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Extended Unemployment Benefits and Early Retirement: Program Complementarity and Program Substitution

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April 2013

Extended Unemployment Benefits and Early Retirement: Program Complementarity and Program Substitution*

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Abstract

This paper explores how extended unemployment insurance (UI) benefits targeted to older workers affect early retirement and social welfare. The trade-off of optimal UI between consumption smoothing and moral hazard requires accounting for the entire early retirement system, which often includes extended UI and relaxed access to disability insurance (DI). We argue that extended UI generates program complementarity (increased take-up of UI followed by DI and/or regular retirement benefits) and program substitution (increased take-up of UI instead of DI). Exploiting Austria's regional extended benefit program, which extended regular UI benefits to up to 4 years, we find: (i) program complementarity is quantitatively important for workers aged 50+; and (ii) program substitution is quantitatively relevant for workers aged 55+. We derive a simple rule for optimal UI that accounts for program complementarity and program substitution. Using the sufficient statistics approach, we conclude that UI for older workers was too generous and the regional extended benefit program was a suboptimal policy.

Keywords: Early retirement, unemployment, disability, policy reform, optimal benefits

JEL Codes: J14; J26; J65.

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1 Introduction

Extending the potential duration of unemployment insurance (UI) benefits is one of the most important policy instruments to ease economic hardships of job losers. For instance, the United States extended UI benefits from 26 weeks to up to 99 weeks during the Great Recession. Many UI systems let UI generosity not only vary over the business cycle but also across groups with different labor market conditions. In particular, many countries grant more generous UI benefits to older job losers. The present paper studies the impact of extended UI benefits on employment and retirement behavior of older workers and explores the welfare implications of increased UI generosity for the elderly.

The social desirability of UI benefit extensions is highly controversial. Theoretical arguments show that optimal UI faces a trade-off between moral hazard effects, captured by labor supply/job search responses, and consumption smoothing benefits, captured by relaxed liquidity constraints (Baily (1978), Chetty (2008)).[1] In the context of older workers, this general logic needs to be broadened by considering the costs and benefits of *all* welfare benefits that protect older workers in case of a job loss. In many countries, early retirement schemes allow older unemployed workers to withdraw from the work force by using extended UI benefits in combination with other public transfers (DI benefits and/or retirement benefits). This is what we call *program complementarity.* Alternatively, more generous UI benefits may induce workers to reduce take-up of other welfare programs, in particular DI benefits. This is what we mean by *program substitution.* While program complementarity imposes an additional burden on government budgets, the impact of program substitution is unclear.[2]

The aim of the present paper is twofold. *First*, we study the causal impact of extended UI benefits on (i) the incidence of early retirement and (ii) the particular pathways through which workers exit the labor market. We focus on Austria where we can study how extended UI benefits interact with take-up of DI benefits and retirement benefits. Under the Austrian system of the late 1980s and early 1990s, workers aged 50+ were eligible for 1 year of regular UI benefits. Moreover, worker aged 55+ had relaxed access to DI benefits. To empirically identify the causal impact of extended UI benefits for older workers we exploit a policy intervention that changed early retirement incentives dramatically: the regional extended benefits program (REBP). This program was in place between June 1988 and July 1993 and granted regular UI benefits for up to 4 years to workers aged 50+ living in certain regions of the country. Variation in the maximum duration of UI benefits across regions and age groups allows us to identify the causal impact of extended UI benefits on the

[1] While several empirical papers have documented both the consumption smoothing benefits of UI benefits (Gruber (1997), Browning and Crossley (2001)), a large literature documents the adverse consequences of more generous benefits for unemployment exit rates (see, e.g., Meyer, 1990, Katz and Meyer (1990), and Card and Levine (2000)).

[2] When DI take-up is associated with stigma costs or a disutility due to medical checks/bureaucratic hassles, a worker may decide to stay unemployed even when UI benefits are smaller than DI benefits. This saves money to the government. In contrast, DI benefits often provide a constant stream of income while alternative early retirement pathways imply varying income levels over time. Liquidity constrained workers may thus prefer DI benefits even if lifetime income is lower. Program substitution is associated with higher government expenditures when the latter effect dominates.

incidence of early retirement and the particular pathways by which workers leave the labor market. Our estimation strategy is a difference-in-differences approach. Since the REBP was only in effect for a limited period of time we can test whether the effects of introducing and abolishing extended UI benefits are symmetric.

We find that the REBP had a strong effect on the incidence of early retirement. The probability that a job loser aged 50-54 permanently withdraws from the labor market increases by 17 percentage points when the worker is eligible to the REBP. Among job losers aged 55-57, the incidence of early retirement increases by 10.8 percentage for those eligible to the REBP.[3] The program also affected the pathways into early retirement. For workers aged 50-54, *program complementarity* – increased take-up of UI followed by higher DI benefit claims and/or retirement benefits – is quantitatively important. The 17 percentage point increase in early retirement is associated with a 12.6 percentage point increase in a subsequent DI take-up. For workers aged 55-57 not only program complementarity but also *program substitution* – higher take-up of UI but lower take-up of DI – are at work. The 10.8 percentage point increase in early retirement is associated with a 23.1 percentage point increase in subsequently claiming of retirement benefits and a 12.7 percentage reduction in claiming of DI benefits.

The *second* aim of this paper is to explore the welfare consequences of early retirement rules. We follow the sufficient statistics approach proposed by Chetty (2006a) and set up a simple model that makes precise the impact of more generous UI benefits on labor supply and retirement.[4] The model establishes a simple rule for optimal UI that accounts for both program complementarity and program substitution. We find that, given the Austrian early retirement rules of the late 1980s and early 1990s, the extension of UI benefits was welfare-improving only if the degree of risk aversion exceeds 2.07. The value of risk aversion remains disputed and a growing body of literature suggests that risk preferences are context-specific (Chetty and Szeidl (2007), Barseghyan et al. (2011), Einav et al. (2012)). Studies that use labor supply elasticities to estimate risk aversion come closest to our setting. These studies typically find values of risk aversion below 1 (Chetty, 2006b). We therefore conclude that extended UI through the REBP was most likely a suboptimal policy.

We think our study is of general interest for two reasons. *First*, policy makers in many countries have implemented early retirement schemes and these schemes are both very costly and very controversial. In many countries, reforms reducing the generosity of these schemes are debated or under way. In this context, Austria is an interesting case study because early retirement schemes were heavily used to mitigate labor market problems of older workers over the past decades. As a result, Austria's effective retirement age has fallen below age 59, well below the OECD average.[5] *Second*, while the Austrian early retirement system created particularly large incentives, it

[3] As we explain in more detail in the next section, retirement incentives are different before and after age 55 due to relaxed access to DI benefits. Moreover retirement incentives between REBP- and non-REBP regions disappear after age 57. This is why our analysis looks at age groups 50-54 and 55-57.

[4] Recent applications of the sufficient statistic approach for optimal UI design include Shimer and Werning (2007), Chetty (2008), Kroft (2008), Landais et al. (2010), Kroft and Notowidigdo (2011), Schmieder et al. (2012), and Landais (2012). See the article by Chetty and Finkelstein (2012) for a detailed discussion of this literature.

[5] According to OECD (2006), in 2004 the average effective retirement age among males ranged from 58 years in

works qualitatively similar than in many other countries. Early retirement schemes often feature relaxed DI-eligibility criteria for older workers, including the United States (Chen and van der Klaauw, 2008), and extended UI benefit durations are extended above certain age thresholds, as in Germany, (Schmieder et al., 2012).[6] This suggests that our results speak to mechanisms (policy changes) that are at work (debated or implemented) in many early retirement systems.

Our paper is related to a growing literature that studies how multiple social insurance programs affect workers' labor supply decisions and differs from the larger literature that studies the isolated effect of a single program on labor supply and/or early retirement. Autor and Duggan (2003) examine the interaction between unemployment and disability insurance in the United States. They find that less strict medical screening, declining demand for less skilled workers, and an increase in the earnings replacement rate are the most plausible candidates to explain the rise in DI take-up. Using administrative data from the Netherlands, Borghans et al. (2012) provide empirical evidence that reducing the generosity of DI benefits increases enrollment into other forms of social insurance. Petrongolo (2009) studies the impact of the UK JSA reform of 1996 that imposed stricter job search requirements and additional administrative hurdles for UI benefit claimants. It turns out that the fall in UI benefit recipients was associated with higher take-up of DI benefits. Furthermore, rather than increasing the transition to regular jobs, the reform temporarily decreased the outflow to employment.[7]

A recent literature studies the impact of UI and/or DI on labor supply and retirement of older workers.[8] Karlström et al. (2008) find that stricter eligibility criteria for DI benefits in Sweden increased take-up of unemployment and sickness benefits, but did not increase employment rates. In contrast, Kyyrä (2010) provide evidence that increasing age-thresholds for UI benefits and tightening medical criteria for DI eligibility in Finland raised the effective retirement age by almost 4 months. The results of Staubli (2011) suggest that increasing the minimum age of relaxed DI access in Austria lead to a significant decline in DI enrollment but only a slight increase in employment. Kyyrä and Ollikainen (2008) document a strong increase in early retirement after a reform in Finland that increased the eligibility age for extended UI benefits from 53 to 55. Lammers et al. (2013) show that increased search requirements for older unemployed in the Netherlands increased not only employment rates but also DI take-up. Our paper extends this literature by investigating how extended UI benefits for older workers affect retirement behavior through program complementarity and program substitution; and by using the estimated behavioral elasticities to

Hungary to 74 years in Mexico. The effective retirement ages in US, UK, Switzerland, Germany and France were 63, 62, 66, 61, and 59.

[6] Countries other than Austria and the United States that relax access to DI for older workers include Australia, Denmark, Finland (until 2003), and Sweden (until 1997). Countries other than Austria and Germany that extend UI above certain age thresholds include France, Finland, Greece, Italy, and Portugal.

[7] Spillover effects among social insurance programs have been examined in other contexts by Garrett and Glied (2000), Schmidt and Sevak (2004), Bound et al. (2004), Duggan et al. (2007), Roelofs and van Vuuren (2011), and Staubli and Zweimüller (2012).

[8] Related to these studies is the work on the extension of UI benefits for older workers by Winter-Ebmer (2003), Kyyrä and Wilke (2007), Lalive and Zweimüller (2004a, 2004b) and Lalive (2008). These papers analyze the UI program in isolation and ignore potential interactions with other social insurance programs.

explore the welfare implications of extended UI benefits for older unemployed workers.

The paper is organized as follows. In the next section we review the institutional background of Austria. In particular, we discuss the various pathways to early retirement that the Austrian welfare state offers to older workers and the rules associated with the regional extended benefit program. In Section 3 we describe our data and provide some preliminary descriptive evidence of the impact of the REBP. Section 4 lays out our identification strategy. In Section 5 we discuss our main results. In Section 6 we develop a theoretical early retirement framework which allows us to address the welfare consequences of extending the unemployment benefits duration. Section 7 summarizes our main results and draws some policy conclusions.

2 Institutional Background

2.1 Austria's Public Pension System

There are three types of government-provided benefits in Austria that are important for the labor market withdrawal of older unemployed: old-age pensions, disability pensions, and unemployment benefits. Disability and old-age pensions provide the main source of retirement income and replace on average 80% of the last net wage up to a maximum of approximately 2,900 euros per month. Both pensions are subject to income taxation and mandatory health insurance contributions.

Under the rules in place during the 1990s, an old-age pension can be claimed at any age after 60 for men and 55 for women, conditional on having 35 contribution years or 37.5 insurance years. Insurance years comprise both contributing years (periods of employment, including sickness, and maternity leave) and qualifying years (periods of unemployment, military service, or secondary education). Eligibility criteria are relaxed for individuals who have been unemployed for at least 12 months in the past 15 months. They only need 15 contribution years to qualify for an old-age pension at the early retirement age of 60 for men and 55 for women.

In Austria disability pensions play an important role for early retirement, because access to a disability pension is relaxed at age 55.[9] In particular, below that age threshold applicants are generally eligible for benefits if a medically determinable impairment reduces the capacity to work by at least 50 percent in any occupation in the economy. Applicants above age 55 are classified as disabled if their capacity to work is reduced by more than 50% in the same occupation. As a consequence of this relaxation in eligibility criteria, disability enrollment raises significantly beginning at age 55. Because men first become eligible for old-age pensions at age 60 as opposed to 55 for women, labor market withdrawal through the disability insurance is particularly common among older men.

The unemployment insurance system plays an important role in the labor market exit of older

[9] In 1996, the age limit for relaxed access to disability pensions was raised to age 57, for an evaluation of this policy change, see Staubli (2011). All individuals that are considered in the empirical analysis below, were subject to pre-1996 disability pension rules.

workers not only because older unemployed enjoy relaxed access to an old-age pension but also because they are eligible for extended unemployment benefits. Unemployment benefits are not taxed and replace around 55% of the last net wage, subject to a minimum and maximum (though only a small fraction of individuals are at the maximum). Regular unemployment benefits can be claimed for a limited period based on previous work history. Individuals who have worked 1 year or more in the last 2 years receive benefits for 20 weeks, while those with at least 3 years of employment in the past 5 years receive benefits for 30 weeks. Job losers aged 50 and older who have paid unemployment insurance contributions for 9 years or more in the last 15 years can claim unemployment benefits for 52 week.[10] Job losers who exhaust the regular unemployment benefits can apply for unemployment assistance. These means-tested transfers last for an indefinite period and can be at most 92% of regular unemployment benefits.[11]

In addition, unemployed men aged 59 or older and unemployed women aged 54 or older can claim special income support, provided that they had contributed to the unemployment insurance for at least 15 out of the previous 25 years. Special income support is equivalent to an unemployment spell in legal terms, but with 25% higher benefits. Benefits are paid for a period of 12 months to bridge the gap until individuals become eligible for an old-age pension. The rules are more generous for workers in the mining sector who can claim special income support for up to 5 years starting at age 55 for men and age 50 for women. Special income support can be combined with regular unemployment benefits and unemployment assistance. Thus, eligible unemployed can claim unemployment benefits up to age 54 for women and age 59 for men followed by special income support.

2.2 Heterogeneity in Replacement Rates

The amount of an old-age pension is determined by the "assessment basis" and the "pension coefficient". The assessment basis corresponds to the average earnings of the best 15 years after applying an earnings cap in each year. The pension coefficient corresponds to the percentage of the assessment basis that is replaced by the old-age pension. The pension coefficient increases with the number of insurance years up to a maximum of 80%. Disability pensions are calculated in the same way as old-age pensions, except for a special increment that is granted to claimants below age 55. Postponing a disability or old-age pension claim by one year increases the replacement rate by roughly 2 percentage points. Regular unemployment benefits are a function of annual earnings one or two years before unemployment entry (depending on the starting month of the unemployment spell), subject to a minimum and a maximum. The gross replacement rate declines with previous earnings from a maximum of around 60% for low-income earners to approximately 40% for high-income earners. On top of regular unemployment benefits, family allowances are paid.

