Eq. (4)). The augmented specification deducts the sum of the coefficients of the women not eligibile for the pension for women ($\Delta_c^E - \Delta_c^{NE}$). We control in all specifications for the number of children, region, pension entitlements, for changes in the legislation for disability pensions and in the entitlement rules for unemployment insurance. Standard errors clustered by individuals in parentheses. Significance levels: †p < 0.10, * p < 0.05, ** p < 0.01.
Source: FDZ-RV – SUFVSKT 2004–2012, own calculations.

to substitute into unemployment. Overall, the results speak to a substitution effect rather than to a preference effect, i.e. women with longer employment histories are more likely to substitute retirement with unemployment.

5.3. Overall effects of the pension reform

The previous empirical analysis of the direct effects provides evidence that the introduction of deductions affects retirement and employment behaviour and induces significant substitution effects into unemployment for women older than 60. In the following, we extend the analysis and study the anticipation effects prior to the age of 60 in addition to the direct effects. As specified in Eq. (4), we focus on several outcome variables. We study the effect on durations in the different outcomes between the ages of 55 and 60, the ages of 60 and 65, and, lastly, over the full period between the ages of 55 and 65. We report average effects by cohort in Tables 5–7. In addition, Table 8 shows average effects on employment outcomes by change in the NRA by one year with deductions of 3.6% p.a. For the overall effects, we omit the discussion of the heterogenous effects as the results and the pattern is comparable to the direct effects by subgroups.

Table 8
Average change in outcome variables per year increase in the NRA with deductions of 3.6% (in months).

	Retirement	Employment	Unemployment
Age 55–65			
Basic	3.69**	3.58**	0.17
	(0.44)	(0.57)	(0.40)
Augmented	2.96**	2.95**	−0.13
	(0.70)	(0.63)	(0.45)
Age 55–59			
Basic	0.78*	1.76**	−0.82*
	(0.32)	(0.45)	(0.39)
Augmented	0.37	1.44**	−0.88*
	(0.42)	(0.49)	(0.41)
Age 60–65			
Basic	2.90**	1.82**	1.00**
	(0.27)	(0.24)	(0.10)
Augmented	2.59**	1.51**	0.76**
	(0.43)	(0.28)	(0.15)

Notes: The table reports results from Eq. (6). The augmented version subtracts the average change of the women not eligible for the pension for women. Standard errors clustered by individuals in parentheses; Significance levels: †p < 0.10, * p < 0.05, ** p < 0.01.
Source: FDZ-RV – SUFVSKT 2004–2012, own calculations.

Retirement age. First, we analyse the effects of deductions on the retirement age. In Table 5 we present the sums of age coefficients by cohort. The basic specification shows the sum of coefficients only for eligible women. In the augmented specification, we subtracted the trend of women not eligible for the pension for women. As mentioned above, the sum of coefficients can be interpreted as the average difference in the retirement age of *c* cohort compared to the 1939 cohort (see Eq. (5)).

In line with the previous results, we find that the pension reform has positive effects on the retirement age. More specifically, according to the basic estimation the average retirement age increased by about 3 to 4 months per cohort compared to the 1939 cohort. The effect amounts to more than 17 months for the 1944 cohort in the basic specification. In general, the results are similar in the augmented specification, which supports the identifying assumption that cohort effects – absent from the pension reform – are not important. According to the augmented model, the retirement age for the 1944 cohort increases by about 14 months. Table 5 also shows that most of the increase in the retirement age occurs after age 60. We find a small positive effect before age 60, however, this effect is not significant in the augmented specification. This suggests that the reform has not induced people to retire prior to age 60 through disability benefits.

Employment and unemployment. In the next set of results, we focus on the overall reform effect on employment and unemployment. The interpretation differs slightly from the effect on retirement since employment and unemployment are non-absorbing states and may change from year to year. In this case, the sum of coefficients can be interpreted as the average difference in the time spent in employment or unemployment by cohort *c* compared to the 1939 cohort (see Eq. (5)). We study the effect on durations in the different outcomes between the ages of 55 and 59, the ages of 60 and 65 and finally over the full period between the ages of 55 and 65.

