The Impact of Early Retirement Incentives on Labor Market Participation: Evidence from a Parametric Change in the Czech Republic

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Abstract

We investigate the impact of a change in the Czech early retirement scheme on the labor force participation of older male workers. Using the difference-in-differences method we find that a reduction in early retirement benefits by 2–3 % leads to approximately the same decrease in the probability of being inactive. Our finding implies high elasticity of older male workers participation rate. The public policy implication is that a reduction in early retirement benefits can serve as a very effective tool to increase the participation of older men in the Czech labor market.

JEL classification: J21, J26
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Nontechnical Summary

The aging society is a crucial issue for the Czech Republic, and the Czech government has introduced various policy measures. In July 2001, penalization for early retirement with permanently cut benefits was increased and hence early retirement benefits were lowered after the change.

Changes in early retirement schemes have been introduced in various countries. There is no full consensus in the recent literature on the final impact on the labor market behavior of older workers. Gruber and Wise (2002) provide a cross-country comparison of social security incentives and suggest that they play an important role in retirement and labor market decisions. Brinch, Hernaes, and Strom (2001) show that the introduction of the early retirement option has decreased the labor supply in Norway. On the other hand, Baker and Benjamin (1999) provide evidence from Canada and the USA where the reaction to changes in early retirement benefits was modest or even non-existent. Based on this literature we test the hypothesis that the change in early retirement benefits in the Czech Republic increased the labor market participation of older males.

First, we quantify the real change in benefits and monetary incentives using various simulations. We use various indicators for representative individuals. We find a decrease in early retirement benefits by 2–3 %; in terms of the net wage it is approximately 1–2 %. We also computed social security wealth, accrual rate, peak value and option value as dynamic indicators of incentives to retire. Generally, we found that social security wealth from early retirement substantially decreased, but the optimal retirement age did not change substantially.

After the reform, the social security statistics show a substantial decrease in the number of newly granted early retirement benefits. This suggests that the reform strongly affected labor market participation. To test this we use Czech Labor Force survey data and we employ the difference-in-difference method (Baker and Benjamin 1999) to evaluate the effect of reform on males labor market behavior. Our treatment group contains individuals who are eligible for early retirement benefits; younger individuals are in the control group.

We find that a reduction in early retirement benefits by 2–3 % leads to approximately the same decrease in the probability of being inactive. This finding was confirmed by various robustness checks. The results are not dependent on length and number of periods before and after the reform.

1 Introduction

As policy makers face the commonly known problem of an aging society, the labor supply of older workers becomes more important. The labor market decisions of older workers influence government expenditure on various social programs. For example, the way incentives to retire are formed is a crucial issue in keeping the pension system sustainable while the population is aging. Governments thus attempt to change the design of social security systems in order to respect demographic changes.

The Czech Republic is an example of an aging society[1]. The Czech government has reacted to this development and has decreased the incentives to retire early created by the social security system. Policy makers expect this step to reduce the number of people who receive retirement benefits and at the same time increase the number of contributors to the pension system. These unambiguous advantages make this policy step popular also among many other governments facing the issue of aging.[2]

The policy relevance of this topic is reflected in the current empirical literature. But it doesnt exist clear answer about the causal impact of retirement incentives on the labor supply of older workers.

Cross-country comparisons show a strong negative relationship between early retirement incentives and labor force participation (Gruber and Wise 2002; Borsch-Supan 2000). Papers examining changes in national policies suggest that the introduction of early retirement benefits as a specific form of retirement incentive decreases labor force participation (e.g. Brinch, Hernaes, and Strom (2001)).

By contrast, other studies do not find clear evidence about the sensitivity of the labor supply of older workers to changes in the early retirement scheme. For example, Baker and Benjamin (1999) provide evidence from the USA and Canada which shows a relatively modest or non-existent reaction of the labor supply to changes in the early retirement scheme. Similarly, Moffitt (1987) finds relatively small effects of social security law on the labor supply of older workers in the USA.

There are only a few papers about the labor supply of Czech workers. Direct evidence concerning the labor supply of older workers is provided in

[1] According to the projection of the Czech Statistical Office, the share of people aged 60 years and over will double in the next 30 years. Babecky and Dybczak (2009) try to model this aging scenario using an OLG model.

[2] It needs to be emphasized that the overall fiscal balance is improved unless retirees are proportionally compensated for longer service and unless employees leave the labor market and become unemployed or accept disability social assistance and/or become recipients of support from other social programs.

Galuscak (2001) and Bicakova, Slacalek, and Slavik (2006). Galuscak (2001) shows that the introduction of an earnings test, which imposed a benefit eligibility constraint on working pensioners, led to a significant and substantial decrease in the participation rate of workers who had reached statutory retirement age, whereas Bicakova, Slacalek, and Slavik (2006) estimated the effect of tax changes on the labor supply of average Czech workers as being relatively modest. There is no direct evidence about the causal impact of early retirement incentives and the participation of older workers.

Retirement incentives can take various forms: explicit and implicit taxation and/or legal rules that restrict full-time work at a certain age. In our case we investigate the effect of reducing early retirement benefits, which are offered as non-labor income for individuals three years before the statutory retirement age. The policy change became effective in July 2001 and cut early retirement benefits by approximately 3 % for new claimants. To illustrate this we also compare several incentive measures before and after the reform.

The social security statistics show that one year after the policy change, the number of new early retirees had decreased by half. This suggests that the direct impact of this policy step was strong. However, as we describe in the next section, older workers face several options regarding how to become nonemployed (retire early[3] , become unemployed, or enter disability retirement[4]). The positive causal effect of the policy change on the labor supply of older workers is under question.

In order to find the causal impact of the policy step, we use the difference-in-differences estimation method. The treatment group includes workers who are eligible for early retirement benefits (at most three years before the statutory retirement age). The control group contains workers who are just about to enter the eligibility age for early retirement, six to three years before the statutory retirement age to be more specific. The eligibility age for entering early retirement starts three years before the statutory retirement age. In particular, a marginal probit model is used for testing whether the policy change affects the participation rate of individuals who are eligible for early retirement, controlling for other characteristics of the individuals.

Our analysis shows that this policy increased the probability of a male participating in the labor market by 2–3 % for those eligible for early retirement. This paper is organized as follows. The next section provides a detailed insight into the social security system in the Czech Republic. The

[3]The exact preconditions for early retirement are described in Act No. 155/1995 Coll.

[4]To enter disability retirement certain health criteria have to be met. Hence, it is not a free choice of the individual.

official statistics and simulations of the policy change on individuals are described in section 3. Section 4 covers the data description of the treatment and control group. A graphical overview is presented in section 5, the econometric methodology is explained in section 6, and the results are described in section 7. Section 8 concludes.