[10] Before August 1989, the potential unemployment duration was 30 for all individuals above age 50. See Lalive et al. (2006) for a detailed description of the policy change and its impact on the unemployment duration of job losers.

[11] In 1990, the median unemployment assistance benefits were about 70% of the median unemployment benefits (Lalive, 2008).

Notice that unemployment benefits depend only on earnings in the previous job, while disability and old-age pensions are based on the entire work history. Thus, an individual's replacement rate of a disability or an old-age pension can be very different from the replacement rate of unemployment benefits. For example, an unemployed whose earnings prior to job loss are high compared to his or her life-time earnings will have relatively high unemployment benefits but a relatively low disability or old-age pension, and vice versa. As a consequence of the heterogeneity in replacement rates across individuals for the same social insurance program, job losers who are similar in observable characteristics may have very different incentives to retire early via a particular program. This aspect will be of central importance in our empirical analysis and the theoretical model described below.

To illustrate the heterogeneity in replacement rates across individuals, we split our sample of job losers (described in more detail in Section 3 below) into quartiles according to their UI and DI net replacement rates. As Table 1 illustrates, there is a large dispersion of UI and DI replacement rates among older unemployed. For example, the median replacement rate for 50-54 year old job losers in the bottom quartile of the UI replacement rate distribution is roughly constant at 55% but the median DI replacement rate varies between 54.5% (column 1) and 96.0% (column 4). Table 1 also shows that the number of unemployment entrants in each cell is large, suggesting that the correlation between previous earnings and life-time earnings is not very strong.

Table 1: Heterogeneity in UI and DI replacement rates

	DI repl. rate age 50-54				DI repl. rate age 55-57			
	1st quartile	2nd quartile	3rd quartile	4th quartile	1st quartile	2nd quartile	3rd quartile	4th quartile
UI repl. rate								
1st quartile								
No. of Obs.	3,767	3,897	3,021	1,481	1,227	1,306	1,410	719
Median DI repl. rate	54.5	66.6	75.1	96.0	55.4	67.0	75.7	86.9
Median UI repl. rate	54.9	53.1	53.8	54.8	54.4	52.9	52.0	54.6
2nd quartile								
No. of Obs.	4,225	3,371	3,022	1,549	1,579	1,427	1,026	630
Median DI repl. rate	54.7	66.2	75.9	89.4	55.5	66.5	75.5	86.3
Median UI repl. rate	58.0	58.4	59.3	59.8	57.8	58.1	58.3	58.6
3rd quartile								
No. of Obs.	2,121	3,011	3,662	3,372	883	1,119	1,342	1,318
Median DI repl. rate	54.6	66.8	76.0	92.9	55.5	67.3	76.0	89.6
Median UI repl. rate	61.2	61.2	61.2	61.3	61.0	61.0	60.9	60.7
4th quartile								
No. of Obs.	2,054	1,887	2,462	5,764	973	810	884	1,995
Median DI repl. rate	53.5	66.8	76.4	105.2	53.3	67.0	76.0	97.5
Median UI repl. rate	63.0	62.0	61.9	62.3	61.9	61.8	61.7	61.9

Notes: All replacement rates are after taxes. Sample includes unemployment spells starting in January 1985 to December 1995 (except spells starting between January 1988 and June 1988) by men in the age group 50-57. See Section 3.1 for details on the construction of the sample.

2.3 The Regional Extended Benefit Program and Retirement Pathways

To preclude Soviet appropriation after World War II, Austria nationalized its iron, steel, and oil industries, and related heavy industries. After the mid-1970, the state-run company Österreichische Industrie AG, in charge of administrating the nationalized firms, faced shrinking markets due to the international oil and steel crisis, low productivity, and outdated smokestack industries. At the beginning the resulting financial losses were covered by governmental subsidies, but in 1986 a speculation scandal in the steel industry triggered the abolishment of the protectionist policy. A new management was appointed that implemented a strict restructuring plan. This process caused layoffs and downsizing of production plants, particularly in the steel industry.

To protect older workers against adverse labor market conditions in the steel industry, the Austrian government enacted the Regional Extended Benefit Program (REBP) in June 1988. The program extended the potential unemployment duration from 52 weeks to 209 weeks for a subgroup of workers. To become eligible for the benefit extension an unemployed worker had to satisfy each of the following criteria at the beginning of the unemployment spell: (i) age 50 or older, (ii) continuous work history (15 years of employment in the past 25 years), (iii) location of residence in one of the eligible regions for at least 6 months prior to unemployment entry, and (iv) start of a new unemployment spell after June 1988 or spell in progress in June 1988.

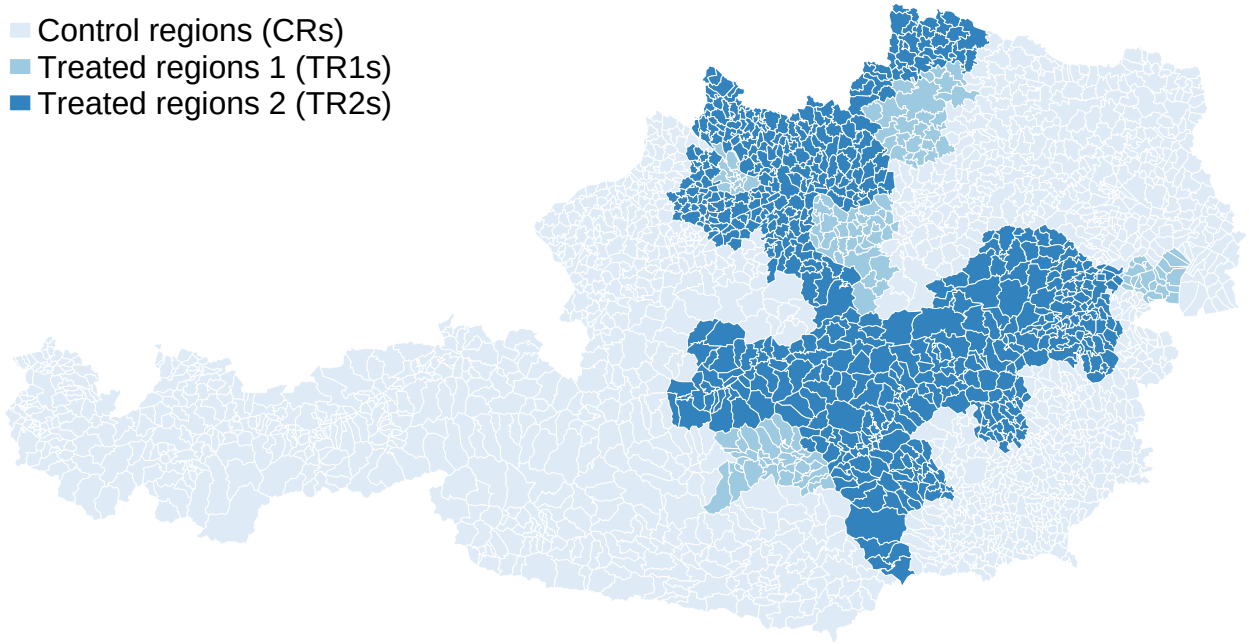

Figure 1: Regional distribution of REBP

The REBP was initially implemented in 28 of about 100 labor market districts. The minister for social affairs, a member of the ruling social democratic party (SPÖ), was in charge of selecting the regions that were included in the program. While the records of the meetings in which the set of regions eligible to the program was decided upon is not open to the public, Lalive and Zweimüller

(2004b) show that eligible regions were characterized by a relatively high share of employment in the steel sector (around 17% in REBP regions versus roughly 5% in non-REBP regions).[12] However, there were no differences between treated and non-treated regions in terms of the unemployment rate or the fraction of long-term unemployed. In December 1991 a reform took place that became effective in January 1992. The reform abolished the benefit extension in six of the originally 28 regions. The 1991 reform also tightened eligibility criteria, as individuals had to be not only residents, but also previously employed in a REBP region. We label the set of treated regions that were excluded after the reform as "TR1s". In the remaining 22 regions the REBP was in effect until August 1993 when it was abolished entirely. We label the regions that kept eligibility after the reform as "TR2s". The regions that were never entitled to the REBP are labeled as "CRs". Figure 1 plots the distribution of REBP across the 2,361 communities in Austria. The Figure illustrates that treated regions (communities with black or dark-gray shading) are all located on a contiguous area in the Eastern and Central parts of Austria.

The introduction of the REBP dramatically changes the incentives for early retirement for older unemployed, as shown in Figure 2. Prior to the REBP older job losers could withdraw from the labor force at age 58 and bridge the gap until the eligibility age for an old-age pension by claiming unemployment benefits for 12 months followed by special income support for 12 months. With the introduction of the REBP eligible unemployed can effectively withdraw through the unemployment insurance system at age 55. Thus, we expect that during the program is in effect there will be an increase in the fraction of 55-57 year old unemployed who use the REBP as a bridge to an old-age pension. This is an example of a program complementarity effect: the more generous UI benefits increase the *sequential take-up* of multiple programs.

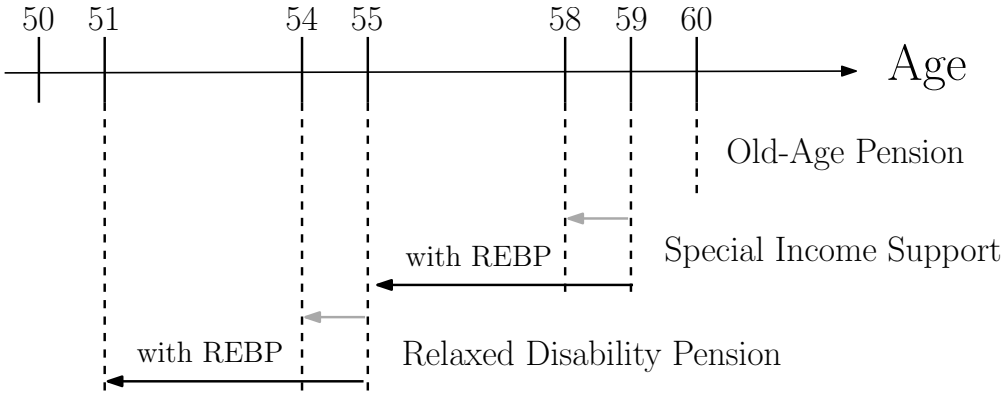

Figure 2: Early retirement pathways with/without REBP-eligibility

Job losers above age 55 also have the option to retire early via disability insurance, since eligibility criteria for a disability pension are significantly relaxed after age 55. It is very likely that some 55-57 year old unemployed who would have claimed a DI pension under the regular duration of UI benefits of one year may use the REBP to retire early via the unemployment insurance. This is

[12]The ultimate decision on set of regions that became eligible to the program was heavily criticized by opposition parties and media as being biased towards the clientele of the ruling parties.

an example of a program substitution effect: the more generous UI benefits reduce *contemporaneous take-up* of another program.

Figure 2 shows that the REBP also leads to important changes in the early retirement incentives for job losers below age 55. More specifically, prior to the REBP job losers below age 55 could withdraw from the labor market at age 54 by claiming unemployment benefits for 12 months followed by a disability pension at age 55. With the introduction of the REBP this option is already available to job losers who are age 51 and older. Thus, we expect that the REBP leads to a program complementarity effect among job losers below age 55, because some unemployed who would have returned to employment under the less generous rules use the REBP as a bridge to a disability pension.

3 Data and Descriptive Evidence

3.1 Data

To examine how extended UI benefits for older workers affect the incidence of and the pathway into early retirement, we combine register data from two different sources. The Austrian Social Security Database (ASSD) provides very detailed longitudinal information on the entire labor market and earnings history of all private-sector workers in Austria (Zweimüller et al., 2009). The second source is the Austrian unemployment register, which contains information on the place of residence (community) and relevant socio-economic characteristics.

Our main sample consists of all male job losers who are between age 50-57 at the beginning of their unemployment spell and who enter unemployment from a job in the non-steel sector between 1/1985 and 12/1987 and between 6/1988 and 12/1995. These spells are followed up until end of 2006. We focus on men because women are already eligible for an old age pension at age 55 (as opposed to age 60 for men), which is also the age for relaxed access to a disability pension. Hence, our empirical design is useful to understand program complementarity and substitution for males but it is less appropriate in the case of females. We exclude unemployment spells starting between 1/1988 and 5/1988 because ongoing spells were also eligible for the REBP. Excluding these spells guarantees that the before-period is not strongly affected by the REBP. We exclude job losers from the steel sector because older steel workers in treated workers may face worse labor market prospects due to the steel crisis. In our observation period 196,364 unemployment spells were started by men in the age group 50-57. From these, we drop 41,130 unemployed men with less than 15 employment years in the past 25 years. Only job seekers who satisfy this criterion are eligible for the REBP.[13] Because the Austrian labor market is characterized by large seasonal employment fluctuations (Del Bono and Weber, 2008), we also exclude 87,920 men who were recalled by their previous employers to eliminate job seekers on temporary layoffs who are not searching for a job. The final sample thus comprises 67,314 unemployment spells.

[13]This contribution requirement also guarantees that job seekers in our sample will be eligible for special income support at age 59 and for an old-age pension at age 60.

Table 2: Sample statistics in treated (TRs) and control regions (CRs) before, during, and after REBP

	Before REBP		During REBP		After REBP	
	CRs	TRs	CRs	TRs	CRs	TRs
Exit destinations (%)						
Early retirement	33.7	41.5	44.1	75.4	47.9	56.8
Disability pension	22.4	29.7	30.2	45.7	33.0	42.1
Old-age pension	9.8	9.8	11.5	26.6	11.7	11.4
Censored	1.5	2.0	2.4	3.2	3.2	3.3
Background characteristics						
Age at UI entry	53.5	53.4	53.3	53.6	53.5	53.5
Sick days	113	117	112	93	97	101
Married	0.752	0.777	0.753	0.807	0.759	0.770
Education						
Low	0.575	0.621	0.495	0.485	0.429	0.455
Medium	0.356	0.336	0.404	0.436	0.443	0.444
High	0.070	0.043	0.101	0.079	0.128	0.101
Daily wage	56.6	54.5	63.7	69.4	68.9	68.2
Blue collar	0.802	0.837	0.726	0.745	0.664	0.719
Experience (years)	11.3	11.3	11.1	11.8	11.2	11.2
Tenure (years)	3.1	3.1	3.6	5.1	4.1	4.3
No. of Obs.	10,677	2,578	24,287	9,049	16,669	4,054

Notes: "Before" denotes unemployment spells starting in January 1985 to December 1987. "During" denotes unemployment spells starting in June 1988 to July 1993 (December 1991 in TR1s). "After" denotes unemployment spells starting in August 1993 (January 1992 in TR1s) to December 1995. "Sick days" is the sum of days spent in sick leave prior to unemployment entry, "experience" denotes work experience in the last 13 years, and "tenure" refers to tenure in last job. Daily wage is adjusted for inflation.