Table 6 shows results for employment. Employment increases across all cohorts and age groups compared to the 1939 cohort. The total effect in the basic specification increases from about 4 (1940) to 17 (1944) months. The augmented specification shows similar but slightly smaller effects. The overall effect is similar in magnitude to the increase in the retirement age. However, the pattern between the age groups is different. We find sizeable employment effects even before the age of 60. For example, women between the ages of 55 and 59 in the 1944 cohort are employed, on average, for 6 to 7 months longer than those in the 1939 cohort. The effect is even larger for older women.

The results of the model estimating the effect on the duration of unemployment in Table 5 underscore the importance of the anticipation effect. Interestingly, in both specifications we find only small and, in general, insignificant differences across cohorts over the age range (55–65).

This is because the reform effects in the different sub-periods cancel out. Specifically, we find a negative effect on the duration of unemployment for the 55–59 age-group. For example, for cohorts 1942 to 1944 unemployment is reduced by about 3 to 4 months. The effects do not differ much between the basic and augmented specifications. The opposite is true for the 60–65 age-group: For that age group, we find positive and significant effects for all cohorts. These effects are consistent with the incentives induced by the design of the unemployment benefits and the pension system. They show that unemployment is used as a bridge into retirement. At the same time, these findings imply that an increase in the deduction for pensions does not lead to an overall increase in unemployment. The documented direct substitution effect (Table 3) for women aged 60 to 65 is, thus, mainly a shifting effect.

Average effects. The previous tables showed changes in outcome variables across cohorts. In the following, we calculate the average effects of the reform on the treated cohorts compared to the base cohort 1939. That measure facilitates the comparison to other studies. Therefore, we derive the change in outcome variables by a one-year increase in the NRA. Note that a one-year increase in the NRA is always associated with a simultaneous increase in pension deductions of 3.6% per year. Following Mastrobuoni (2009), we calculate a simple weighted average over the different Δ_c's:

$$\overline{\Delta_j} = \frac{1}{5}\sum_{c=1940}^{1944} \frac{\Delta_{c,j}}{|1939 - c|} \tag{6}$$

Again, for the augmented specification, we calculate $\overline{\Delta_j}$ for the women not eligible for the pension for women and take the difference between both groups.

Table 8 presents the results for the basic and the augmented specification for all outcome variables and age groups. We find that a one year increase in the NRA increases the retirement age by about 3 months. The size of the overall effect on employment is similar to the effect on retirement. Employment increases by about 3 months per year if the NRA is shifted by one year combined with deductions of 3.6%. The effect is split half and half between the age-groups 55–59 and 60–65. The overall effect on unemployment is again insignificant. For the age-group 55–59 we find a negative effect of 0.9 months per year increase in the NRA. Unemployment increases in the age-group 60–65 by about 0.8 months per year increase in the NRA.

Our results are comparable to the findings in previous studies. For example, Hanel and Riphahn (2012) analyse the change in the NRA for women in Switzerland at a deduction rate of 3.4% and find an increase in the retirement age of about 2 to 4 months per year. Our effect is also similar to the results of Mastrobuoni (2009) for the US. He finds an increase that is about twice as large as our effect. However, as explained above, we cannot disentangle the change in the NRA and the increase in deductions. Deductions in the US are about 1.8 times larger than in Germany. Once the magnitude of our effect is adjusted by that factor, then the size of the effects is comparable.

We find that the total effect of the reform, i.e. the shift in the NRA from 60 to 65 combined with deduction of 18% increases the retirement age by about 15 months (3 months × 5 years). The total effect is similar to the findings in Berkel and Börsch-Supan (2004). They use an option-value model evaluating the same reform and predict an increase of the average retirement age by about 8 months for the entire female population. Since only about 50% of all women are eligible for the pension for women and, thus, affected by the reform, their result comes close to our *ex-post* estimates. Note, our results differ to the findings in Hanel (2010): Using an option-value model, she predicts an increase in the benefit claiming age of 27 to 33 months. Moreover, her results suggest that women do not increase employment due to the reform. We cannot confirm this result; in fact, we find sizeable positive employment effects.

6. Conclusion

This paper provides novel insights about the effects of pension reforms on labour market outcomes. We exploit exogenous cohort-specific variation in the introduction of actuarial deductions for early retirement in Germany. Specifically, we focus on the 1992 pension reform that increased the NRA and introduced deductions for early retirement for women born after December 1939. The estimation is based on high-quality administrative data from the German Federal Pension Insurance.