2 Institutional Setting

The Czech retirement scheme is a standard pay-as-you-go (PAYG) system with mandatory participation for all employees and the self-employed as well. The basic features of the Czech pension system were inherited from the system run under the communist regime. A few legislative changes were implemented in the years after the fall of communism, but the basic features remained unchanged. The statutory retirement age is different for male and female workers; the retirement age of the latter depends on the number of children raised. Beside this differentiation the retirement age has been prolonged by two months for males and four months for females per year after 1996 to the year the male or female was supposed to retire under the former conditions. The retirement age for males in 1996 was set at 60 years.[5] The retirement age for females without children was 57 and each child raised reduces the retirement age by one year. At the time of the policy change the average retirement age was approximately 61.

Pension benefits are computed based on a formula that has an individual specific part (a percentage-based assessment) and a part which is the same for everybody (the basic amount). The basic amount is the amount of money laid down by law that is received by everybody who is an old-age pension recipient. It can be understood as the minimum pension. The individual part reflects individual-specific characteristics, such as the earning history since 1986 and number of years in service. The wage history is discounted to the current value and then modified by reduction limits and reduction percentages to a calculation base (CB). The calculation CB represents the crucial step in the Czech pension formula and causes a high degree of redistribution in the system. Amount that is lower than the first reduction limit is fully included. But 30 % of the amount between the first and second reduction limit is included and only 10 % of the reminder which is above the second

[5]After that there is no single retirement age for the male population in a given year. The exact formulation is that the retirement age is prolonged by two months for each initiated age-year after December 31, 1995 before the individual reaches the age of 60. In practice this means that if a worker is 60 in February 2000, then his retirement age is 60 plus ten months. Therefore, the men from this example will retire in January 2001.

reduction limit. The number of years in service proportionately increases (1.5 percentage points per year) the size of the adjustment percentage (AP) and therefore the size of the percentage of the CB which will be counted as the percentage-based assessment (PA) in the pension formula. The longer an individual is in service, the higher the PA and therefore the higher the pension benefit will be. The exact formula can be found in Appendix A.

This formula is applied to every kind of retirement benefits, including early retirement benefits.[6] The early retirement benefits are lower than the standard ones, because they are reduced by an adjustment coefficient (rPYI), which was subject to the policy change. In particular, the penalty for early retirement before the reform was 0.6 percentage points and 0.3 percentage points[7] per each 90 days remaining to the standard retirement age before the policy was introduced. The policy step changed the degree of penalization for early retirement. In fact, both rates that adjust early retirement benefits (0.6 percentage points and 0.3 percentage points) were increased to 0.9 percentage points . For example, considering an individual who retires one year before her retirement age (a 0.6 percentage points reduction applied before the reform), the adjustment percentage of her benefit decreased by 3.6 percentage points after the reform instead of by 2.4 percentage points which would apply before the policy change—lower by 1.2 percentage points.

This decrease in the adjustment percentage proportionally decreases the pension benefit and hence has an influence on the motivation of workers to stay active on the Czech labor market until the statutory retirement age.

Table 1 shows the drop in officially newly granted early retirement benefits. The fall was approximately 10 % of regular pension benefits. This observed change is most likely caused by two effects. The first one is driven by the change in early retirement benefits. The second one is driven by

[6]The Czech social security scheme recognizes two types of early retirement. One is with permanently cut benefits, which allows individuals to retire at most three years before the eligibility age and the individual is not allowed to work after retiring. The decreased pension benefits are collected for the rest of the individuals life. The second is early retirement with temporarily cut benefits, which allows the individual to retire at most two years before the eligibility age and is tied to unemployment status for half of the year at least. The decreased pension benefits are recalculated when the eligibility age is reached and increased to the level as if one had retired at the eligibility age. Apart from that, two more ways of escaping employment status are available: becoming unemployed and becoming disabled. However, social support for disabled people is strictly tied to the health situation of the individual and hence cannot be regarded as a fully free choice of the individual, though it can be influenced by the individual exerting pressure on the doctor who makes the decision about the disability pension.

[7]This applies for the case when an individual who applies for early retirement benefits and is aged 60 or more. For all other cases the permanent penalty is then just 0.6 pecentage points per each 90 days before the standard retirement age.

a change in the characteristics of workers who applied for early retirement before and after the policy step.

Table 1: Newly granted pensions (in CZK)

	1999	2000	2001	2002	2003	2004	2005
(1) all pensions	5,991	6,106	6,399	7,055	7,224	7,760	8,391
(2) at retirement age	6,222	6,485	6,823	7,226	7,512	7,968	8,693
(3) after retirement age	7,272	7,485	7,916	8,621	9,157	9,410	10,306
(4) early ret. - temp. cut	5,370	5,513	5,838	5,917	6,224	6,404	6,836
(5) **early ret. - perm. cut**	**5,593**	**5,659**	**5,844**	**5,667**	**5,996**	**6,261**	**6,984**
(5)/(2) (in %)	90	87	86	78	80	79	80

Source: MLSA (2006), own computation of averages

The comparison of newly granted early retirement benefits before and after the reform does not provide a clear picture about the effect of the policy on benefits. It is probable that workers who applied for early retirement after the reform had stronger preferences toward leisure than workers who applied before the reform, and they might also have had different working histories[8] , which determine their benefits. Therefore, we attempt to isolate the pure policy change effect from the sorting effect. For that purpose we create several typical individuals with different wage histories, which serve—together with length of service—as a major input for the computation of benefits.

We also compute the early retirement benefits before and after the change for individuals with virtually the same characteristics. The only parameter that changes is the degree of penalization, which was subject to the policy change. Our computations show that the net decrease in early retirement benefits was approximately 2–3 % (CZK 120–250 per month in absolute terms). The cut corresponds approximately to 1–2.5 % of the average net wage for male workers in the economy.

[8]Different wage histories and number of years in service, etc.

Table 2: Changes in early retirement benefits due to the policy change

	Years before eligible age T	Absolute decrease before/after (in CZK/month)	Relative decrease in early retirement benefit before/after (in %)	Change in terms of net wage (in percentage points)
70% of avg. wage	T-3	191	-3	-2.4
	T-2	133	-2	-1.6
	T-1	131	-2	-1.1
Avg. wage	T-3	218	-3	-1.9
	T-2	149	-2	-1.3
	T-1	152	-2	-1.3
150% of avg. wage	T-3	237	-3	-1.3
	T-2	162	-2	-0.9
	T-1	166	-2	-0.9

Source: Own computation based on the official formula published in MLSA (2002).
Note: Benefits are computed for 46 years of service. The net wage is CZK 11,324 in 2001. Three income groups were chosen arbitrarily. 70 % of the average wage reflects approximately the group of workers with the median wage and 150 % of the average wage represents managers and high-paid workers in the Czech economy.

The ratio of the net wage to early retirement benefits (the net replacement rate) decreased by 0.9–2.4 percentage points. Generally, the highest decrease applied to those who wanted to enter early retirement three years before the eligibility age. Lower-income workers were penalized relatively more than upper-income groups. This is a result of the pension formula: benefits are relatively higher for low-income than for high-income workers. This implies that the policy change affected more strongly individuals who face a relatively disadvantaged position on the labor market.