Table 2 presents summary statistics on job losers entering unemployment before (1/1985–12/1987), during (6/1988–7/1993), and after the REBP (7/1993–12/1995) by region of residence. A comparison of exit destinations before, during, and after the REBP illustrates the impact of the program on early retirement behavior of unemployed men. More specifically, before the REBP the probability to retire early is 7.8 percentage points higher in treated regions (41.5%) relative to control regions (33.7%) because job losers in treated regions are more likely to exit unemployment by claiming a disability pension. Here early retirement comprises exits to disability pensions and old-age pensions (including special income support) as well as censored spells. The difference in the probability to retire early increases to 31.3 percentage points during the REBP. The increase in the incidence of early retirement during the REBP is driven by more unemployed men claiming disability and old-age pensions. After the abolishment of the program, the difference in the incidence of early retirement between treated and non-treated regions decreases again to the pre-REBP level. Note also the upward trend in the incidence of early retirement and disability over the whole

period, suggesting that labor market conditions over the observation period deteriorated in treated and non-treated regions.

A comparison of background characteristics shows that job losers in treated regions are more likely to work in blue-collar occupations and tend to be less educated than job losers in control regions. These differences partially explain the higher probability to claim a disability pension in the treated regions before and after the REBP. Table 2 also illustrates that during the REBP the unemployment inflow increases in treated regions relative to control regions. More specifically, the ratio of unemployment spells in treated regions versus non-treated regions is roughly 1 to 4 before the REBP. This ratio increases to approximately 1 to 2.5 during the REBP. Winter-Ebmer (2003) finds that this increase occurs because firms used the REBP to get rid of high-tenured and expensive older workers. This finding is consistent with the statistics in Table 2, given that during the REBP job losers in treated regions earn higher wages and have more tenure compared to job losers in non-treated regions.

3.2 Descriptive Evidence

To graphically assess the impact of extended UI benefits on the incidence of and pathway into early retirement, Figures 3-5 plot the fraction of transitions from unemployment into different exit states by age of UI entry and region of residence before, during, and after the REBP.

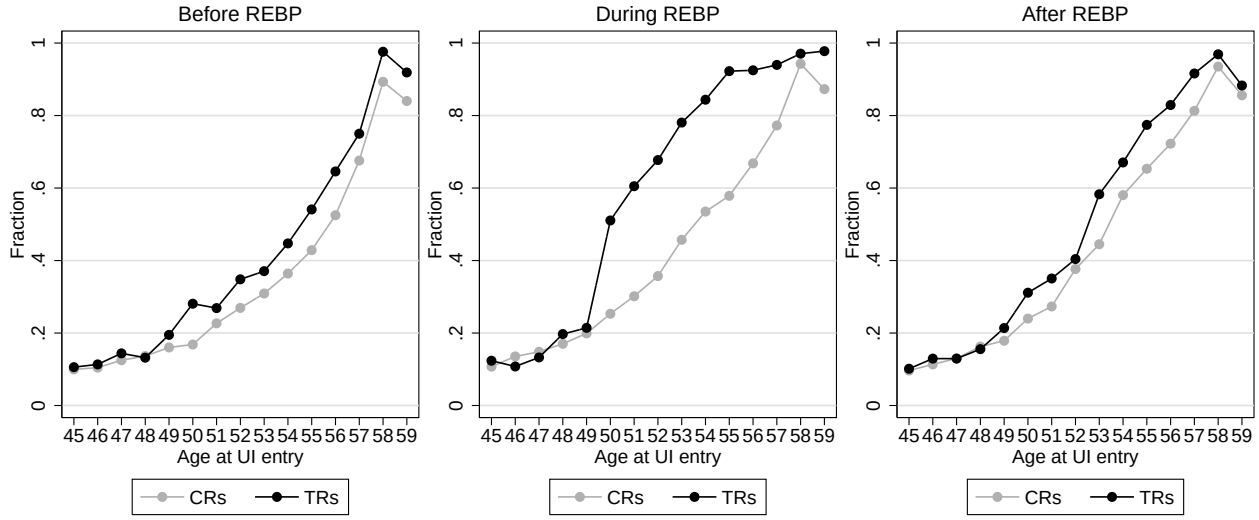

Figure 3: Transitions into early retirement by age in treated (TRs) and control regions (CRs) before, during, and after REBP
Source: Own calculations, based on Austrian Social Security Data.

Figure 3 illustrates that the REBP had a strong effect on the incidence of early retirement among eligible unemployed. More specifically, there is a drastic increase in transitions into early retirement at ages 50-57 in treated regions during the program was in effect. The regional difference in transitions into early retirement during the REBP amounts to almost 30 percentage points for

the age group 50-55 and is somewhat smaller for the age group 56-57. For the age group 58-59 there are only small regional differences during the REBP because unemployed men in this age group can rely on regular unemployment benefits and special income support to retire early. Also for the age group 45-49 there are almost no regional differences in transitions into early retirement, as these individuals are not eligible for the REBP.

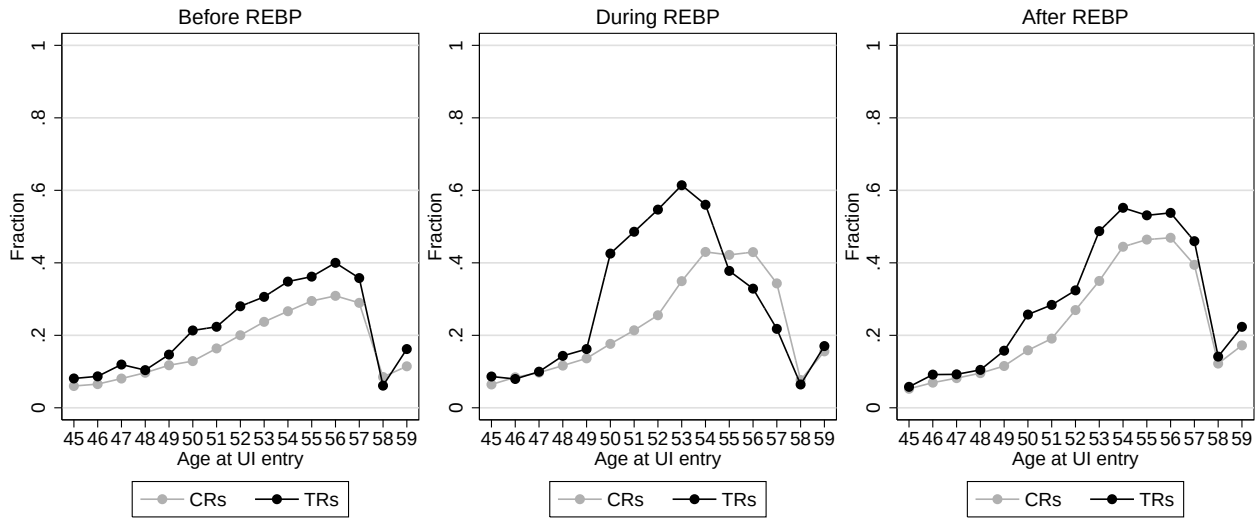

Figure 4: Transitions into disability pensions by age in treated (TRs) and control regions (CRs) before, during, and after REBP
Source: Own calculations, based on Austrian Social Security Data.

Figure 4 shows the corresponding picture for transitions from unemployment into disability pensions. The middle panel of Figure 4 illustrates that the higher incidence of early retirement for the age group 50-54 is driven by an increase in transitions into disability pensions. For this age group the transition rate into disability pensions is around 20 percentage points higher in treated regions compared to control regions during the REBP is in effect. Thus, the increased duration of unemployment benefits during the REBP strengthens the sequential take-up of multiple programs (program complementarity). For the age group 55-57 there is clear evidence for both a program substitution and a program complementarity effect. More specifically, there is a decline in transitions into disability pensions during the REBP in treated regions relative to control regions (program substitution) and, as illustrated in Figure 5, a significant increase in transitions into old-age pensions (program complementarity).

Figures 3 and 4 also show that transitions into early retirement and disability pensions tend to be slightly higher in treated regions after age 50 before the implementation of the program and after its abolishment. These differences are likely to reflect underlying differences in the structure of the workforce between treated and non-treated regions. For example, Table 2 shows that job losers in treated regions work more often in blue-collar occupations and are less educated on average. Both factors are likely to increase the risk of experiencing a career ending disability.

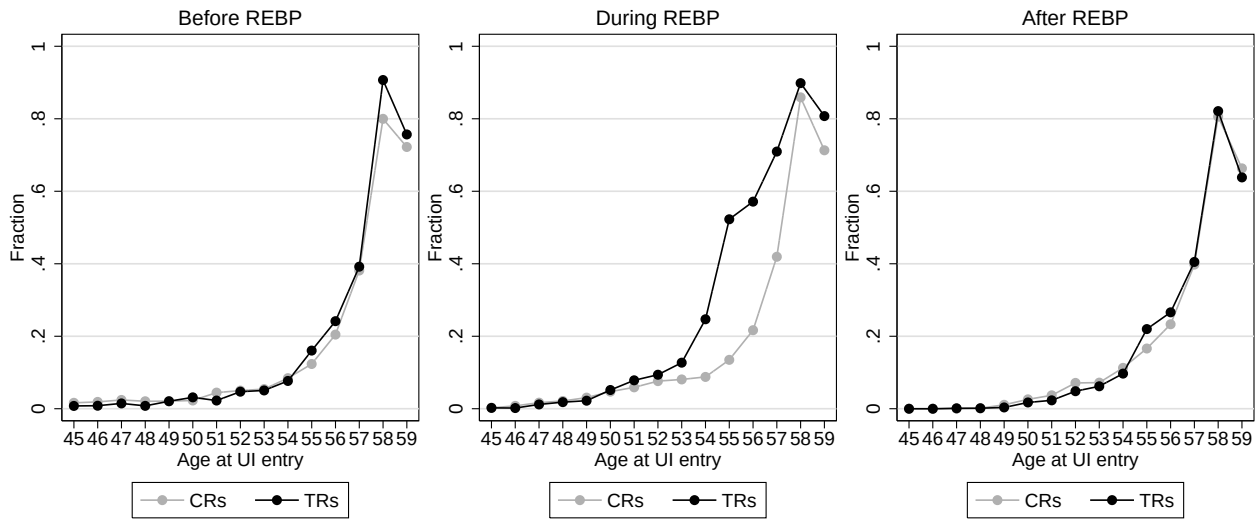

Figure 5: Transitions into old-age pensions by age in treated (TRs) and control regions (CRs) before, during, and after REBP
Source: Own calculations, based on Austrian Social Security Data.

Figure 6 illustrates how transitions into early retirement, disability pensions, and old-age pension for the age groups 50-54 and 55-57 develop over time in treated and non-treated regions. For both age groups there are only small regional differences in transition rates into different exit states before the REBP started. In the second half of 1988, the period when the program started, transitions rates start to diverge. For the age group 50-54 transition rates into early retirement, disability pensions, and (to a smaller extent) old-age pensions increase in REBP-regions relative to non-REBP regions. For the age group 55-57, there is a decline in transitions into disability pensions and a disproportionate increase in transitions into old-age pensions so that overall transitions into early retirement increase. After the second half of 1993, when the program was abolished, the effects of the REBP are reversed and regional differences in transition rates are relatively small again.

In sum, these figures provide evidence that the REBP increased the incidence of early retirement among eligible unemployed. For the age group 50-54 the increase in early retirement is driven by a program complementarity effect: there is an increase in transitions into disability pensions and old-age pensions during the REBP. For the age group 55-57 there is both a program substitution and a program complementarity effect: there is a decline in transitions into disability pensions and an increase in transitions into old-age pensions during the program is in effect.

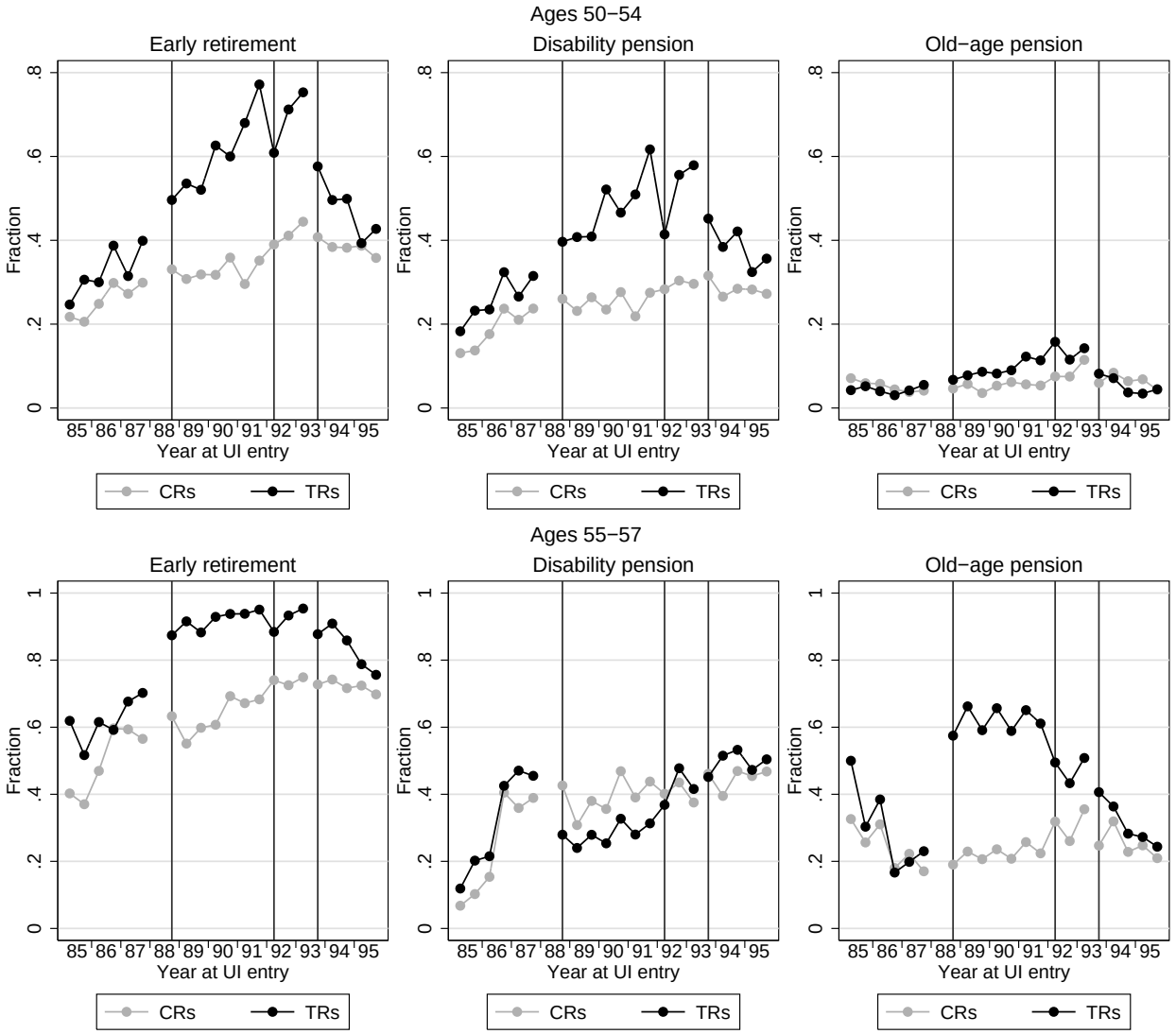

Figure 6: Trends in transitions into early retirement, disability pensions, and old-age pensions in treated (TRs) and control regions (CRs) by year and age group

Source: Own calculations, based on Austrian Social Security Data.