Our empirical analysis shows that the introduction of actuarial deductions for early retirement leads to sizeable labour market effects for women. In particular, for women older than 60 years who are directly affected by the pension reform, we find that an increase in the deductions by one percentage point reduces the average retirement rate by about 1.9 percentage points. It leads to an increase in the employment rate of about 1 percentage point and the unemployment rate of about 0.9 percentage points. Furthermore, the analysis documents that anticipation effects are important. That is, employment behaviour is affected, even before reaching the pension eligibility age. First, we show that the anticipation effect reinforces the direct effects (after age 60) on retirement and employment. We find that, due to the pension reform, employment prior to the age of 60 increases. Second, when including the anticipation effect, the substitution effect into unemployment has a noteworthy pattern. We find that, prior to the age of 60, unemployment is reduced but it increases after the age of 60. In fact, the overall effect of the pension reform seems to be positive but close to zero. Hence, our results suggest that the pension reform induces a shifting of unemployment spells to older ages rather than a stronger substitution into unemployment. This shifting is consistent with previous evidence that unemployment is often used as a bridge into retirement but it also shows that the reform did not induce additional substitution effects.

Based on these estimation results, we can calculate the overall effects of the pension reform that introduced maximum deductions for the women's pension of 18 percentage points. According to our estimation, the introduction of the deduction increased the retirement age by about 15 months. Furthermore, the reform increased the duration of employment between the ages of 55 and 65 by close to 15 months. Finally, our analysis suggests that the reform did not have a significant effect on overall unemployment between the ages of 55 and 65, yet it induced a sizeable shifting in the age pattern of unemployment. In this respect, our results suggest that the introduction of deductions are an efficient policy to increase employment for the elderly.

Appendix A. Pathways to retirement in Germany

The German public pension system provides different types of pensions depending on different prerequisites. In addition to retirement at the statutory retirement age of 65 and the pension for women there are several other options to retire before the statutory retirement age: for people with a severe disability,[20] for people with long service records, and for people who were unemployed or following old-age part-time.[21] In Table A.9 the different options and the requirements for eligibility are described.

[20] Note that this old-age pension differs from the disability pension. The old-age pension for severely disabled people is accessible if the disability status is recognized under German law with a degree of disability of at least 50%. See also footnote 4 and Section 2.3 for more information.

[21] Additionally, survivor's pensions also contain deductions in case the spouse passed away before the full-pension retirement age.

Table A.9
Pathways to pensions for observed cohorts.

Pension type	Earliest age	Years of contribution
Regular	65	5
Women	60	15 (10 after age 40)
Disability pension II	60	35
Long-term insured	63	35
Unemployed/old-age part-time	60	15 (8 in last 10 years)
Disability	before 60	5 (3 in last 5 years)

Note: The pension for women and the pension because of unemployment or old-age part-time were abolished for cohorts born after 1951. The statutory retirement age of 65 has been increased since 2012 and will be 67 in 2029.

Table A.10
Share of pension types by cohort.

Pension type	1938	1939	1940	1941	1942	1943	1944
Regular	37.3	36.6	35.9	35.3	35.7	36.5	38.3
Women	40.1	42.5	41	42.3	41.3	39.9	36.8
Long-term insured	2.3	2	2	2	2.1	2.2	2.3
Disability pension II	2	2	3.6	4.5	5.2	6	6.7
Unemployed/old-age part-time	2.7	2	2.9	1.1	0.8	0.8	1.3
Disability	15.6	14.9	14.6	14.7	14.9	14.6	14.6

Note: The table shows the shares of the different types of public pensions by cohort. The statistics refer to the full population and are not conditioned on eligibility for the women's pension.
Source: Deutsche Rentenversicherung (2015).