Another way to assess the effect of this policy change is suggested in Borsch-Supan (2000). The author stresses the importance of the time dimension how much it is worth to give up one year of retirement in terms of net benefit or social security wealth (SSW) computed as the difference between the expected discounted stream of all future benefits and social security taxes paid, which are computed as a percentage of gross earnings. The SSW formula, which states how to compute the social security wealth for an individual at age S planning to retire at age R, is

$$SSW_S(R) = \sum_{t=R}^{E} \pi(t|S) \cdot \delta^{t-S} \cdot B_t(R) - \sum_{t=S}^{R-1} \pi(t|S) \cdot \delta^{t-S} \cdot c \cdot W_t,$$

where:

SSW	-	social security wealth,
S	-	planning age,
R	-	planned retirement age,
E	-	expected age of death at age S,
$\pi(t\|S)$	-	probability of being alive at age t conditional on being alive at age S,
B_t(R)	-	pension at age t for retirement at age R,
W_t	-	wage at age t,
δ	-	discount factor,
c	-	social security contribution rate.

SSW is very sensitive to many assumptions.[9] We employ the values for the discount factor and wage growth[10] from Coile and Gruber (2007) to keep the analysis consistent with the analysis of peak value (Coile and Gruber 2007) and option value (Stock and Wise 1990). In our computation of SSW we do not assume any indexation. The process of indexation in the Czech Republic depends very much on government discretion, as described in Dusek (2007) and Dusek and Kopecsni (2008).

Table 3 shows the basic computations of retirement incentives employing the lifetime budget constraint for an average earner.

Each row corresponds to the age at which a worker enters retirement. In this exercise we assume for the sake of simplicity that the statutory retirement age is 61. This means that everybody who enters retirement before the age of 61 is in early retirement regime and the worker is eligible for early retirement benefits at 58.

Comparing SSW before and after the reform, one can see a decrease in SSW for those who enter early retirement. SSW before and after the reform are highest at 58. The higher pension after longer time contributing to the social system cannot compensate for the social security contribution and hence SSW steadily decreases and therefore it is the best decision to retire as soon as possible since it maximizes the SSW.

[9] Assumptions regarding the individual discount rate, the future indexation of benefits under PAYG, the interest rate path, wage growth, etc.

[10] For simplicity we assume the same wage growth for all income groups.

Table 3: Monetary incentives before and after the reform (average earner)

Last age of work	Replace. rate– before	Replace. rate– after	SSW– before	SSW– after	Accrual rate– before	Accrual rate– after
58	0.837	0.828	699,347	690,703	-0.007	-0.007
59	0.870	0.864	650,158	644,474	-0.076	-0.072
60	0.906	0.903	598,921	595,727	-0.086	-0.082
61	0.936	0.936	545,586	544,716	-0.098	-0.094
62	0.964	0.964	489,416	488,365	-0.115	-0.115
63	1.012	1.012	445,006	443,768	-0.100	-0.100
64	1.037	1.037	389,143	387,718	-0.145	-0.145
65	1.105	1.105	352,27	350,657	-0.105	-0.106

Note: SSW – social security wealth – is defined as the sum of all discounted pension benefits and social security contributions. The accrual rate is defined as the relative year-to-year change in SSW.

A forward-looking approach to assessing the incentives created by the pension system can be studied using peak value and option value. Peak value (Coile and Gruber 2007) is defined as all discounted benefits from entering retirement. In fact, it is maximized when SSW reaches its maximum. We performed this analysis and it obviously supports the preceding analysis that the reform has increased the incentives for the average earner to stay on the labor market. The second approach to assessing financial incentives is the option value model (Stock and Wise 1990). The option value attempts to evaluate the optimal retirement age in utility terms and involves calculating the forgone earnings that could have been earned on the labor market. It is defined as the change in utility that results from working to the optimal age, which is determined by maximizing the lifetime utility over consumption and leisure. The problem of this approach is that one needs to employ certain assumptions about wage profile in the final career stage.

We employ the standard assumption of a linear wage profile, which is not necessarily a realistic assumption. Our results are summarized in Appendix B and suggest that both according to the peak value and option value the optimal retirement age was not changed by the reform and is at the age of 58 in the case of option value and at 56 in the case of peak value. However, there is one small exception of high earner whose option value reacts to the policy change and the optimal retirement age is moved by one year from 59 to 60.

One of the questions that this reform raised is what margin of the labor supply is affected, and in particular whether the reform affected the extensive

or intensive margin of the labor supply of older workers. The extensive margin is affected only since the labor code restricts early retirement benefits: people who retire earlier (claim early retirement benefits) are not allowed to work at all.

3 Data Description and Treatment and Control Group

For the purposes of our research we use Czech Labor Force Survey data from 19982005 containing detailed information about the labor market status of a representative sample of 60,000 individuals and their households. On a rotating panel base, individuals and their households are surveyed during five consecutive quarters. Therefore, one fifth of the sample is replaced every quarter. We choose the subsample of males who are in the age window of six to zero years until the statutory standard retirement age. Hence, our sample includes 50,152 observations for 11,843 individuals. Summary statistics for the treatment and control groups can be found in Appendix D.

We divide this sample into four time periods one period before the reform and three periods after the reform. Participation in the survey is restricted to up to five quarters. Within this period, we do not observe a sufficient number of changes in labor market status, thus we treat our sample as repeated cross-sectional data. The reason we choose only one period before the policy change is the low stability of the social security system: the legal system was stable for only two years before the policy change and approximately four years after the policy change. Our time span also reflects the comparability of the data. We define four consecutive periods, each 1.5 years long. The first is before the policy change (1Q2000—2Q2001), the second is immediately after the policy change (3Q2001—4Q2002), the third is from 1Q2003 to 2Q2004, and the fourth covers 3Q2004—4Q2005. We also try alternative time spans, but this does not change our results significantly (see Appendix F). This division of the total time span into four periods covers the most institutionally stable period before and after the reform. On top of that, the results for several time periods after the reform confirm that the impact of the policy change is the same over time.

The important problem is the actual eligibility age, since the statutory retirement age has been lengthening by two months per year and gives additional noise to our data. To diminish this problem we calculate the individual statutory retirement age as defined by law. For that purpose we have to approximate the actual age of the respondents in the Labor Force

Survey, because the survey per se does not provide information about the exact actual age (the accuracy is yearly frequency). Thus, we use only those individuals for which we observe a change in age during the period they were surveyed (Galuscak 2001). Using these individuals we approximate the exact individual age at an accuracy of one quarter and calculate the actual individual statutory retirement age and simultaneously the eligibility age for the early-retirement. Based on this approximation we can also calculate the number of years to retirement. This makes our analysis more accurate and allows us to disentangle the effect of the early retirement change from the prolonging of the retirement age.

Using the number of years to the statutory retirement age we define the treatment and control groups. The treatment group contains people who are eligible for early retirement: up to three years before their standard retirement age. The younger individuals (more than three years before the eligibility age) are in the control group, because they were not directly affected by the policy. The relatively broad definition of the treatment group allows us to capture all individuals who were eligible for early retirement and could make the decision during the entire period of three years before reaching the statutory retirement age. The disadvantage is that in the period after the policy change the treatment group consists of two types of retirees: men who entered early retirement in the old system and those who entered in new system. This is reflected in our analyses and we interpret the results with respect to this fact.