4 Identification Strategy

To estimate the causal effect of extended UI benefits on early retirement, we exploit the quasi-experimental variation in the duration of UI benefits across Austrian regions generated by the REBP. Our identification strategy relies on a difference-in-differences (DD) approach. The first difference is over time, since the program was in effect only from June 1988 to July 1993. The second difference is across geographic areas; only older job seekers living in one of the 28 selected regions were eligible for the benefit extension. Because the REBP was only in effect for a limited period of time, we are able to test whether the policy effects of introducing and abolishing extended UI benefits are symmetric.

A third difference would be age because only unemployed aged 50 or older were eligible for the REBP. However, as Figures 3-5 illustrated, few unemployed workers below age 50 enter early retirement by claiming a disability pension or an old-age pension. A comparison between job losers below and above age 50 would therefore not be very informative to identify the effect of extended UI benefits on transitions from unemployment into early retirement.

The difference-in-differences comparison is implemented by estimating regressions of the following type:

$$y_{it} = \alpha + \beta TR1_i + \gamma TR2_i + \delta D_t + \eta A_t + \pi(D_t \times TR_i) + \mu(A_t \times TR_i) + \lambda_t + X'_{it}\theta + \varepsilon_{it}, \qquad (1)$$

where i denotes individual and t is the start date of the unemployment spell. The outcome variable y_{it} is a dummy, which is equal to 1 if an individual leaves unemployment into the exit state of interest and 0 otherwise. We distinguish between three different types of exits: early retirement, disability pension, and old-age pension. The variables $TR1$ and $TR2$ are dummy variables that indicate whether or not an individual lives in treated region 1 or treated region 2 to control for region-specific differences; TR is an indicator taking the value 1 if an individual lives in a treated region; D is an indicator taking the value 1 if the unemployment spell started after the REBP was in effect (June 1988); and A is an indicator taking the value 1 if the unemployment spell started after the REBP was abolished (January 1992 in TR1s and August 1993 in TR2s). We include year effects (λ_t) to control for macroeconomic conditions and a set of background characteristics (X_{it}) to control for observable differences that might confound the analysis (age fixed effects, marital status, blue-collar status, education, work experience, years of service, sick leave history, last wage, previous industry, and quarter of inflow). To account for the possibility that observations may not be independent within labor market regions, standard errors are clustered within the labor market regions of the Austrian unemployment insurance administration. There are roughly 150 of these regions.

The coefficients of interest in equation (1) are π and μ which measure the effect of the REBP on older job losers in treated regions relative to control regions in the years when the program was in effect relative to before its implementation (π) and in the years after which the program was abolished relative to during the program (μ). Clearly, if the introduction and abolishment of the

REBP have symmetric effects on the outcome variable of interest we have $\pi = -\mu$.

Equation (1) is estimated separately for the age groups 50-54 and 55-57 because the impact of the REBP on early retirement behavior is likely to be very different for both groups. In particular, job losers in the age group 50-54 may use the REBP to bridge the gap until age 55 when conditions for disability classification are relaxed. Job losers in the age group 55-57 can directly apply for a disability pension under the relaxed eligibility criteria, but may use the REBP instead to bridge the gap until age 60 when they become eligible for an old-age pension.

To explore the impact of the policy reform for each age separately, we generalize this identification strategy to an interaction term analysis:

$$\begin{aligned} y_{it} &= \alpha + \sum_{j=50}^{57} \beta_j (d_{ij} \times TR1_i) + \sum_{j=50}^{57} \gamma_j (d_{ij} \times TR2_i) + \sum_{j=50}^{57} \delta_j (d_{ij} \times D_t) + \sum_{j=50}^{57} \eta_j (d_{ij} \times A_t) \\ &\quad + \sum_{j=50}^{57} \pi_j (d_{ij} \times D_t \times TR_i) + \sum_{j=50}^{57} \mu_j (d_{ij} \times A_t \times TR_i) + \lambda_t + X_{it}'\theta + \varepsilon_{it}, \end{aligned} \tag{2}$$

where d_{ij} is a dummy that indicates whether individual i is age j at the start date of the unemployment spell. Each coefficient π_j and μ_j captures all variation in the outcome variable specific to individuals of age j in treated regions (relative to control regions) when the program was in effect (π_j) and after the program was abolished (μ_j), using variation in the duration of unemployment benefits over time.

The central identifying assumption is that trends in the outcome variable in non-treated regions are informative on the counterfactual in the absence of the REBP. This assumption means that there are no omitted time-varying and region-specific effects correlated with the program. There are some doubts on the validity of this assumption, given that the motivation behind the implementation of this policy was to provide a better protection to older unemployed who were previously employed in the steel sector. It therefore seems plausible that the steel crisis caused worse labor market prospects for older steel workers in treated regions during the REBP was in effect. Such an idiosyncratic shock to steel workers in treated regions would violate the identifying assumption. For this reason we limit our sample to job losers who were not previously employed in the steel sector. However, excluding steel workers may still yield biased results if there are spillover effects from the steel sector to non-steel sectors. We run several robustness checks to test for this possibility.

First, the availability of data from several years pre- and post-REBP allow us to examine the importance of spillovers from the steel sector affecting the entire region. In particular, labor market trends in treated and control regions should move in parallel in the absence of negative spillover effects from the steel sector. The graphical analysis from the previous section suggests that labor market trends in treated and non-treated regions are similar given that there are no substantial differences in transition rates from unemployment into other states prior to the inception of the REBP and after its abolishment. To examine the existence of differential trends across regions in more detail, equation (1) is generalized by replacing $(D_t \times TR_i)$ and $(A_t \times TR_i)$ with a full set of

treatment times half-year interaction terms:

$$y_{it} = \alpha + \beta TR1_i + \gamma TR2_i + \delta D_t + \eta A_t + \sum_{j=1985h1}^{1995h2} \pi_j (d_{jt} \times TR_i) + \lambda_t + X'_{it}\theta + \varepsilon_{it}, \qquad (3)$$

where d_{jt} is a dummy that equals 1 if the unemployment spell (t) starts in half-year j and 0 otherwise and λ_t denotes half-year fixed effects. Here, we set TR equal to 0 in $TR1s$ after the reform of the REBP in December 1991. Each coefficient π_t can be interpreted as an estimate of the impact of the policy change in a given half-year on the treatment group relative to the comparison group. The interaction terms provide tests for anticipatory behavior and differential trends. The coefficients π_j should be zero prior to 1988 and after the first half of 1993, if the REBP was an exogenous and unanticipated policy.

As a second robustness test to examine the presence of region-specific labor market shocks we restrict attention in the estimation to unemployed who live no farther than 30 minutes car drive from the border between treated and control regions. The idea is that job losers living close to the border are likely to operate in the same local labor market. Hence, labor market shocks should affect treated and non-treated job losers in the same way. However, this approach is potentially problematic if the REBP affects employment opportunities of job losers living in control regions close to the border due to reduced competition for jobs. Such spillover effects to non-treated workers would violate the assumption that trends in control regions are informative on the counterfactual. To examine whether the REBP had an effect on non-treated job losers we will estimate equation (1) for job losers in the age groups 45-49 and 58-59. Because these individuals were not eligible for the REBP (age group 45-49) or did not need the REBP to retire early (age group 58-59), the estimated coefficients should be zero; any statistical significance would indicate direct spillover effects from treated to non-treated individuals.

As a third robustness test we will estimate equation (1) for a sample of job losers who previously worked in the tradable-goods sector with the exception of industries that are directly linked with the steel sector via the factor market (iron and steel product manufacturing) or via the product market (ore mining). The idea behind this approach is that labor demand prospects in this sector are less influenced by local economic conditions. Hence, potential spillovers effects from the steel sector to non-steel sectors should be less important. Moreover, this approach is less susceptible to externalities of the REBP on non-treated individuals, because treated and non-treated individuals are less likely to operate in the same local labor market.

Another threat to the validity of our identification strategy is the possibility that the more generous unemployment rules lead to selective unemployment inflow. As illustrated in Table 2, the inflow rate into unemployment rises substantially in treated regions relative to control regions during the REBP is in effect. Moreover, during the REBP job losers in treated regions have higher earnings on their last job and more tenure than job losers in control regions. This pattern is consistent with Winter-Ebmer (2003) who finds that the higher inflow is due to firms using the REBP to get rid of high-tenured and expensive older workers. Lalive and Zweimüller (2004a) show that most of the

excess unemployment inflow in treated regions is concentrated in the periods immediately before the reform (December 1991) and the abolishment of the REBP (August 1993). We perform two robustness tests to ascertain that selective inflow does not affect our results. First, we estimate equation (1) excluding all unemployment spells that started in periods of high unemployment inflow (after September 1991). In the second robustness test we additionally exclude job losers with high tenure and high earnings in their last job.

5 Results

5.1 Main Results

The first set of results is summarized in Table 3, with columns 1 through 3 providing the results from equation (1) for the age group 50-54 and the next three columns displaying the analogous results for the age group 45-49. The dependent variable is an indicator, which is equal to 1 if an individual exits unemployment through the state in question and 0 otherwise.

Table 3: Average effect on unemployment exit of age groups 50-54 and 45-49

	Age 50-54			Age 45-49		
	Early retirement	Disability pension	Old-age pension	Early retirement	Disability pension	Old-age pension
REBP introduced	0.170***	0.126***	0.039*	-0.007	-0.008	0.004
($D \times TR$)	(0.022)	(0.028)	(0.022)	(0.012)	(0.011)	(0.004)
REBP abolished	-0.187***	-0.123***	-0.048***	0.006	0.002	0.003
($A \times TR$)	(0.017)	(0.022)	(0.013)	(0.010)	(0.008)	(0.003)
During	0.142***	0.127***	-0.008	0.024**	0.005	-0.022***
(D)	(0.019)	(0.014)	(0.014)	(0.012)	(0.008)	(0.005)
After	-0.008	0.005	-0.017*	-0.008	-0.004	-0.001
(A)	(0.012)	(0.013)	(0.010)	(0.008)	(0.007)	(0.002)
Treated regions 1	0.014	0.025	-0.014	-0.009	0.010	-0.010**
($TR1$)	(0.037)	(0.036)	(0.014)	(0.014)	(0.014)	(0.004)
Treated regions 2	0.081***	0.080***	-0.006	0.003	0.016	-0.008*
($TR2$)	(0.019)	(0.022)	(0.013)	(0.012)	(0.012)	(0.005)
R^2	0.194	0.144	0.084	0.133	0.103	0.011
Mean in TRs pre-REBP	0.336	0.269	0.044	0.079	0.061	0.017
No. of Obs.	48,666	48,666	48,666	63,689	63,689	63,689

Notes: The Table reports coefficients from a linear probability model. Standard errors adjusted for clustering within labor market regions. Controls: marital status, education, last annual wage, unemployment, blue collar status, employment history, tenure in last job, previous industry, age, year and quarter of inflow. Significance levels: *** = 1%, ** = 5%, * = 10%.

The first row shows that the REBP increases the probability of entering early retirement among 50-54 year old job losers in treated regions by 17 percentage points, or 50% of the baseline transition rate into early retirement in the pre-REBP period. This decline is mostly driven by an increase in

transitions into disability pensions of 12.6 percentage points (column 2) and - to a lesser extent - by an increase in transitions into old-age pensions by 3.9 percentage points (column 3). The third row shows that the effects on transitions from unemployment into different exit states are reversed after the program is abolished. The effect on transitions into early retirement is somewhat larger in absolute value, but the difference is statistically not significant.

The next three columns present analogues estimates for the age group 45-49 who were not eligible for the REBP. The point estimates are always small and insignificant. This finding suggests that the REBP had no substantial spillover effects to the labor demand for the age group 45-49 via general equilibrium effects and that labor market prospects of job losers in treated regions and non-treated regions followed similar trends. Table 3 also illustrates that over the period under consideration there is an upward trend in the incidence of early retirement for the age group 50-54 both in treated and non-treated regions. More specifically, among 50-54 year old job losers there is 14.2 percentage point increase in the probability to enter early retirement. The rise in early retirement is due to an increase in transitions into disability pensions. No such increase can be observed for the age group 45-49. This pattern may indicate a general decline in labor market conditions for older workers.

Table 4: Exit to disability pensions for age group 50-54

	Exit age 50-54	Exit Age 55+
REBP introduced	-0.025**	0.151***
($D \times TR$)	(0.011)	(0.026)
REBP abolished	0.013	-0.136***
($A \times TR$)	(0.008)	(0.023)
During	0.038***	0.090***
(D)	(0.010)	(0.013)
After	-0.018**	0.023**
(A)	(0.009)	(0.011)
Treated regions 1	0.013	0.012
($TR1$)	(0.017)	(0.024)
Treated regions 2	0.026**	0.054***
($TR2$)	(0.013)	(0.017)
R^2	0.035	0.155
Mean in TRs pre-REBP	0.100	0.169
No. of Obs.	48,666	48,666

Notes: The Table reports coefficients from a linear probability model. Standard errors adjusted for clustering within labor market regions. Controls: marital status, education, last annual wage, unemployment, blue collar status, employment history, tenure in last job, previous industry, and quarter of inflow. Significance levels: *** = 1%, ** = 5%, * = 10%.