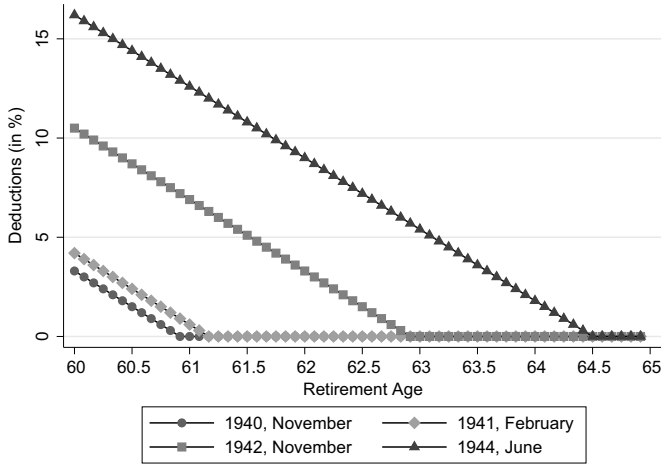

Fig. A.4. Deductions for early retirement by retirement age and cohort. Notes: the figure shows the deductions for early retirement by cohort and retirement age. Source: own illustration.

In Table A.10 we provide information on the importance of the different types of pensions for women born between 1938 and 1944. During our sample period, the most important pension types for women are the regular pension and the pension for women.[22] Table A.10 shows the shares of different pension types by cohort for women born between 1938 and 1944. About 77% of all pensions were either regular pensions or pensions for women. If we focus on old-age pensions and abstract from disability pensions, their share amounts even to about 90%. Note that individuals might be eligible for different types of early retirement pensions. For example, an unemployed women at age 60 could be eligible for both the pension for women and the pension after unemployment. Both pensions would be calculated the same way; the only difference is that actuarial deductions were introduced earlier starting with cohort 1937. Thus, women born after 1936 who enter early retirement would usually chose the pension for women. For the same reason, the share of the pension after unemployment is not the same as the share of unemployed women before entering early retirement.

As a supplement to Table 1, we present graphically the pattern of deductions by cohort and retirement age in Fig. A.4.

In addition to the introduction of deductions for the pension of women, actuarial deductions were also introduced for other types of pensions (Table A.11). Note that our population of interest, namely women born between 1938 and 1944, were only partly affected by these reforms. The introduction of deductions for pensions for unemployed/old-age part-time starting with cohort 1937 mainly affected men. As shown in Table A.10, only two percent of women enter retirement through this pension type and this fraction remains constant across the cohorts. The same is true for

[22] For men, the picture is different as they are not eligible for the women's pension by definition. In addition to regular retirement, retirement for long term insured and retirement after unemployment are the most frequent pathways.

Table A.11
Deductions for early retirement programmes.

Pension type	First cohort affected	Fully phased-in with cohort	Shift in NRA
Regular	–	–	–
Women	January 1940	December 1944	60 to 65
Disability pension II	January 1941	December 1943	60 to 63
Unemployed/old-age part-time	January 1937	December 1941	60 to 65
Long-term insured	January 1937	December 1938	63 to 65
Disability pension	Retirement entry after January 2001		

Note: The reference age for deductions for disability pension is 63. Deductions amount to a maximum of 10.8%. Nearly 100% of these pensions are reduced by maximum deductions since most people claim this pension before age 60 (Deutsche Rentenversicherung, 2015, p.83).

the pension for long-term insured. The fraction of women entering retirement through the pathway for individuals with severe disability status is also low, but slightly increases across the cohorts. Since the deductions for this pension are lower than the deductions for women's pensions, this increase might be interpreted as a substitution effect. However, even for the 1944 cohort, the fraction is, at 6%, very small, thus not driving our results. Finally, the disability pension scheme was changed in 2001 (see Section 2.3). In the empirical analysis, we control for this change in the legislation.

Appendix B. Sample

In Table B.12, we present detailed information about the number of observations that we use for the empirical analysis. In addition to the cohort-specific number of observations, the table shows the fraction of women who are excluded from the analysis and who are not eligible for the women's pension. We exclude women with special pension schemes who were not affected by the reforms (miners, civil servants, and self-employed), people with pensions according to the Foreign Pension Law (*Fremdrentengesetz*), and people with partial pensions. For eligibility, women need to fulfil a 15-year waiting period, and must have accumulated more than 120 months of compulsory contributions after their 40th birthday. Moreover, we restrict the sample to women who already fulfil the eligibility criteria at age 55.

Table B.12
Number of observations.