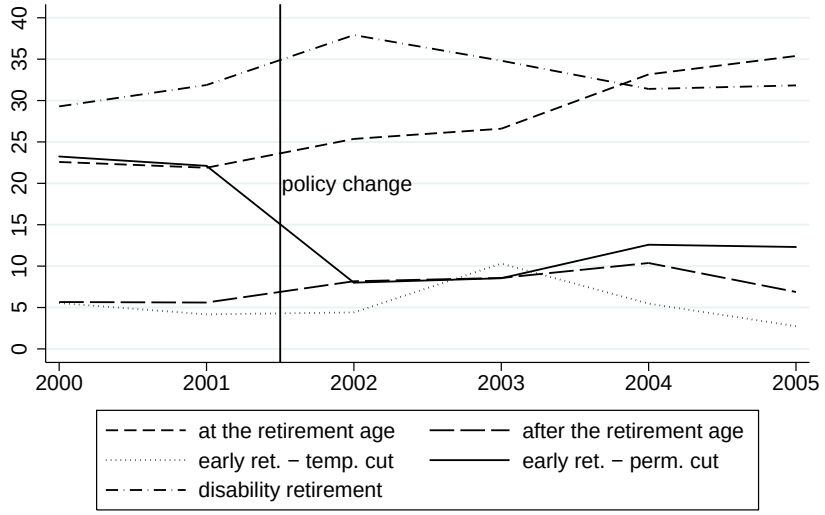
The LFS data contain information about individual characteristics that are important for our analysis. For the purposes of our analysis we used the following characteristics: education, family status, number of persons in the household, and geographical location. The data do not include any information about wages or retirement benefits.

4 Graphical Overview

As we described above, the change in the early retirement scheme increases the incentive to stay in the labor market. As a preview of our results we present the official statistics of newly granted pensions (Fig. 1) . The share of newly granted pensions for this particular pension scheme dropped significantly (the solid line).

This suggests that this reform could have a strong impact on the labor market decision. However, the total impact on the participation rate can be questioned, because the share of the other options for early exit could be used, as can be seen in Figure 1.

Figure 1: Newly Granted Pensions (men - in % of total)

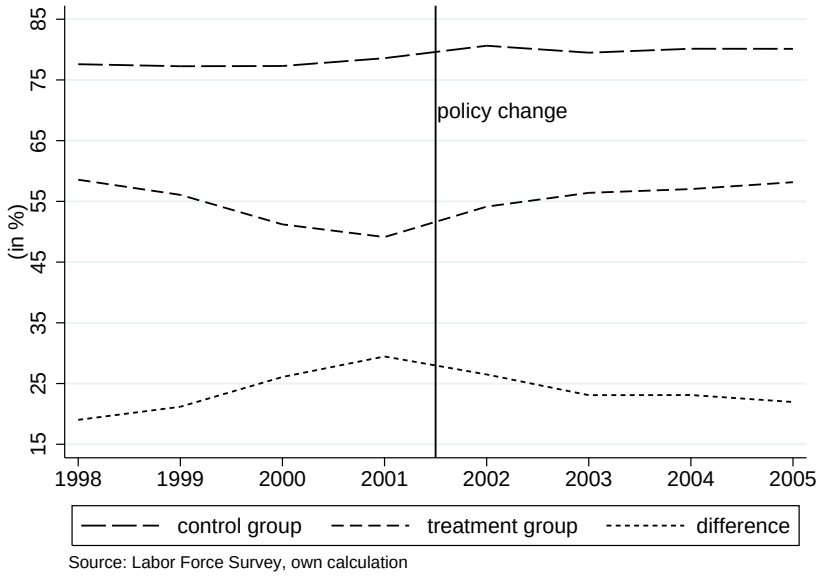


Source: Czech Social Security Administration, own calculation
Note: The short time span before the actual policy change is given by the limitation of official statistics.
The remainder to 100% are e.g. widower's and orphan's pensions.

Further, we present the behavior of individuals using the Labor Force Survey data described above. Figure 2 depicts the participation rate of the control and treatment groups during 1998—2005. The participation rate of the treatment group increased by around ten percentage points between 2001 and 2004. The participation rate also increased in comparison with the control group. This suggests that our treatment group was subject to a specific shock that did not affect the control group. One can observe that this increase continued at a lower rate even during the period from the second half of 2003 to almost the end of 2004. It also contains the effect of the policy change, because in the first period after the policy change, the treatment group still contains older cohorts that entered early retirement before the policy change and remain in the treatment group. Due to data limitations and the institutional set-up, we cannot define the treatment group more precisely than 0—3 years before retirement.

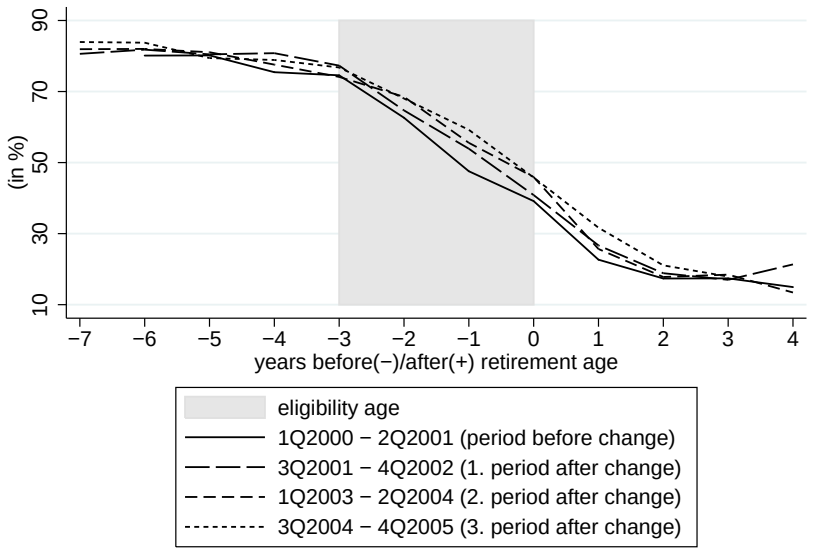
In Figure 3 we can see how the participation rate changes over time in different years to/after retirement age. This quasi-cohort approach shows that the participation rate during the early retirement window (between -3 and 0) is the lowest in the period before the reform was introduced. Moreover, the trend that we observe in Figure 3 is clearly increasing. The difference between the pre-reform period and the last period studied at one year before the statutory retirement age is 12 percentage points.

Figure 2: Participation rate of control and treatment group in 1998-2005



Source: Labor Force Survey, own calculation

Figure 3: Participation rate in different distances to/after retirement age



Source: Labor Force Survey, own calculation

We also present an alternative indicator the hazard rate representing the probability of labor force withdrawal due to retirement. Figure 4 depicts

the hazard rates for two periods: before and 3—4.5 years after the policy change. In the cross-sectional setting, the definition of the hazard rate is one minus the retention rate, which is the participation rate of workers at age t divided by the participation rate of workers aged t–1 in the given year (Hurd 1996).