The increased inflow into DI by 50-54 year old unemployed in treated regions should occur after age 55, because eligibility criteria for a disability pension are very strict before age 55. To investigate how the REBP affects the claiming age of a disability pension, we estimate two versions

of equation (1). In the first version the dependent variable is an indicator taking the value 1 if a 50-54 year old job loser claims a disability pension before age 55. In the second version the dependent variable is an indicator taking the value 1 if a 50-54 year old job loser claims a disability pension after age 55. The first column of Table 4 shows that the probability to claim a disability pension before age 55 declines by 2.5 percentage points during the REBP and increases by 1.3 percentage points after the REBP. As illustrated in the second column, the REBP has a large impact on the claiming of a disability pension after age 55. More specifically, the probability to enter DI after age 55 increases by 15.1 percentage points during the REBP and decreases by 13.6 percentage points after the REBP. These results are consistent with the claim that 50-54 year old job losers use the REBP to bridge the gap until age 55 when eligibility criteria for a disability pension are relaxed.

Table 5: Average effect on unemployment exit of age groups 55-57 and 58-59

	Age 55-57			Age 58-59		
	Early retirement	Disability pension	Old-age pension	Early retirement	Disability pension	Old-age pension
REBP introduced	0.108***	-0.127***	0.231***	-0.017	0.001	-0.019
$(D \times TR)$	(0.029)	(0.046)	(0.042)	(0.012)	(0.015)	(0.021)
REBP abolished	-0.101***	0.134***	-0.240***	-0.018	0.038*	-0.055**
$(A \times TR)$	(0.019)	(0.022)	(0.023)	(0.013)	(0.023)	(0.028)
During	0.242***	0.377***	-0.146***	0.452***	0.199***	0.237***
(D)	(0.054)	(0.035)	(0.048)	(0.079)	(0.029)	(0.074)
After	0.025	0.000	0.020	-0.004	-0.010	0.008
(A)	(0.018)	(0.023)	(0.025)	(0.014)	(0.015)	(0.019)
Treated regions 1	0.071**	0.065	0.009	0.061***	-0.050*	0.112***
$(TR1)$	(0.031)	(0.056)	(0.052)	(0.020)	(0.026)	(0.034)
Treated regions 2	0.094***	0.048	0.046	0.045***	-0.001	0.046
$(TR2)$	(0.030)	(0.042)	(0.039)	(0.014)	(0.020)	(0.028)
R^2	0.204	0.079	0.250	0.141	0.087	0.169
Mean in TRs pre-REBP	0.632	0.374	0.249	0.971	0.070	0.893
No. of Obs.	18,648	18,648	18,648	11,501	11,501	11,501

Notes: The Table reports coefficients from a linear probability model. Standard errors adjusted for clustering within labor market regions. Controls: marital status, education, last annual wage, unemployment, blue collar status, employment history, tenure in last job, previous industry, age, year and quarter of inflow. Significance levels: *** = 1%, ** = 5%, * = 10%.

Table 5 presents estimates of equation (1) for the age group 55-57 (columns 1 to 3) and the age group 58-59 (columns 4 to 6). The first row indicates that the introduction of the REBP led to an increase in transitions from unemployment to early retirement of 10.8 percentage points among the treated individuals aged 55-57. There is also clear evidence for a program substitution effect: in the years the program was in effect older job seekers are significantly less likely to enter the DI program and more likely to use the REBP as a bridge to an old-age pension. More specifically, during the REBP there is a decline in transitions into disability pensions of 12.7 percentage points and an

increase in transitions into old-age pensions of 23.1 percentage points. Similar to unemployed men in the age group 50-54, there is a clear reversal in the effects on early retirement behavior after the program was abolished, as shown in the third row. Columns 4 to 6 present analogous estimates for the age group 58-59. The point estimates are mostly insignificant, which is consistent with the proposition that for this age group the REBP had no impact on the set of available pathways to early retirement.

In the estimates presented in Tables 3 to 5, the variables to correct for differences in observable characteristics between treated and non-treated regions enter in a linear way. However, if the impact of the policy is heterogeneous with respect to observable characteristics, it is important to control for relevant observable characteristics in a very flexible way. The linear specification may not be sufficient to capture the influence of covariates. To allow for more flexibility, we follow Blundell et al. (2004) and match on two propensity scores to estimate the effects of the introduction of the REBP. These propensity scores balance the distribution of observable characteristics in the treated and non-treated regions before and during the REBP. A similar matching method can be applied to estimate the effects of the abolishment of the REBP. We estimate the propensity score with a probit model and use radius matching with a radius of 0.02. Estimates of the matching difference-in-differences approach are reported in Table 6. The first three columns show that for the age group 50-54 the estimates are very similar as the OLS estimates reported in Table 3. For the age group 55-57 we find similar effects for the abolishment of the REBP as in Table 5 and a somewhat larger program substitution effect during the REBP. Overall, these results suggest that the linear model corrects well for regional differences in observable characteristics.

Table 6: Difference-in-differences matching

	Age 50-54			Age 55-57		
	Early retirement	Disability pension	Old-age pension	Early retirement	Disability pension	Old-age pension
REBP introduced	0.165***	0.128***	0.031**	0.113***	-0.186***	0.284***
	(0.021)	(0.020)	(0.013)	(0.023)	(0.038)	(0.038)
REBP abolished	-0.166***	-0.102***	-0.044***	-0.112***	0.115***	-0.233***
	(0.012)	(0.013)	(0.007)	(0.017)	(0.023)	(0.021)

Notes: Estimation based on the approach by Blundell et al. (2004). Radius matching with a radius of 0.02. Propensity score estimated with a probit model. Controls: marital status, education, last annual wage, unemployment, blue collar status, employment history, tenure in last job, previous industry, age, and quarter of inflow. Significance levels: *** = 1%, ** = 5%, * = 10%.

To further explore the impact of the introduction and abolishment of the REBP, Figure 7 plots the estimated coefficients of the interaction terms from equation (2) for each age j separately. Each dot on the solid lines is an indicator for living in a treated region and being a given age during the REBP (black line) and after the REBP (gray line). A 95-percent confidence interval is shown by dotted lines.

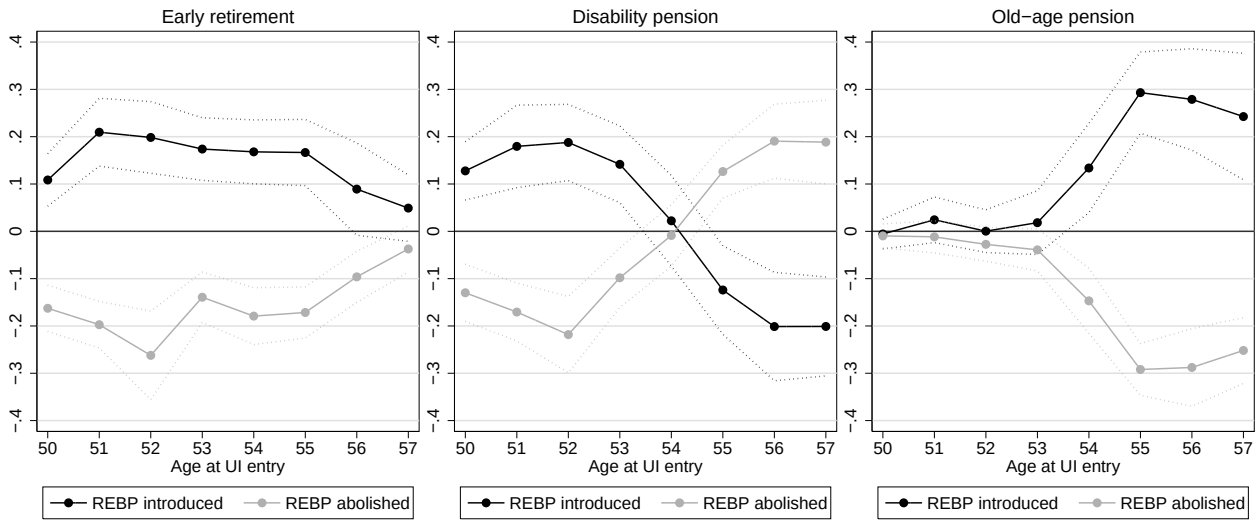

Figure 7: Coefficients of the interactions ($d_{ij} \times D_t \times TR_i$) and ($d_{ij} \times A_t \times TR_i$) in equation (2) for transitions into early retirement, disability pensions, and old-age pensions. The dotted lines represent 95-percent confidence interval.
Source: Own calculations, based on Austrian Social Security Data.

As shown in the first panel, coefficients for entering early retirement are positive for all ages during the REBP is in effect. The point estimate at age 50 amounts to approximately 10 percentage points and increases to around 20 percentage points for the ages 51 to 55. The effect is not so strong for 50 year olds because in addition to the REBP these individuals need to draw one year of unemployment assistance, which is lower than regular unemployment benefits, to bridge the gap until the age for relaxed access to a disability pension. The point estimates decline at ages 56 and 57 because these job losers are relatively close to age 59 when they become eligible for special income support. Hence, many of these job losers permanently retire even without the REBP. As the gray line illustrates, the impact of extended unemployment benefits on the incidence of early retirement is reversed after the program is abolished.

The black line in the middle panel shows that for job losers below age 54 in treated regions there is a significant increase in transitions from unemployment to disability pension of almost 20 percentage points. The point estimate for age 54 is insignificant because 54 year old job losers in non-treated regions can also bridge the time until age 55 with the regular duration of UI benefits of one year. With the abolishment of the REBP excess DI entry in the age group 50-53 is reversed, as shown by the gray line.

For unemployed workers in the age group 55-57, estimated coefficients for entering disability are negative, providing evidence for a program substitution effect. More specifically, with the introduction of the REBP, the exit channel into an old-age pension became financially more attractive relative to claiming a disability pension. The estimated decline during the REBP is large and amounts from 12 to 20 percentage points. Consistent with this view, for unemployed men above age 55 transitions into old-age pensions increase by almost 30 percentage points during the REBP

is in effect, as illustrated in the third panel. There is also a significant increase in transitions into old-age pensions for 54 year old job losers, even though these individuals need to rely on one year of unemployment assistance to bridge the time until age 60 when they become eligible for an old-age pension. Finally, the gray line in the third subfigure highlights that after the abolishment of the REBP the effects on transitions into old-age pensions are reversed for all ages.

5.2 Policy Endogeneity

The key assumption of our identification strategy is that trends in transitions from unemployment into different exit states would be the same in treated and non-treated regions in the absence of the REBP. This assumption rules out differential trends that existed already prior to the REBP as well as idiosyncratic shocks to treated and non-treated regions.

The availability of several years of data before and after the REBP allows us to investigate to what extent trends differ across regions. More specifically, Figure 8 plots the estimated coefficients of the interaction terms (equation (3)) for the age groups 50-54 and 55-57 over the full sample period 1985 to 1995. Each dot on the solid line is the coefficient of the interaction between an indicator variable for half-year and living in a treated region (a 95-percent confidence interval is shown by dotted lines). In all six panels the estimated coefficients fluctuate around 0 before the REBP (June 1988) and after its complete abolishment (July 1993), providing evidence that the empirical strategy is not simply picking up long-run trends in differences between treated and non-treated regions. As shown in the top left and bottom left panels, coefficients for early retirement turn significantly positive during the REBP. For the age group 50-54 the effect increases over time, except for a sharp drop after the REBP was abolished in TR1s (January 1992). For the age group 55-57 the estimated increase declines over time. The raise in early retirement in the age group 50-54 is driven by a large increase in transitions into disability pensions and, to a lesser extent, transitions into old-age pensions (top right panel). The bottom middle and the bottom right panel indicate that for the age group 55-57 there is a decline in transitions into disability pensions and a large increase in transitions into old-age pensions during the REBP.

Table 7 presents OLS estimates of equation (1) for job losers who live no farther than a 30 minutes car drive from the border between treated and control regions. Labor market conditions should be quite similar within this tightly defined geographical area. Thus, spillovers from the problems in the steel sector in non-treated regions close to the border should be as important as in treated regions close to the border.