Cohorts	Total	Excluded		All women		Eligible women	
	person	Person	%	Person	Person-months	Person	Person-months
1938	1,782	314	0.18	1,468	176,160	758	90,960
1939	1,667	295	0.18	1,372	164,640	709	85,080
1940	1,693	265	0.16	1,428	171,360	742	89,040
1941	1,779	278	0.16	1,501	180,120	756	90,720
1942	1,568	235	0.15	1,333	159,960	698	83,760
1943	1,530	232	0.15	1,298	155,760	690	82,800
1944	1,473	228	0.15	1,245	149,400	661	79,320
Total	11,492	1,847	0.16	9,645	1,157,400	5,014	601,680

Appendix C. Outcomes of non-eligible women

Figs. C.5–C.7 show the average shares in retirement, employment, and employment by age for selected cohorts. The age-specific employment, unemployment and retirement rates for the non-eligible women do not differ strongly across cohorts and the pattern is completely different from the pattern of the sample of eligible women (see Figs. 1–3).

Table C.13 contains the results of estimating Eq. (3) using the sample of non-eligible women. As expected, we do not find a significant impact of the deduction variable on labour market outcomes.

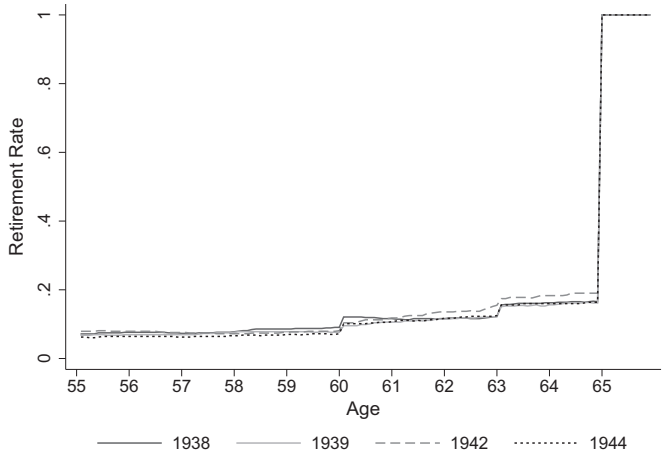

Fig. C.5. Retirement rates by age and cohort – not eligible for the pension for women. Notes: the figure shows the share of retired women by age (monthly data) among women not eligible for the pension for women. Source: FDZ-RV – SUFVSKT2004-2012, own calculations.

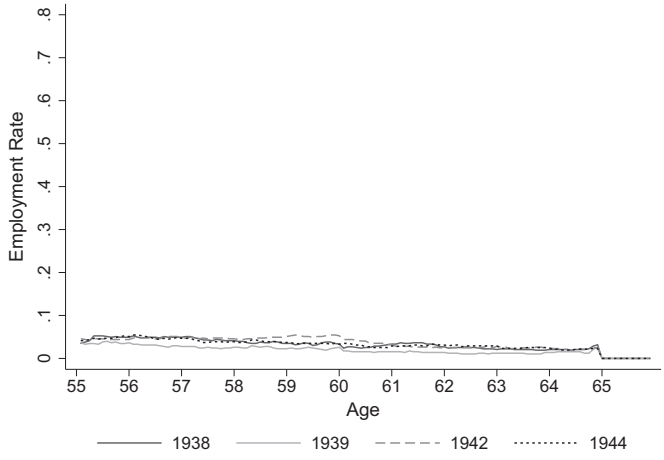

Fig. C.6. Employment rates by age and cohort – not eligible for the pension for women. Notes: the figure shows the share of retired women by age (monthly data) among women not eligible for the pension for women. Source: FDZ-RV – SUFVSKT2004–2012, own calculations.

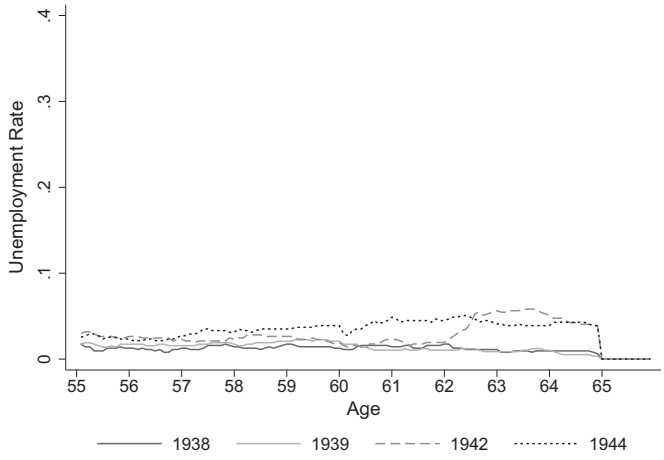

Fig. C.7. Unemployment rates by age and cohort – not eligible for the pension for women. Notes: the figure shows the share of retired women by age (monthly data) among women not eligible for the pension for women. Source: FDZ-RV – SUFVSKT2004–2012, own calculations.