Figure 4: Hazard rates in different distances to/after retirement age

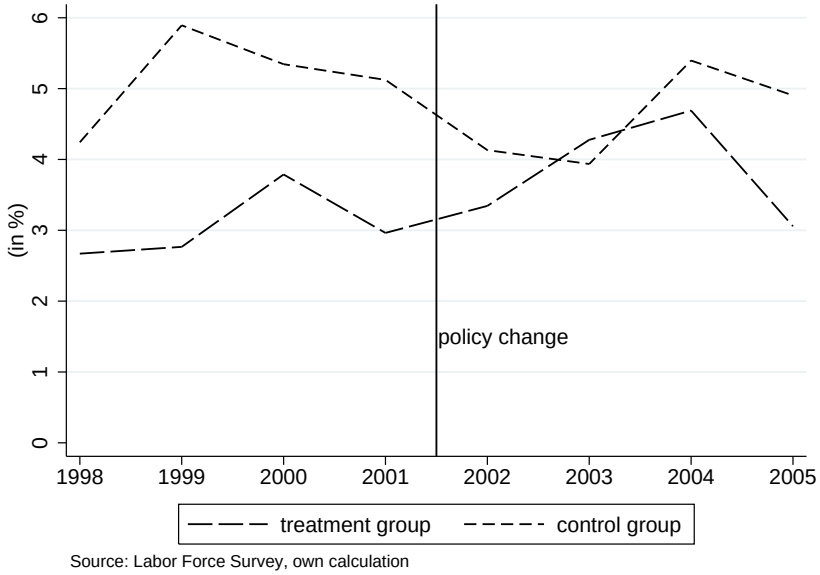
Source: Labor Force Survey, own calculation

The line in Figure 4 representing the period before the policy change has two peaks: the first one (around -2, two to three years before the statutory retirement age) reflects entering early retirement before the policy change, while the second (around 0) represents entering standard retirement. The line for the period three years after the policy change shows a substantial change in the behavior of retirees. One can see the hazard rate smoothed over the number of years before/after retirement. Although early retirement frequently occurs, one cannot observe any particular peak before the statutory retirement age in the period starting with the third quarter of 2004. This is most probably an effect of the treatment we study. One can also see that it is also more common to retire after the statutory retirement age. This is in line with the hypothesis that workers generally stay longer in their jobs.

We also consider the problem of unemployment, which can potentially change over time and therefore raise questions about our results. Figure 5 shows the development of the unemployment rate over time. Unemployment rate is defined for each group separately so that we can control for the changes

in labor force in particular group. The trend in unemployment is not clear, despite an upward movement of unemployment in the treatment group right after the policy change. However, one needs to be aware that the number of unemployed individuals in our sample is relatively small and this change is most probably not statistically significant. Moreover, the dynamics of the increase is slower when we calculate the unemployment rate using the labor force across the groups.

Figure 5: Unemployment rate



Source: Labor Force Survey, own calculation

This graphical overview suggests that our treatment group was hit by an external shock around the year 2001 which influenced its participation in the labor market. We believe that this shock was with high probability the change in the early retirement setting. This is, of course, not a rigorous analysis, because we cannot say whether the shift in participation in the labor market is statistically significant. The next sections thus provide a formal econometric analysis and computation of the increase in the probability of staying in the labor force.

5 Methodology of Econometric Analysis

As an identification strategy we use difference-in-differences (Baker and Benjamin 1999). The treatment group includes workers who are eligible for early

retirement benefits (at most three years before the actual statutory retirement age). The control group contains workers between 6–3 years to the statutory retirement age. The time periods chosen for the estimation are the following: 1.5 years before the policy change and 4.5 years after the policy change, divided into three periods of equal length. The increase in the total number of early retirement benefits was dramatic in the late 1990s. We do not want to mix the previous changes in the social security system into our analysis, so we use only one period before the policy as a benchmark for our analysis. The basic specification is the following:

$$\begin{aligned} y_{it} &= \alpha_i + \beta_1 OLD_{it} + \beta_2 AFTER1_{it} + \beta_3 AFTER2_{it} + \beta_4 AFTER3_{it} + \\ &\quad \beta_5(OLD_{it} \cdot AFTER1_{it}) + \beta_6(OLD_{it} \cdot AFTER2_{it}) + \\ &\quad \beta_7(OLD_{it} \cdot AFTER3_{it}) + \beta_8 X_{it} + \epsilon_{it}, \end{aligned}$$

where y_{it} is one if an individual i is inactive (out of the labor force) at time t and zero when an individual is active in the same period. OLD_{it} is a dummy for the treatment group. $AFTER1_{it}$, $AFTER2_{it}$ and $AFTER3_{it}$ are dummy variables for the three consecutive periods (1.5 years long) after the policy change. The period before the policy change is defined as 1.5 years before the policy change became effective. X_{it} is the vector of observable individual characteristics (basic demographic characteristics: education, number of people in the household, marital status, geographical location) and ϵ_{it} is the error term. This model is estimated by a probit model with the standard maximum likelihood estimation technique.

The estimated coefficient β_1 captures all differences between the treatment and control groups that are unrelated to the policy change. β_2, β_3 and β_4 capture all the period-specific changes that influence the probability of being employed for the control and treatment groups. β_5, β_6 and β_7 are the coefficients of interest. They reflect the impact of the policy change on the inactivity of the treatment group relative to the control group. The vector of coefficients β_8 captures the influence of major demographic characteristics.

6 Results

Our final sample contains 50,152 observations, 26,735 from the treatment group and 23,417 from the control group. The estimated coefficients indicate that the treatment significantly increased the labor supply of the treatment group. The coefficients have the expected sign; however, the first period after the change does not have a significant impact on the labor supply. The

reason is that our treatment group also contains people who entered early retirement under the previous system. Therefore, the pass-through to the participation rate of the treatment group is lagged and becomes visible only in periods AFTER2 and AFTER3. β_5 is not significant in our specification, and β_6 together with β_7 are negative and significant. After controlling for other observable characteristics, the results change mainly in the significance of the coefficients. The other controls are significant with the expected signs: higher education decreases the probability of being inactive. The number of household members has the same effect. We do not include the labor market status of spouses, because the labor market activity of spouses can also potentially be affected by the reform and thus it is an endogenous variable. To reveal the magnitude of the estimated effects—the impact on the probability—the marginal effects are presented in Table 4.