The first row shows that among unemployed in the age group 50-54 there is a 16.7 percentage point increase in early retirement during the REBP. This estimate is almost identical to the estimate for the full sample reported in Table 3 (17 percentage points). As the second (third) column illustrates, the increase in transitions into disability pensions (old-age pensions) is roughly 3 percentage points smaller (larger) than the estimate for the full sample of 50-54 year old job losers, but the difference is statistically not significant. Similarly, the third row shows that the effects of the abolishment of the REBP for 50-54 year old losers living close to the border are quantitatively

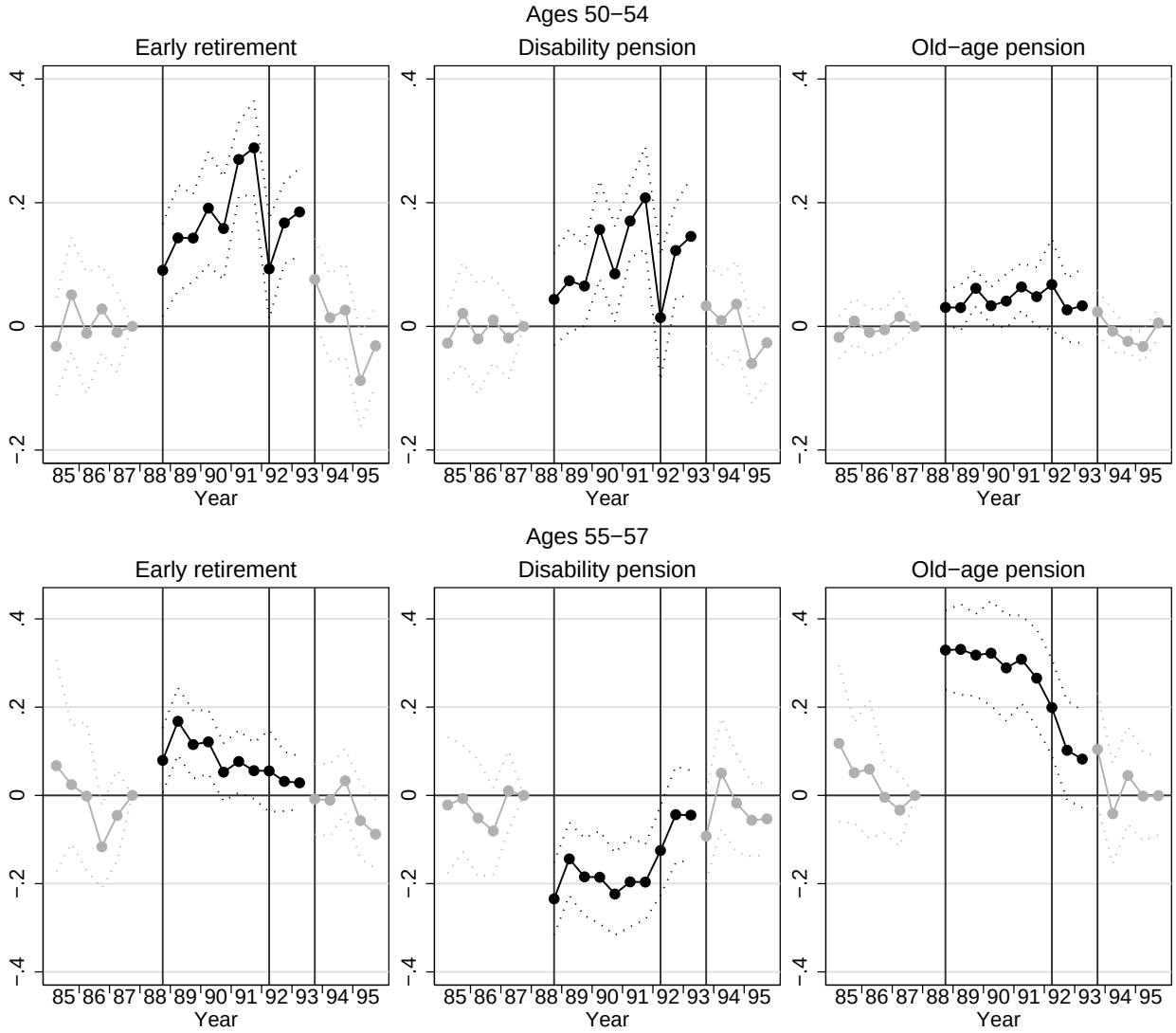

Figure 8: Coefficients of the interactions ($d_{jt} \times TR_i$) in equation (3) for transitions into early retirement, disability pensions, and old-age pensions by age group. The dotted lines represent 95-percent confidence interval.

Source: Own calculations, based on Austrian Social Security Data.

similar to the estimates for the full sample.

Turning to the results for the age group 55-57 (columns 4-6), we find that transitions into early retirement increase by 8.4 percentage points during the REBP and decrease by 8.2 percentage points after the REBP. These estimates are around 2 percentage points below the estimates for the full sample, as reported in Table 5. Similarly, as column 6 illustrates, the estimates for transitions to old-age pensions are around 2-3 percentage points below the estimates for the full sample. However, these differences are statistically not significant. These results suggest that spillover effects are quantitatively small for both groups.

Table 7: Effects for unemployed who live within 30 minutes driving time to the border

	Age 50-54			Age 55-57		
	Early retirement	Disability pension	Old-age pension	Early retirement	Disability pension	Old-age pension
REBP introduced	0.167***	0.099**	0.066***	0.084**	-0.131**	0.203***
($D \times TR$)	(0.032)	(0.046)	(0.024)	(0.032)	(0.058)	(0.048)
REBP abolished	-0.176***	-0.116***	-0.058***	-0.082***	0.140***	-0.220***
($A \times TR$)	(0.026)	(0.032)	(0.014)	(0.022)	(0.030)	(0.026)
During	0.121***	0.114***	-0.015	0.333***	0.465***	-0.129
(D)	(0.035)	(0.037)	(0.019)	(0.047)	(0.083)	(0.079)
After	0.019	0.029	-0.010	0.029	0.000	0.019
(A)	(0.025)	(0.025)	(0.013)	(0.035)	(0.054)	(0.054)
Treated regions 1	-0.012	-0.007	-0.008	0.051	0.012	0.039
($TR1$)	(0.041)	(0.037)	(0.014)	(0.035)	(0.050)	(0.048)
Treated regions 2	0.056**	0.054	-0.006	0.092***	0.032	0.065
($TR2$)	(0.028)	(0.032)	(0.015)	(0.032)	(0.061)	(0.051)
R^2	0.215	0.142	0.088	0.230	0.095	0.269
Mean in TRs pre-REBP	0.317	0.253	0.039	0.599	0.347	0.242
No. of Obs.	12,057	12,057	12,057	4,953	4,953	4,953

Notes: The Table reports coefficients from a linear probability model. Standard errors adjusted for clustering within labor market regions. Controls: marital status, education, last annual wage, unemployment, blue collar status, employment history, tenure in last job, previous industry, age, year and quarter of inflow. Significance levels: *** = 1%, ** = 5%, * = 10%.

As an additional robustness check we replicate our findings for job losers whose last job was in the tradable goods sector with the exception of industries that are directly linked with the steel sector via the factor market (iron and steel product manufacturing) or via the product market (ore mining). The idea behind this approach is that labor demand prospects in the tradable-goods sector are less dependent on local economic conditions. Hence, the estimates should be less afflicted by sectoral spillover effects and by spillover effects from treated to non-treated individuals via changes in local labor demand due to the REBP. OLS estimates of equation (1) for job losers who previously worked in the tradable goods sector are shown in Table 8. The estimates are quantitatively very similar to the estimates for the full sample reported in Tables 3 and 5. The only exception is the

estimated impact of the REBP on transitions into early retirement for the age group 55-57 which is significantly lower (at the 10%-level) than the corresponding estimate for the full sample.

Table 8: Effects for unemployed whose last job was in the tradable goods sector

	Age 50-54			Age 55-57		
	Early retirement	Disability pension	Old-age pension	Early retirement	Disability pension	Old-age pension
REBP introduced	0.170***	0.135***	0.031	0.070**	-0.148***	0.220***
$(D \times TR)$	(0.028)	(0.032)	(0.025)	(0.034)	(0.049)	(0.047)
REBP abolished	-0.193***	-0.132***	-0.038***	-0.113***	0.134***	-0.248***
$(A \times TR)$	(0.028)	(0.014)	(0.016)	(0.020)	(0.032)	(0.035)
During	0.144***	0.110***	0.004	0.212***	0.364***	-0.165**
(D)	(0.030)	(0.022)	(0.023)	(0.055)	(0.046)	(0.064)
After	-0.022	0.019	-0.037**	0.028	0.011	0.015
(A)	(0.019)	(0.020)	(0.015)	(0.022)	(0.033)	(0.034)
Treated regions 1	-0.001	0.008	-0.013	0.089**	0.068	0.024
$(TR1)$	(0.040)	(0.042)	(0.018)	(0.036)	(0.077)	(0.069)
Treated regions 2	0.087***	0.088***	-0.009	0.113***	0.074*	0.038
$(TR2)$	(0.026)	(0.027)	(0.018)	(0.035)	(0.044)	(0.044)
R^2	0.211	0.162	0.100	0.225	0.089	0.223
Mean in TRs pre-REBP	0.373	0.291	0.058	0.715	0.396	0.309
No. of Obs.	24,681	24,681	24,681	9,604	9,604	9,604

Notes: The Table reports coefficients from a linear probability model. Standard errors adjusted for clustering within labor market regions. Controls: marital status, education, last annual wage, unemployment, blue collar status, employment history, tenure in last job, previous industry, age, year and quarter of inflow. Significance levels: *** = 1%, ** = 5%, * = 10%.

5.3 Unemployment Inflow

The descriptive statistics in Table 2 indicate a higher inflow of unemployed in treated regions during the REBP. To examine the impact of the REBP on unemployment inflow in more detail, Figure 9 plots the quarterly unemployment inflow relative to the total unemployment inflow between 1985 and 1995 in CRs and TRs. There are no particular regional differences in inflow rates before the REBP starts. Regional UI inflow rates are also similar during the period the program was in effect except for the quarter just before the REBP was abolished in TR1s. In this quarter the inflow rate in treated regions is roughly twice as large as the inflow rate in non-treated regions. Similarly, the inflow rate in treated regions rises substantially in the three quarters before the abolishment of the REBP (August 1993).

A potential concern for our analysis is that the composition of the excess inflow in REBP regions is affected by the eligibility status for the program. The increase in unemployment inflow could either occur because firms are more likely to lay off workers that are eligible for the REBP or because workers voluntary quit to retire early via the REBP. Winter-Ebmer (2003) finds that

the increase in unemployment entry is not driven by voluntary quits but by layoffs by firms who want to get rid of high-tenured and expensive older workers. To ascertain that selective firing does not affect our results, we first replicate our findings for job losers who start an unemployment spell before October 1991. The estimates for this sample should be less affected by selective inflow because during this period there are only small regional differences in unemployment inflow rates, as shown in Figure 9. In a second robustness check, we additionally exclude job losers whose tenure or wage in the last job is above the 75th percentile of the tenure or wage distribution.

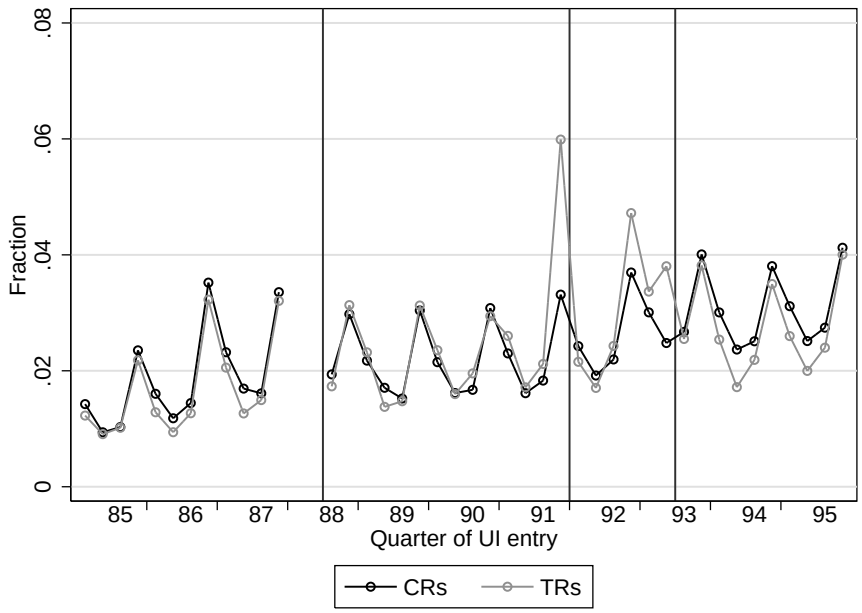

Figure 9: Quarterly UI inflow relative to total UI inflow between 01/1985 and 12/1995 in treated (TRs) and control regions (CRs)
Source: Own calculations, based on Austrian Social Security Data.

The estimates of these two robustness tests are reported in Table 9. Columns 1-3 of Panel A indicate that the introduction of the REBP had quantitatively similar effects for 50-54 year old job losers who started an unemployment spell before October 1991 as for the full sample. The estimates are 1-2 percentage points smaller if we additionally exclude high-tenure and high-wage individuals (columns 1-3 of Panel B), but they are not significantly different from the estimates for the full sample reported in Table 3. For the age group 55-57 there is an increase in transitions into early retirement of 11.5 percentage points during the REBP (column 4 of Panel A), which is almost identical to the estimate for the full sample (column 1 of Table 5). However, the decline in exits to disability pensions and the increase in exits to old-age pensions (columns 5 and 6 of Panel A) are roughly 5 percentage points larger than the corresponding estimates for the full sample. These differences appears to be driven by job losers with high tenure or high earnings on the previous job given that excluding unemployed whose previous job tenure or wage is above the 75th percentile of the tenure or wage distribution yields estimates that are not significantly different from those for

the full sample (Columns 4-6 of Panel B). In sum, these findings suggest that our estimates are not affected by selective unemployment inflow.

Table 9: Effects for unemployed entering before 10/1991

	Age 50-54			Age 55-57		
	Early retirement	Disability pension	Old-age pension	Early retirement	Disability pension	Old-age pension
A. inflow prior to 10/1991						
REBP introduced	0.164***	0.113***	0.041**	0.115***	-0.170***	0.285***
$(D \times TR)$	(0.020)	(0.022)	(0.017)	(0.030)	(0.046)	(0.039)
R^2	0.174	0.136	0.053	0.227	0.079	0.297
Mean in TRs pre-REBP	0.336	0.269	0.044	0.632	0.374	0.249
No. of Obs.	22,161	22,161	22,161	8,911	8,911	8,911
B. only low tenure/wage						
REBP introduced	0.143***	0.104***	0.031**	0.128***	-0.125***	0.245***
$(D \times TR)$	(0.022)	(0.022)	(0.014)	(0.036)	(0.043)	(0.041)
R^2	0.146	0.113	0.040	0.199	0.084	0.248
Mean in TRs pre-REBP	0.303	0.239	0.034	0.584	0.359	0.217
No. of Obs.	12,966	12,966	12,966	5,173	5,173	5,173

Notes: The Table reports coefficients from a linear probability model. Standard errors adjusted for clustering within labor market regions. Controls: marital status, education, last annual wage, unemployment, blue collar status, employment history, tenure in last job, previous industry, age, year and quarter of inflow. Significance levels: *** = 1%, ** = 5%, * = 10%.

6 Social Welfare Analysis

In this section we use our above results to shed light on the welfare implications of extended UI benefits provided by the REBP. More specifically, we ask whether the benefits provided by the REBP – the eased access to early retirement in the case of job loss – justified the costs of the REBP to the taxpayer. We build on the sufficient statistics approach developed by Chetty (2006a) building on the work of Baily (1978). We develop our argument in three steps. In a first step, we set up a simple model of early retirement featuring program complementarity and program substitution effects. In a second step, we use this model and derive an extended Baily-Chetty formula accounting for multiple retirement pathways. This formula allows us to (locally) evaluate the welfare effects of providing unemployment benefits as an early retirement program. In a third part we undertake a calibration exercise that feeds our empirical estimates together with the changes of institutional environment generated by the REBP into the model.