Table C.13
Regression results: direct effects on labour market behaviour (sample of non-eligible women).

	Retirement			Employment			Unemployment		
	I	II	III	IV	V	VI	VII	VIII	IX
Penalty in %	0.000	0.000		0.000	0.000		0.000	0.000	
	(0.000)	(0.000)		(0.000)	(0.000)		(0.000)	(0.000)	
0.3–3.6			−0.000			0.002			−0.001
			(0.003)			(0.002)			(0.003)
3.9–7.2			0.000			0.003			−0.003
			(0.004)			(0.003)			(0.004)
7.5–10.8			0.001			0.001			0.003
			(0.005)			(0.004)			(0.005)
11.1–14.4			0.002			−0.001			0.006
			(0.006)			(0.005)			(0.006)
14.7–18.0			0.001			−0.001			0.015*
			(0.007)			(0.007)			(0.007)
West Germany		−0.395**	−0.395**		0.057**	0.057**		−0.031†	−0.031†
		(0.032)	(0.032)		(0.010)	(0.010)		(0.018)	(0.018)
Children		−0.013**	−0.013**		−0.004**	−0.004**		−0.001	−0.001
		(0.002)	(0.002)		(0.001)	(0.001)		(0.001)	(0.001)
Pension points		0.016**	0.016**		0.002**	0.002**		0.000	0.000
		(0.001)	(0.001)		(0.000)	(0.000)		(0.000)	(0.000)
Observations	487,560	487,560	487,560	487,560	487,560	487,560	487,560	487,560	487,560
Cohort Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
X Variables	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Pre-reform mean	0.104			0.028			0.013		

Notes: The estimated coefficients are based on the same estimation as the results in Table 3 using the sample of non-eligible women. Columns III, VI and IX show results with a non-linear specification of the deduction variable based on the range specific indicator functions. In addition to the reported variables we control in Specifications II, III, V, VI, VIII and IX, for changes in the legislation for disability pensions and in the entitlement rules for unemployment insurance. Standard errors in parentheses are clustered on the individual level; Significance levels: †p < 0.10, * p < 0.05, ** p < 0.01. The mean is calculated for pre-reform cohorts 1938 and 1939. The estimated model is described in Section 4.1.
Source: FDZ-RV – SUFVSKT 2004–2012, own calculations

Appendix D. Additional model specifications: direct reform effects

In Table D.14, we present the estimation results of the direct reform effects for the full sample of women including women who are not eligible for the pension reform. As expected, the pattern of the reform effects is very similar when including non-eligible women, yet effects are at a lower level. Table D.15.

Table D.14
Regression results: direct effects on labour market behaviour (full sample).

	Retirement			Employment			Unemployment		
	I	II	III	IV	V	VI	VII	VIII	IX
Penalty in %	−0.011**	−0.010**		0.006**	0.006**		0.005**	0.005**	
	(0.001)	(0.001)		(0.001)	(0.001)		(0.001)	(0.001)	
No penalty			base			base			base
0.3–3.6			−0.086**			0.046**			0.039**
			(0.005)			(0.004)			(0.003)
3.9–7.2			−0.106**			0.060**			0.046**
			(0.006)			(0.005)			(0.004)
7.5–10.8			−0.121**			0.069**			0.057**
			(0.008)			(0.006)			(0.006)
11.1–14.4			−0.132**			0.068**			0.066**
			(0.010)			(0.008)			(0.008)
14.7–18.0			−0.124**			0.061**			0.069**
			(0.011)			(0.010)			(0.010)
West Germany		−0.145**	−0.145**		0.128**	0.128**		−0.118**	−0.118**
		(0.007)	(0.007)		(0.007)	(0.007)		(0.006)	(0.006)
Children		−0.002	−0.002		0.000	0.000		−0.000	−0.000
		(0.002)	(0.002)		(0.002)	(0.002)		(0.001)	(0.001)
Pension points		0.013**	0.013**		0.009**	0.009**		0.003**	0.003**
		(0.000)	(0.000)		(0.000)	(0.000)		(0.000)	(0.000)
Observations	1,157,400								
Cohort Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
X Variables	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes

Notes: In addition to the reported variables we control in Specifications III, VI, and IX, for changes in the legislation for disability pensions and in the entitlement rules for unemployment insurance. Standard errors in parentheses; Significance levels: †p < 0.10, * p < 0.05, ** p < 0.01. The mean is calculated for pre-reform cohorts 1938 and 1939. The estimated model is described in Section 4.1.
Source: FDZ-RV – SUFVSKT 2004–2012, own calculations.

Table D.15
Heterogeneity of the direct effect of deductions on labour market behaviour.

Deduction	West	East	High	Low	Children	No children
Retirement						
0.3–3.6	−0.176**	−0.077**	−0.161**	−0.132**	−0.154**	−0.152**
	(0.008)	(0.013)	(0.008)	(0.014)	(0.008)	(0.020)
3.9–7.2	−0.217**	−0.115**	−0.205**	−0.161**	−0.196**	−0.178**
	(0.011)	(0.017)	(0.010)	(0.018)	(0.010)	(0.026)
7.5–10.8	−0.248**	−0.145**	−0.239**	−0.184**	−0.231**	−0.187**
	(0.013)	(0.022)	(0.013)	(0.023)	(0.012)	(0.033)
11.1–14.4	−0.268**	−0.169**	−0.258**	−0.215**	−0.255**	−0.191**
	(0.017)	(0.029)	(0.017)	(0.030)	(0.016)	(0.041)
14.7–18.0	−0.250**	−0.163**	−0.238**	−0.216**	−0.239**	−0.188**
	(0.020)	(0.037)	(0.020)	(0.035)	(0.019)	(0.050)
Employment						
0.3–3.6	0.106**	0.011	0.073**	0.111**	0.085**	0.065**
	(0.008)	(0.010)	(0.007)	(0.013)	(0.007)	(0.019)
3.9–7.2	0.138**	0.017	0.098**	0.136**	0.111**	0.084**
	(0.009)	(0.013)	(0.009)	(0.016)	(0.008)	(0.024)
7.5–10.8	0.158**	0.032†	0.118**	0.152**	0.135**	0.061*
	(0.012)	(0.017)	(0.011)	(0.020)	(0.010)	(0.030)
11.1–14.4	0.156**	0.041†	0.115**	0.162**	0.140**	0.023
	(0.015)	(0.022)	(0.015)	(0.025)	(0.013)	(0.038)
14.7–18.0	0.149**	0.012	0.097**	0.172**	0.130**	0.008
	(0.018)	(0.031)	(0.018)	(0.030)	(0.016)	(0.049)
Unemployment						
0.3–3.6	0.068**	0.062**	0.085**	0.021*	0.068**	0.070**
	(0.006)	(0.012)	(0.006)	(0.010)	(0.006)	(0.014)
3.9–7.2	0.082**	0.079**	0.100**	0.034*	0.083**	0.085**
	(0.008)	(0.016)	(0.009)	(0.014)	(0.008)	(0.019)
7.5–10.8	0.098**	0.102**	0.118**	0.053**	0.099**	0.129**
	(0.010)	(0.022)	(0.011)	(0.019)	(0.011)	(0.026)
11.1–14.4	0.113**	0.104**	0.135**	0.058*	0.110**	0.167**
	(0.014)	(0.031)	(0.015)	(0.025)	(0.014)	(0.032)
14.7–18.0	0.101**	0.125**	0.135**	0.038	0.101**	0.181**
	(0.017)	(0.042)	(0.019)	(0.031)	(0.017)	(0.050)
	457,200	144,480	451,320	150,360	534,360	67,320

Notes: High is defined as above median accumulated pension points. Standard errors in parentheses; Significance levels: †p < 0.10, * p < 0.05, ** p < 0.01. The last row denotes the number of observations.
Source: FDZ-RV – SUFVSKT 2004-2012, own calculations.

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