Table 4: Estimated coefficients from the probit model in three different specifications

Model	(1)	(2)	(3)
OLD*AFTER1	-0.0159	-0.0108	-0.0096
	(0.0180)	(0.0182)	(0.0182)
OLD*AFTER2	-0.0509***	-0.0340*	-0.0318*
	(0.0179)	(0.0184)	(0.0184)
OLD*AFTER3	-0.0457**	-0.0354*	-0.0317
	(0.0187)	(0.0189)	(0.0191)
Personal characteristics		X	X
District dummies			X
N	50,152	50,152	50,152
Pseudo R-squared	0.07	0.10	0.14

Note: Coefficients are recalculated into the probability measure (min 0, max 1). The excluded variables are dummies for: control group, one period before policy change, interaction of control group and all periods. Full results are presented in Appendix E. Standard errors are in parentheses. We also performed linear probability estimation with OLS and it does not change the significance of the results.

*** p<0.01, ** p<0.05, * p<0.1

We estimated three different specifications. The most extended version contains individual characteristics and 76 dummies for districts. In all models this effect remains negative. The marginal effect of the reform on the probability of being inactive is close to -0.03, which can be interpreted as a 3% drop in the probability of being inactive for workers who are at most three

years before the statutory retirement age. These results show that inactivity significantly decreased in the treatment group during 2003–2005 relative to the control group and the period before. Our results also show that there is no significant effect of the policy change in the period immediately after the policy change. This is probably due to the fact that the left-hand-side variable is a stock (the probability of being inactive) and thus the treatment group in the first period after the policy change contains a lot of individuals who entered early retirement before the policy change.

We are also aware of the problem with expectations, which might have influenced the behavior of people right before the reform became effective. In our case it would mean that people entered early retirement earlier just because the policy change occurred. This fact would bias our results. We cannot fully account for this phenomenon owing to data limitations. Thus, we did a robustness check and skipped the first half of 2001, since the law introducing the reform was passed in the Czech parliament at the beginning of 2001 and became effective in July 2001. We thus shorten the baseline period to one year. The results are summarized in Table 5 and suggest that even in this setting the reform decreased the inactivity rate among older workers. The size of this effect is, however, smaller and in specifications (2) and (3) the significance has vanished. However, the result for specification (1) could be considered as the lower bound of the estimated effect, because those people who reacted purely to the announcement of the reform would probably have entered early retirement later on if they behave rationally.

The dummies that represent geographical location show high variation in labor market behavior across different regions in the Czech Republic. For example, individuals from the Karvina region (border region to Poland strongly affected by the structural changes after fall of socialism) have a 40% higher chance of being inactive compared to individuals from Prague, even after controlling for all possible observable characteristics.

Our results show that the probability of being inactive (out of the labor force) has decreased since the reform came into force. This means that people have not started to leave the labor force by using other social programs (e.g. disability pensions), but this leaves the possibility of becoming unemployed and so this policy change might still have a negative impact on the fiscal position. Therefore, we decided to run the same probit specification but with the indicator variable of being employed. The results, available in Appendix G, are quite similar to those obtained earlier.

The Appendix H presents additional robustness check and further extension of our analysis. We divided the control and treatment into the three smaller fractions of the length of one year. Further we also explore other labor statuses—employed and unemployed. The control group is considered only

those who are 3–4 years before retirement. The results show that the reform was really efficient for increasing activity on the labor market. However, we also see that unemployment was also temporally increased. The employment is increased, but results are not significant. This will be explored further in the next version of this paper.

Table 5: Estimated coefficients from the probit model in three different specifications without the first half of 2001

Model	(1)	(2)	(3)
OLD*AFTER1	-0.0004	0.0034	0.0031
	(0.0209)	(0.0211)	(.02104)
OLD*AFTER2	-0.0361*	-0.0201	-0.0197
	(0.0196)	(0.0201)	(0.0201)
OLD*AFTER3	-0.0308	-0.0214	-0.0193
	(0.0204)	(0.0206)	(0.0207)
Personal characteristics		X	X
District dummies			X
N	46,127	46,127	46,127
Pseudo R-squared	0.06	0.11	0.13

Note: Coefficients are recalculated into the probability measure (min 0, max 1). The excluded variables are dummies for: control group, one period before policy change, interaction of control group and all periods. Full results are presented in Appendix E. Standard errors are in parentheses. We also performed linear probability estimation with OLS and it does not change the significance of the results.

*** p<0.01, ** p<0.05, * p<0.1

One more approach to check the robustness of our results is reported in Appendix I. This Annex reports results for the multinomial logit in which we compare the relative risks between the three basic statuses on the labor market—employed, unemployed and inactive. We find that for the treatment group in second and third period after the policy change the risk to be employed is higher than inactive. However we find the temporal effect for the unemployment as well which is even robust for all three equation specification.

We also attempted to use an explanatory variable that indicates change in labor market status. However, as we mentioned earlier, we face a problem with the lack of observations for people who change status during the period they were surveyed (i.e., four or five quarters). We divided our time span into two periods: two years before the reform and two years after the reform.

We observed only a few changes in labor market status for the treatment group: 172 out of 2,541 individuals for the two years before the policy change and 113 out of 2,587 after the policy change. We can conclude that these numbers are in line with our hypothesis that the reduction in early retirement benefits caused fewer workers to enter early retirement. However, the number of observations in our sample does not allow any formal econometric analysis in this setting.

7 Conclusions and Policy Implications

Our results confirm that the 2–3% cut in early retirement benefits due to the 2001 reform boosted the labor participation of males eligible for early retirement by approximately the same amount. The reform increased the probability of being employed in the three-year period before a worker reaches the statutory standard retirement age. These results show that the elasticity of the extensive margin of labor supply of older Czech workers is relatively high, although we are not able to calculate the exact value because we lack individual data on wages. Nevertheless the policy change was not purely fiscal improving since some of the affected people did not continue to work, but rather switched to unemployment as a substitute to early retirement.

Our findings are generally in line with those, for example, from Germany, where Borsch-Supan (2000) found a high sensitivity of older workers employment to the social security system design. Our results also correspond with Galuscak (2001), who found a substantially high sensitivity of the participation rate to change in the earnings test for workers older than the statutory retirement age. In this respect, our results are not fully comparable, because we examine older workers who are eligible for early retirement and have not reached the statutory retirement age.

In our approach, we assume that the difference in the labor supply between older and younger cohorts was not affected by any other shock than the policy change. This is the only possible way of empirically testing a public policy intervention affecting the whole population of one country.

The extent of our analyses is also limited by data availability. The dataset contains important characteristics about the retirement of males and on top of that it does not contain wages. Therefore, our analysis does not cover the labor supply of females and we do not directly estimate the elasticity of the labor supply to the individual budget constraint. Our results also indicate high differences of labor supply behavior across males with different characteristics (education, geographic location). This could be the subject of additional research.