6.1 Modeling the Early Retirement Decision

Consider the early retirement decision of an older worker. Assuming there is no possibility for self-insurance, the worker has no savings and has to rely of current earnings or public benefits to finance current consumption. The worker's remaining lifetime consists of (at most) three periods

$t = 0, 1, 2$. Periods 0 and 1 have length 1 and period 2 has length T.[14] In $t = 0$ and $t = 1$ the worker can still work on the labor market. In $t = 2$ the worker is retired and draws an old-age pension. To keep things simple (and in the spirit of our empirical analysis) we assume that, during periods $t = 0$ and $t = 1$, the worker can be in only one of three states: UI, DI, or working. Within-period durations are either 0 or 1, i.e. varying within-period durations are ignored. When losing the job, the worker either goes back to work immediately or retires early. At $t = 2$ the worker retires and draws a regular old-age pension.

Displacement at $t = 1$. Consider a worker who gets displaced at the beginning of $t = 1$. If the worker goes back to work in $t = 1$ he generates income w. However, in order to find a job, a search cost θ_1 has to be incurred. We think of θ_1 as cost and effort of job search as well as the cost to the worker of adjusting to a new work environment. θ_1 is a random variable drawn from a continuous distribution function $F(\theta)$. Alternatively, the worker may retire early at $t = 1$. Early retirement through the DI system yields a benefit d. Claiming a disability pension is associated with utility costs κ reflecting the hassle of a medical check and other bureaucratic obstacles, or stigma-costs associated with DI status. Early retirement through the UI system yields a benefit b (any costs associated with claiming UI benefits are normalized to zero).[15]

In $t = 2$ the worker draws an old-age pension p^W if entering from employment, p^D if entering from the DI system, and p^U if entering from the UI system. Assuming that workers do not save and ignoring discounting, the lifetime utilities from going back to work, $W_1 - \theta_1$, retiring early by claiming a disability pension, D_1, and retiring early by claiming UI benefits, U_1, are given by

$$W_1 - \theta_1 = u(w) - \theta_1 + Tu(p^W), \quad D_1 = u(d) - \kappa + Tu(p^D), \quad U_1 = u(b) + Tu(p^U).$$

To make progress, we assume the welfare benefits d, p^D, p^U and p^W are related to each other in ways that capture the Austrian welfare benefit system. According to the Austrian rules outlined in Section 2, workers entering regular retirement directly from DI get an old-age pension equal to the previous disability pension in period 1, $p^D = d$. In contrast, unemployed and employed workers' old-age pension equals the (potential) disability pension in $t = 1$, augmented by some factor $\alpha > 1$, or $p^W = p^U = \alpha d$.[16] Given these rules, heterogeneity in disability pensions and old-age pensions is captured by the parameter d.

[14] Period $t = 0$ can be associated with ages 50-54, period $t = 1$ with ages 55-59, and period $t = 2$ with ages 60+. This captures the early retirement incentives of the Austrian system: extended UI benefits of the REBP become available at age 50; relaxed access to disability pensions at age 55, and regular old-age pensions at age 60.

[15] We think of the UI benefit b as the UI transfer when staying unemployed throughout one period. b is a weighted average UI benefits b^u and UI assistance with $b = \tau b^u + (1-\tau)b^a$. We think of τ as the maximum duration of regular UI benefits b^u. Eligibility to the REBP is associated with an increase of in τ from 0.2 (1 year of the 5-year period) to 0.8 (4 years of a 5-year period).

[16] As outlined in Section 2, the pension p_{t+1} is given by the assessment basis $\hat{\omega}_{t+1}$ times the pension coefficient a_{t+1}. Assuming that the assessment basis remains constant $\hat{\omega}_{t+1} = \hat{\omega}_t$, we obtain $p_{t+1} = p_t\alpha$ with $\alpha = a_{t+1}/a_t$. Notice that we have assumed $p^W = p^U$. This is justified as long as the assessment basis remains constant, because periods of unemployment and periods of unemployment affect the pension coefficient in the same way. Employment and unemployment periods are both counted as insurance years. We will calibrate α such that empirical moments are matched.

Lemma 1. *(i) The worker will claim a disability pension rather than UI benefits if* $d \geq \hat{d}$*, where* $\hat{d}$ satisfies $u(b) = u(\hat{d}) - T(u(\alpha\hat{d}) - u(\hat{d})) - \kappa$*. (ii) The worker will retire early rather than go back to work, if* $\theta_1 \geq \hat{\theta}_1$*, where* $\hat{\theta}_1 = u(\omega) - u(b)$ *if* $d < \hat{d}$ *and* $\hat{\theta}_1(d) = u(\omega) - u(d) + T(u(\alpha d) - u(d)) + \kappa$ *if* $d \geq \hat{d}$*.* Moreover, $\partial\hat{\theta}_1/\partial d \leq 0$ if $1 - (\alpha - 1)T \geq 0$.

Figure 10 illustrates individuals' optimal choices in $t = 1$ given their location in (θ_1, d) space. The threshold $\hat{d}$ says that individuals choose an early retirement path through the UI system when a disability pension falls short of the critical value $\hat{d}$. This reflects part (i) of the Lemma. The threshold $\hat{\theta}_1$ is flat for $d < \hat{d}$, and decreases in d for $d \geq \hat{d}$. At low values of d, early retirement occurs through the UI system rather than the DI system, hence the level of the disability pension is irrelevant for the early retirement decision. However, at high values of d, early retirement occurs via the DI system and individuals with a higher disability pension are more likely to retire early. This reflects part (ii) of the Lemma.[17]

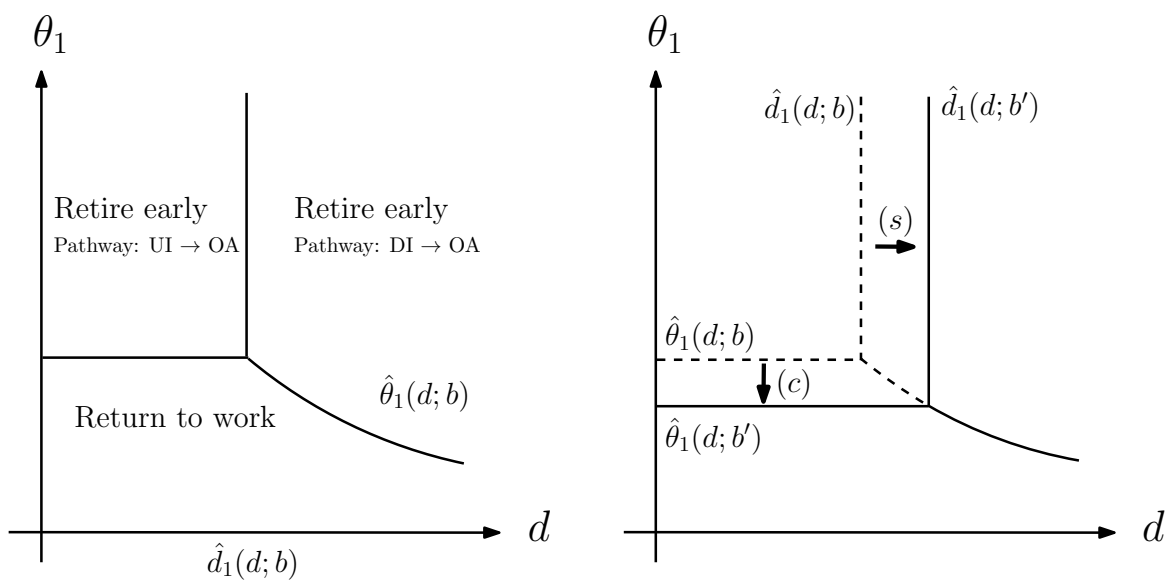

Figure 10: Left panel: early retirement thresholds in $t = 1$. Right panel: program complementarity effects (c) as well as program substitution effects (s) when unemployment benefits increase from b to b'.

How do incentives change when UI benefits become more generous? It is straightforward to see from the above Lemma that the $\hat{d}$-threshold shifts to the right. This reflects the program substitution effect: early retirees use the DI system under less generous UI rules but take up UI benefits under more generous UI rules. Moreover, the $\hat{\theta}_1$-threshold shifts down. This reflects the program complementarity effect of higher UI benefits: individuals go back to work under the less generous UI system, but use UI benefits as a bridge to an old-age pension under more generous UI benefits. This leads to the following proposition.

[17] A sufficient condition for a negative slope is $1-(\alpha-1)T \geq 0$ or, equivalently, $(p^W - p^D)T \leq d$. Future gains from postponing retirement $(p^W - p^D)T$ are lower than current gains from DI take-up d. Delaying retirement is unfair at the margin. This is the relevant case under Austrian disability and old-age pension rules (Hofer and Koman, 2006).

Proposition 1. *Consider workers who get displaced in period $t = 1$. More generous UI benefits increase early retirement due to the program complementarity effect. More generous UI benefits increase the UI rather than the DI pathway due to the program substitution effect.*

Displacement at $t = 0$. Now consider a worker who gets displaced at the beginning of period $t = 0$. For such an individual, there are two options. *First,* the worker may choose early retirement in $t = 0$. We assume that this requires a sequential take-up of different welfare programs: UI benefits b in $t = 0$ and a disability pension d in $t = 1$.[18] In $t = 2$ the workers gets an old-age pension $p^D = d$.

The *second* option for the worker is returning to work in $t = 0$. Going back to work yields utility $u(w)$ but is associated with a search cost θ_0 that has to be incurred at the beginning of $t = 0$. Like before, we assume that θ_0 is a random draw from the distribution function $F(\theta)$. Provided θ_0 is low enough, the worker will go back to work. In $t = 1$ the workers keeps his job with probability $1 - q$ and is fired with probability q. We abstract from selective firing, hence q is the same for all workers. If the worker keeps his job, he earns a wage w also in $t = 1$ without having to bear search costs. If fired, the worker faces exactly the same decision problem as described in "Displacement at $t = 1$". We assume that the search costs after displacement at the beginning of $t = 1$, θ_1, are independently drawn from the same distribution $F(\theta)$ as the search costs after displacement at the beginning of $t = 0$, θ_0.[19] In $t = 2$ the worker draws an old-age pension that depends on employment or benefit-status in $t = 1$, with $p^D = d$ and $p^W = p^U = \alpha d > d$.

In sum, the lifetime utilities at $t = 0$ from going back to work, $W_0 - \theta_0$, and from retiring early, R_0, can be written as:

$$W_0 - \theta_0 = u(w) - \theta_0 + q\mathrm{E}_\theta V_1 + (1 - q)W_1, \quad R_0 = u(b) + (1 + T)u(d) - \kappa,$$

where $\mathrm{E}_\theta V_1 \equiv \int \max(W_1 - \theta, D_1, U_1)dF(\theta)$ is the expected utility when losing the job in $t = 1$. Let us consider the worker's optimal choice in $t = 0$, focusing on heterogeneity in the variables θ_0 and d. We denote by $\hat{\theta}_0(d)$ the critical level of θ that keeps the worker indifferent between retirement early and going back to work.

Lemma 2. *The worker will retire early if $\theta_0 \geq \hat{\theta}_0(d)$, and will go back to work otherwise. When $1 - (\alpha - 1)\,T \geq 0$, we have $\partial\hat{\theta}_0/\partial d \leq 0$.*

[18] We rule out an early retirement path where the individual draws either a disability pension or UI benefits in both periods. We rule out a disability pension in both periods because, under Austrian rules, the DI program as an early-retirement scheme ("relaxed access to disability") is only available at $t = 1$ but not at $t = 0$. We rule out drawing UI benefits in both periods because regular UI benefits have limited duration. While UI assistance is unlimited, benefits are lower and means-tested, and hence dominated by drawing a disability pension in the second period. Finally, we assume a worker's human capital fully depreciates if he is not working at all in $t = 0$. Hence careers where individuals fully exhaust UI in $t = 0$ and then go back to work in $t = 1$ are ruled out.

[19] This implies that average search costs for worker fired in $t = 1$ are higher than the average search costs when fired in $t = 0$. Workers fired in $t = 1$ must have been re-employed after being fired in $t = 0$ meaning their draw θ_0 must have been sufficiently low to induce them going back to work. Average search costs conditional on re-employment are $\mathrm{E}_\theta(\theta \mid \theta \leq \theta_0)$. In contrast, θ_1 is a new independent draw from the same distribution $F(\theta)$ that is not conditional on re-employment. Hence average search costs of workers fired in $t = 1$ are $\mathrm{E}_\theta(\theta) > \mathrm{E}_\theta(\theta \mid \theta \leq \theta_0)$.

Proof. See Appendix. □

Figure 11 illustrates individuals' optimal choices in $t = 0$ given the location in (θ_0, d) space. The threshold $\hat{\theta}_0$ is downward sloping in d. The flat segment that shows up in the early retirement choice at $t = 1$ (see Figure 10 above), does not exist for the early retirement choice at $t = 0$. The reason is that, under our assumptions, the only feasible early retirement path is drawing UI benefits at $t = 0$ and a disability pension at $t = 1$. Since early retirees have to rely on a disability pension, early retirement is discouraged at very low values of d.

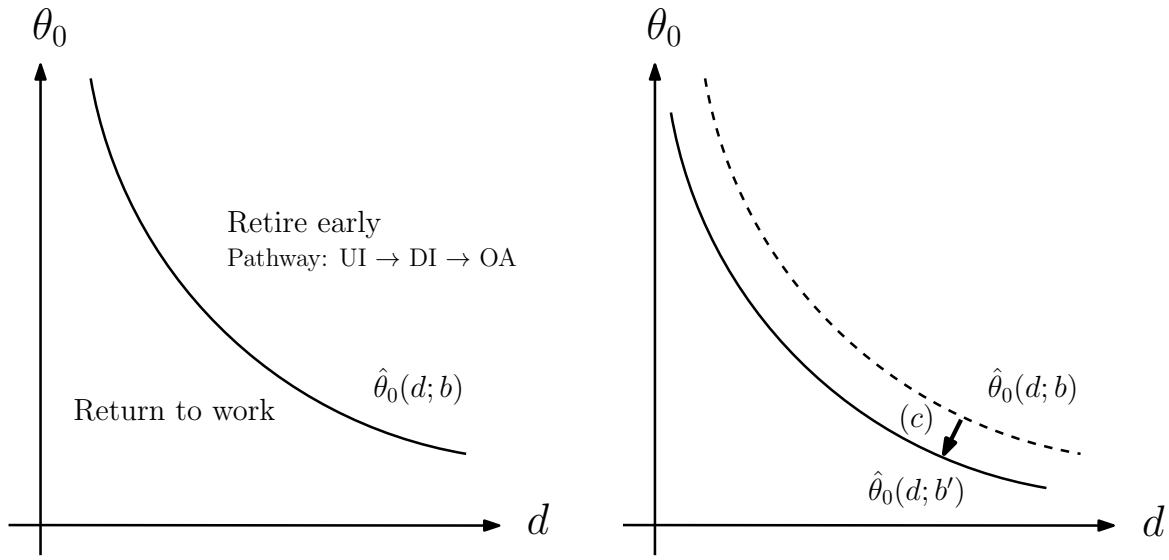

Figure 11: Left panel: early retirement threshold $\hat{\theta}_0(d;b)$ in $t = 0$. Right panel: program complementarity effects (c) when unemployment benefits increase from b to b'.