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A Social security formulae

$$
\begin{aligned}
\text{P} &= \text{BA} + \text{PA} \\
\text{PA} &= \text{CB} \cdot \text{AP} \\
\text{CB} &= \text{PAB} \cdot \text{rp}_1 + \max(0,\text{PAB - rl}_1) \cdot (\text{rp}_1 - \text{rp}_2) + \max(0,\text{PAB - rl}_2) \cdot (\text{rp}_2 - \text{rp}_3) \\
\text{AP} &= \text{int}((\text{IP}_1 + \text{IP}_2 \cdot 0.8)/365) \cdot (\text{PYI - 90per} \cdot \text{rPYI})
\end{aligned}
$$

$$
\text{PAB} = \frac{\sum_{y=Y-1-min(30,Y-1-1986)}^{Y-1} AAB_y}{min(30, Y-1-1986) - EP/365}
$$

$$
\text{AAB}_y = \text{AB}_y \cdot \text{CGGAB}_y
$$

$$
\text{CGGAB}_y = \frac{GAB_{y-2} \cdot CvC_{y-2}}{GAB_y}
$$

where:

P	-	pension benefit
BA	-	basic amout
PA	-	percentage-based assessment
CB	-	calculation base
AP	-	adjustment percentage
PAB	-	personal assessment base
rp_1 = 100 %, rp_2 = 30 %, rp_3 = 10 %	-	reduction percentage
rl_j	-	first and second reduction limit in yearly terms
IP_j, j = 1,2	-	insured period (j = 1) and compensatori insured period (j = 2) counted as 80 % of the length befor reaching the age of 18 (only whole 365 days are included)
PYI	-	percentage for each year of insurance (1.5 %)
90per	-	number of 90-day periods
rPYI	-	reduced percentage for each 90-day period of early reteirement **(subject of policy change)**
AAB	-	annual assessment base
EP	-	excluded period
AB	-	assessment base
CGGAB	-	coefficient of the growth of the general assessment base
GAB	-	general assessment base
CvC	-	conversion coefficient
Y	-	number of years worked
y	-	year in which the retirement benefits are claimed

B Appendix

Table : Monetary incentives before and after the reform (low-wage earner)

Last age of work	Replacement rate - before	Replacement rate - after	SSW - before	SSW - after	Accrual rate - before	Accrual rate - after
58	1.074	1.062	648,662	640,970	-0.005	-0.005
59	1.118	1.110	606,802	601,781	-0.069	-0.065
60	1.165	1.160	561,769	559,087	-0.080	-0.076
61	1.203	1.203	515,824	515,214	-0.089	-0.085
62	1.247	1.247	469,394	468,659	-0.099	-0.099
63	1.304	1.304	428,142	427,275	-0.096	-0.097
64	1.336	1.336	377,901	376,903	-0.133	-0.134
65	1.429	1.429	347,119	345,990	-0.089	-0.089

Note: SSW – social security wealth – is defined as the sum of all discounted pension benefits and social security contributions. The accrual rate is defined as the relative year-to-year change in SSW.

Table : Monetary incentives before and after the reform (high-wage earner)

Last age of work	Replacement rate - before	Replacement rate - after	SSW - before	SSW - after	Accrual rate - before	Accrual rate - after
58	0.658	0.650	783,855	773,719	-0.005	-0.005
59	0.682	0.676	722,477	715,687	-0.069	-0.065
60	0.710	0.707	660,765	656,923	-0.080	-0.076
61	0.731	0.731	595,214	593,909	-0.077	-0.074
62	0.746	0.746	522,766	521,19	-0.089	-0.089
63	0.788	0.788	473,132	471,275	-0.087	-0.088
64	0.809	0.809	407,865	405,728	-0.123	-0.124
65	0.858	0.858	360,896	358,476	-0.085	-0.086

Note: SSW – social security wealth – is defined as the sum of all discounted pension benefits and social security contributions. The accrual rate is defined as the relative year-to-year change in SSW.

C Appendix

Table : Forward-looking social security incentives — Option Value

Ret. age	Before the change				After the change			
	low wage	avg. wage	high wage	SD	low wage	avg. wage	high wage	SD
56	10,84	14,364	20,048	3,794	10,837	14,342	20,571	4,025
57	4,491	6,136	8,97	1,85	4,49	6,126	9,503	2,087
58	0	0	343	162	0	0	883	416
59	1,777	912	0	726	1,462	566	156	545
60	4,117	2,366	178	1,612	3,533	1,734	0	1,442
61	6,752	4,334	1,19	2,277	5,932	3,441	728	2,125
62	9,615	6,862	3,295	2,587	8,795	5,969	2,834	2,435
63	12,107	8,449	3,538	3,511	11,287	7,556	3,076	3,357
64	15,67	11,426	5,68	4,094	14,85	10,532	5,218	3,939
65	17,407	12,743	6,41	4,507	16,587	11,85	5,948	4,352

Note: SD stands for standard deviation.

Table : Forward-looking social security incentives — Peak Value

Ret. age	Before the change				After the change			
	low wage	avg. wage	high wage	SD	low wage	avg. wage	high wage	SD
56	-3,313	-4,652	-6,978	1,514	-3,432	-4,917	-7,327	1,605
57	-3,174	-4,574	-6,909	1,541	-3,389	-4,935	-7,356	1,633
58	-41,86	-49,189	-61,378	8,05	-39,189	-46,229	-58,032	7,774
59	-45,032	-51,238	-61,712	6,883	-42,694	-48,747	-58,765	6,627
60	-45,945	-53,334	-65,551	8,084	-43,872	-51,011	-63,014	7,898
61	-46,429	-56,17	-72,448	10,733	-46,556	-56,351	-72,719	10,793
62	-41,252	-44,409	-49,634	3,456	-41,383	-44,597	-49,915	3,518
63	-50,241	-55,864	-65,267	6,199	-50,372	-56,05	-65,547	6,26
64	-30,782	-36,873	-46,97	6,676	-30,914	-37,061	-47,252	6,738
65	-40,928	-46,833	-56,75	6,528	-41,061	-47,024	-57,036	6,591

Note: SD stands for standard deviation.

D Appendix

Table : Descriptive statistics

variable	control group				treatment group			
	Mean	Std. Dev.	Min.	Max.	Mean	Std. Dev.	Min.	Max.
inactivity status	0.17	0.38	0	1	0.42	0.49	0	1
elementary educ.	0.09	0.29	0	1	0.12	0.32	0	1
apprenticeship	0.54	0.50	0	1	0.50	0.50	0	1
high school educ.	0.24	0.43	0	1	0.25	0.43	0	1
lower tertiary educ.	0.01	0.10	0	1	0.01	0.09	0	1
upper tertiary educ.	0.11	0.32	0	1	0.12	0.32	0	1
unmarried	0.04	0.21	0	1	0.04	0.20	0	1
married	0.84	0.37	0	1	0.84	0.37	0	1
widowed	0.04	0.20	0	1	0.05	0.22	0	1
divorced	0.07	0.26	0	1	0.07	0.26	0	1
before the policy change	0.22	0.42	0	1	0.25	0.43	0	1
1-1.5 year after the policy change	0.24	0.43	0	1	0.26	0.44	0	1
1.5 - 3 years after the policy change	0.28	0.45	0	1	0.26	0.44	0	1
3 - 4.5 years after the policy change	0.26	0.44	0	1	0.23	0.42	0	1
number of household members	2.60	1.07	1	11	2.41	0.97	1	10
age	56.90	0.94	55.0	58.8	59.72	0.78	58.25	62.25

Standard errors are in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

E Appendix

Table : Econometric results of the full baseline model

	Model 1	Model 2	Model 3
eligible age (old)	0.281***	0.275***	0.274***
	(0.0145)	(0.0146)	(0.0147)
1–1.5 year after the policy change (after1)	-0.0234*	-0.0180	-0.0205
	(0.0135)	(0.0136)	(0.0136)
1.5–3 years after the policy change (after2)	-0.0135	-0.0110	-0.0106
	(0.0143)	(0.0144)	(0.0144)
3–4.5 years after the policy change (after3)	-0.0223	-0.0193	-0.0223
	(0.0146)	(0.0147)	(0.0146)
interaction variable (oldxafter1)	-0.0159	-0.0108	-0.00922
	(0.0180)	(0.0182)	(0.0182)
interaction variable (oldxafter2)	-0.0509***	-0.0340*	-0.0318*
	(0.0179)	(0.0184)	(0.0184)
interaction variable (oldxafter3)	-0.0457**	-0.0354*	-0.0317
	(0.0187)	(0.0189)	(0.0191)
apprenticeship		-0.125***	-0.131***
		(0.0130)	(0.0131)
high school educ.		-0.191***	-0.188***
		(0.0108)	(0.0109)
lower tertiary educ.		-0.162***	-0.161***
		(0.0237)	(0.0224)
upper tertiary educ.		-0.250***	-0.243***
		(0.0076)	(0.0077)
unmarried		0.109***	0.118***
		(0.0228)	(0.0231)
widowed		0.0454**	0.0479**
		(0.0199)	(0.0199)
divorced		0.0377**	0.0369**
		(0.0171)	(0.0172)
number of household members		-0.0157***	-0.0161***
		(0.0045)	(0.0046)
76 districts (not reported)			X
Observations	50,152	50,152	50,152
Pseudo R-squared	0.07	0.11	0.14

Standard errors are in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

F Appendix

Table : Estimated coefficients from the probit model in three different specifications (yearly periods)

Model	(1)	(2)	(3)
OLD*AFTER1	-0.0067	-0.0033	-0.0009
	(0.0195)	(0.0198)	(0.0199)
OLD*AFTER2	-0.0689***	-0.0573***	-0.0564***
	(0.0201)	(0.0204)	(0.0203)
OLD*AFTER3	-0.0623***	-0.0435**	-0.0366*
	(0.0198)	(0.0204)	(0.00206)
Personal characteristics		X	X
District dummies			X
N	33,842	33,842	33,842
Pseudo R-squared	0.07	0.11	0.14

Note: Coefficients are recalculated into the probability measure (min 0, max 1). The excluded variables are dummies for: control group, one period before policy change, interaction of control group and all periods. Standard errors are in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

G Appendix

Table : Estimated coefficients from the probit model in three different specifications (dependent variable being employed)

Model	(1)	(2)	(3)
OLD*AFTER1	0.0117	0.0054	0.0049
	(0.0188)	(0.0193)	(0.0193)
OLD*AFTER2	0.0419**	0.0226	0.0196
	(0.0192)	(0.0198)	(0.0199)
OLD*AFTER3	0.0467**	0.0351*	0.0312
	(0.0197)	(0.0201)	(0.0203)
Personal characteristics		X	X
District dummies			X
N	33,842	33,842	33,842
Pseudo R-squared	0.07	0.11	0.14

Note: Coefficients are recalculated into the probability measure (min 0, max 1). The excluded variables are dummies for: control group, one period before policy change, interaction of control group and all periods. Standard errors are in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

H Alternative specification with narrow treatment and control group (one-year age window)

Table : Marginal effects probit

Variables	Active	Employed	Unemployed
OLD1*after1	-0.000	0.011	0.009
	(0.028)	(0.030)	(0.014)
OLD1*after2	0.072***	0.045	0.038**
	(0.023)	(0.027)	(0.020)
OLD1*after3	0.053**	0.040	0.013
	(0.024)	(0.027)	(0.015)
OLD2*after1	0.030	0.024	0.002
	(0.028)	(0.030)	(0.015)
OLD2*after2	0.079***	0.062**	0.034*
	(0.025)	(0.029)	(0.025)
OLD2*after3	0.081***	0.078**	0.008
	(0.026)	(0.029)	(0.018)
OLD3*after1	0.010	-0.019	0.003
	(0.031)	(0.033)	(0.019)
OLD3*after2	0.069**	0.051	0.042
	(0.027)	(0.031)	(0.035)
OLD3*after3	0.041	0.031	0.034
	(0.031)	(0.033)	(0.035)

Note: Coefficients are recalculated into the probability measure (min 0, max 1). Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table : Linear regression

Variables	Active	Employed	Unemployed
OLD1*after1	-0.007	-0.005	0.014
	(0.027)	(0.028)	(0.015)
OLD1*after2	-0.080***	0.047*	0.038**
	(0.0260)	(0.0272)	(0.015)
OLD1*after3	-0.060*	0.045*	0.015
	(0.026)	(0.027)	(0.016)
OLD2*after1	-0.044	0.035	0.006
	(0.029)	(0.030)	(0.015)
OLD2*after2	-0.098***	0.074**	0.030*
	(0.032)	(0.032)	(0.016)
OLD2*after3	-0.1056***	0.0938***	0.010
	(0.0315)	(0.0323)	(0.016)
OLD3*after1	0.007	-0.015	0.011
	(0.030)	(0.0305)	(0.017)
OLD3* after2	-0.081**	0.057*	0.034*
	(0.032)	(0.0331)	(0.019)
OLD3* after3	-0.051	0.037	0.025
	(0.0336)	(0.034)	(0.020)

Note: Control group is defined by the distance 3–4 years before retirement. The other control variables are year, control and treatment group fixed effects are family status, education and districts. *** p<0.01, ** p<0.05, * p<0.1

I Appendix

Table : Estimated coefficients from the multinomial logit

Model	(1)	(2)	(3)
employed			
OLD*AFTER1	1.0601	1.0279	1.0220
	(0.1036)	(0.1041)	(0.10496)
OLD*AFTER2	1.2661**	1.1538	1.1350
	(0.1311)	(0.1226)	(0.1227)
OLD*AFTER3	1.2434**	1.1869	1.1546
	(0.1336)	(0.1305)	(0.1294)
unemployed			
OLD*AFTER1	1.1994	1.1923	1.1943
	(0.3075)	(0.3062)	(0.3096)
OLD*AFTER2	1.9621***	1.9149**	1.9371***
	(0.4999)	(0.4888)	(0.4978)
OLD*AFTER3	1.3542	1.3369	1.3278
	(0.3726)	(0.3679)	(0.3672)
Personal characteristics		X	X
District dummies			X
N	50,152	50,152	50,152
Pseudo R-squared	0.06	0.10	0.13

Note: Coefficients are recalculated into the probability measure (min 0, max 1). Standard errors are in parentheses.
*** p<0.01, ** p<0.05, * p<0.1