We are now able to explore how more generous UI benefits affects early retirement incentives in $t = 0$. A higher b has two countervailing effects on the threshold $\hat{\theta}_0(d;b)$. On the one hand, a higher b increase the incentive to use UI and DI sequentially: program complementarity increases the value of early retirement R_0. One the other hand, higher benefits also increase the value of going back to work. This entitlement effect (Mortensen, 1977) increases the value of going back to work at $t = 0$ because becoming unemployed in $t = 1$ is less harmful. We summarize our discussion in the following proposition.

Proposition 2. *More generous UI benefits b lead to a program complementarity effect and an entitlement effect. The former increases and the latter decreases the probability to retire early at $t = 0$. The program complementarity effect dominates.*

Proof. See Appendix. □

6.2 An Extended Baily-Chetty Formula for Early Retirement

We now look at the social optimality of the REBP as an early retirement program. We proceed by describing the social planner's problem. The social planner has to take into account how older

workers react to changing incentives. Moreover, the social planner also has to take into account that younger individuals are affected since the additional tax burden associated with more generous benefits is shared among the entire population. We therefore extend the above model for one additional period, $t = -1$, during which the worker is not yet eligible to the more generous UI early retirement pathway. Assume period $t = -1$ has length φ and that younger individuals are fully employed.[20] Employed workers contribute payroll taxes τ, so the gross wage w equals $w = \omega + \tau$. We normalize the size of a cohort to unity and assume the population is stationary. Heterogeneity in pension benefits among individuals is captured by the distribution $G(d)$ over the domain $[\underline{d}, \overline{d}]$. The utilitarian social welfare equals

$$\mathcal{W} = \int_{\underline{d}}^{\overline{d}} \left(\varphi u\left(w - \tau\right) + q \int_0^{\infty} V_0(d, \theta) dF(\theta) + (1 - q) W_0(d) \right) dG(d) \tag{4}$$

and represents the average expected lifetime utility among all individuals. The expected value over the periods $t = 0$ to $t = 2$ is recursively defined: at the beginning of $t = 0$ individuals either (i) become unemployed with probability q, draw job search disutility θ, and choose pathways according to $V_0 = \max\{W_0 - \theta, R_0\}$ or (ii) stay employed with probability $(1 - q)$ and obtain utility W_0. As outlined in Section 6.1, the pathway utilities W_0 and R_0 then comprise the subsequent periods as well.

To characterize the government's budget constraint, we need to introduce new notation. *First*, let π_t^i denote the *probability* that a worker displaced at the end of $t - 1$ enters state $i = W, U, D$ during t. Recall that workers cannot enter state D in period $t = 0$ (see footnote 18). Hence we have $\pi_0^W = 1 - \pi_0^U$ and $\pi_1^W = 1 - \pi_1^U - \pi_1^D$. *Second*, denote by Π_t^i the *mass* of workers in state $i = U, D, W$ at date t. Since cohort size equals unity, we have $\Pi_0^U = q\pi_0^U$, $\Pi_0^D = 0$, $\Pi_0^W = 1 - \Pi_0^U$; and $\Pi_1^U = q(1 - q\pi_0^U)\pi_1^U$, $\Pi_1^D = q(1 - q\pi_0^U)\pi_1^D$, $\Pi_1^W = 1 - \Pi_0^U - \Pi_1^U - \Pi_1^D$.[21]

A balanced government budget requires that expenditures on UI, DI and old-age pensions have to be financed by taxes paid by the entire working population. This can be written as

$$(\Pi_0^U + \Pi_1^U)b + N = (\varphi + \Pi_0^W + \Pi_1^W)\tau, \tag{5}$$

where N denotes government expenditures on disability and old-age pensions (described in Appendix A.1).

We can now derive a sufficient statistic in the spirit of Baily (1978) and Chetty (2006a) that allows us to assess the welfare implications of extended UI.[22] The government maximizes social

[20] We ignore unemployment risks for the young because we focus on long-term unemployment benefits targeted to older workers that incentives them to retire early.

[21] The above notation also refers to alternative (early) retirement pathways: Π_0^U workers choose the pathway UD; Π_1^U choose pathway WU; Π_1^D choose pathway WD; and Π_1^W workers choose WW. Since cohort size is unity, we have $\Pi_0^U + \Pi_1^U + \Pi_1^D + \Pi_1^W = 1$. Pathways UU, DD, UW and DW are ruled out by assumption, see footnote 18.

[22] Our framework focuses only on the extensive margin (early retirement versus returning to work after a job loss) which allows us, in a simple way to consider complementarity and substitution effects of UI and DI. This is different from Baily and Chetty who consider a single program (UI) and who focus on the intensive margin (duration of unemployment).

welfare (4) with respect to b subject to the government budget constraint (5). This yields the first-order condition:

$$\frac{d\mathcal{W}}{db} = (\Pi_0^U + \Pi_1^U)u'(b) - (\varphi + \Pi_0^W + \Pi_1^W)u'(w-\tau)\frac{d\tau}{db} \stackrel{!}{=} 0. \tag{6}$$

Optimal UI benefits equate the marginal social benefits of better insurance to the marginal social costs of higher taxes. On the one hand, higher UI benefits provide better insurance in the case of job loss. The marginal social benefit from better insurance is given by the mass of UI beneficiaries in $t = 0$ and $t = 1$, $\Pi_0^U + \Pi_1^U$, times their marginal utility gain, $u'(b)$. On the other hand, higher UI benefits require higher taxes on employed workers. The marginal social cost from higher taxes are given by the mass of employed workers during work life, $\varphi + \Pi_0^W + \Pi_1^W$, times their marginal utility loss, $u'(w-\tau)\,(d\tau/db)$. Notice that the utility effects of workers' labor supply and retirement responses are second-order (Envelope Theorem) and do not show up directly in the above condition (although they show up indirectly in the term $d\tau/db$).

Let us take a closer look at $d\tau/db$, the increase in taxes necessary to finance the more generous UI system.[23] For job losers in $t = 0$, extended UI induces individuals who would have otherwise gone back to work, to retire early through sequential take-up of UI and DI (program complementarity). We denote the total effect on net government expenditures by Δ_0^c. Notice that early retirement in $t = 0$ has an impact on taxes and/or transfers in $t = 0$, $t = 1$, and $t = 2$. In $t = 0$, the government has to pay UI benefits and forgoes the taxes the workers would have paid when going back to work rather than retiring early. Hence an additional early retiree generates a loss for the government equal to $b + \tau$. In $t = 1$, the government has to pay disability pensions and forgoes taxes (and saves UI benefits) on those who would have otherwise worked (become unemployed). In $t = 2$, expenditures for old-age pensions are lower because early retirement in $t = 0$ requires take-up of DI in $t = 1$ which lead to lower pensions compared to the alternative scenario of being employed or unemployed before pension take-up. In Appendix A.2, we explicitly calculate Δ_0^c.

For job losers in $t = 1$, extended UI induces both program complementarity and program substitution. Here program complementarity means the sequential take-up of UI benefits and an old-age pension. Some workers now retire early via UI instead of continuing to work. Government's additional financial burden becomes $\Delta_1^c = b+\tau$. There is no impact on government expenditures in $t = 2$ because pensions do not depend on whether new pension claimants were previously employed or unemployed. In contrast, program substitution in $t = 1$ affects the government budget through future pensions. For each worker who substitutes UI for DI, the government pays UI benefits b and normal old age pension $p^U = \alpha d$. Had the worker instead retired early via DI benefits, this would

[23] To keep things simple, we assume that the required tax increase does not generate an increase in the mass of individuals claiming DI rather than returning to work. This assumption can be made precise using Figure 10 (right panel) which draws the impact of an increase in UI benefits. The implicit assumption in Figure 10 is that the net wage remains constant. When the net wage falls because of higher taxes, the downward sloping branch in the figure shifts down as well. The above assumption implies that the downward shift is small and affected individuals do not change their behavior. Notice, however, that this assumption is not particularly strong because the group that may consider switching to DI is a small proportion of all taxpayers. It consists of individuals at age $t = 1$ with $d > \hat{d}$ and $\theta_1 \geq \hat{\theta}_1$ switching to DI rather than continue to work as a result of the higher taxes.

have affected the government budget with d in $t = 1$ and pension $p^D = d$ in $t = 2$. Hence program substitution induces net government expenditures $\Delta_1^s = b + Tp^U - (1+T)d$.[24]

The second set of parameters that is relevant to calculate the marginal costs of extended UI are workers' employment and retirement responses. We capture these behavioral effects by the following elasticities: (i) $\varepsilon_0^c = (d\pi_0^U/\pi_0^U)/(db/b)$ is the elasticity of UI recipients in $t = 0$ with respect to the UI benefit level. This elasticity captures the program complementarity effect in $t = 0$, i.e. the increase in sequential take-up of UI and DI. (ii) $\varepsilon_1^c = -(d\pi_1^W/\pi_1^U)/(db/b)$ is the percentage increase of UI recipients who take-up UI in $t = 1$ rather than continue to work. This elasticity captures the program complementarity effect at $t = 1$, i.e. the increase in sequential take-up of UI and an old-age pension. Finally, (iii) $\varepsilon_1^s = -(d\pi_1^D/\pi_1^U)/(db/b)$ is the percentage increase in UI recipients who take up UI instead of DI in $t = 1$. This elasticity captures the program substitution effect.

The following Lemma relates the elasticities ε and Δ to the overall fiscal impact.

Lemma 3. *An increase in UI benefits leads to an increase in expenditures and forgone tax revenues,* $\mathcal{E}$,

$$\mathcal{E} = \Pi_0^U \left(1 + \varepsilon_0^c \frac{\Delta_0^c}{b}\right) + \Pi_1^U \left(1 + \varepsilon_1^c \frac{\Delta_1^c}{b} + \varepsilon_1^s \frac{\Delta_1^s}{b}\right). \tag{7}$$

Proof. See Appendix. □

Equation (7) in the above Lemma shows two effects: (i) the mechanical effect, $\Pi_0^U + \Pi_1^U$, that arises because more generous UI benefits have to paid to the unemployed both in $t = 0$ and $t = 1$; and (ii) the behavioral effects that arise due to program complementarity and program substitution. These latter effects correspond to the mass of individuals who take advantage of program complementarity, $\Pi_0^U(\varepsilon_0^c/b)$, and $\Pi_1^U(\varepsilon_1^c/b)$, weighted by their respective financial impacts, Δ_0^c and Δ_1^c.

We are now ready to state our main result which shows how optimal UI benefits depend on workers' degree of risk aversion and the elasticities of program complementarity and program substitution. A balanced budget requires that marginal expenditures and foregone taxes are equal to marginal tax revenues, or $\mathcal{E} = (\varphi + \Pi_0^W + \Pi_1^W)(d\tau/db)$. Combining this with equations (6) and (7) yields

Proposition 3. *Optimal UI benefits for older workers satisfy*

$$\frac{u'(b) - u'(w-\tau)}{u'(w-\tau)} = \varepsilon_0^c \frac{\Delta_0^c}{b} \frac{\Pi_0^U}{\Pi_0^U + \Pi_1^U} + \left(\varepsilon_1^c \frac{\Delta_1^c}{b} + \varepsilon_1^s \frac{\Delta_1^s}{b}\right) \frac{\Pi_1^U}{\Pi_0^U + \Pi_1^U}. \tag{8}$$

The l.h.s. of formula (8) captures the marginal benefit of smoother consumption while the r.h.s. quantifies the costs associated with distorted labor supply and early retirement choices. This formula extends the Baily-Chetty and allows substitution and complementarity - two aspects that

[24] Notice that the model assumes heterogeneity in d and θ. Government expenditures are affected by average DI pension among those who react to the UI extension. See the proof to Lemma B.3 in the Appendix.

are not present in the standard Baily-Chetty framework.[25] Notice that the length of the work life φ and the distribution of search costs θ, $F(\theta)$, do not directly appear in the above formula. However, they appear indirectly because a higher φ implies a lower taxes τ relaxing the overall tax burden allowing for higher benefit generosity for older individuals. $F(\theta)$ does not affect the above formula because individuals' utility is additively separable in search costs θ and consumption c. Hence θ has no impact on marginal consumption values.

6.3 Calibration

This section calibrates formula (8). We assume CRRA utility $u(c) = c^{1-\gamma}/(1-\gamma)$, with the relative risk aversion parameter γ. Then the l.h.s. of equation (8) is $RR(b)^{-\gamma} - 1$ where $RR(b)$ denotes the replacement rate of UI benefits in terms of after tax income $(w - \tau)$. Notice that $RR(b)$ captures the replacement rate over a five-year interval, hence we have $RR(b) = 0.42$ before the REBP (1/5 regular UI benefits and 4/5 UI assistance) and $RR(b) = 0.52$ during the REBP (4/5 regular UI benefits and 1/5 UI assistance).[26] To estimate the r.h.s. of formula (8), we take our results from Table 3 which estimates an increase in the transition from UI to DI (program complementarity) of $\Delta\pi_0^U = 0.126$, starting from the pre-REBP mean of $\pi_0^U = 0.269$ (see second-to-last row in Table 3). Hence the elasticity of program complementarity in $t = 0$ is given by

$$\varepsilon_0^c = \frac{\Delta\pi_0^U/\pi_0^U}{\Delta b/b} = \frac{0.126/0.269}{0.10/0.42} = 1.97.$$

In $t = 1$ workers' responses consist of both program complementarity and program substitution effects. We take our estimates of Table 5 and decompose the total old-age pension treatment effect ($\Delta\pi_1^U = 0.231$) into a program substitution ($-\Delta\pi_1^D = 0.127$) and a program complementarity effect ($-\Delta\pi_1^W = 0.108$). The mean for transitions from UI to old-age pensions in treated regions before the REBP equals $\pi_1^U = 0.249$ (see second-to-last column of Table 5). This yields

$$\varepsilon_1^c = \frac{-\Delta\pi_1^W/\pi_1^U}{\Delta b/b} = \frac{0.108/0.249}{0.10/0.42} = 1.82 \text{ and } \varepsilon_1^s = \frac{-\Delta\pi_1^D/\pi_1^U}{\Delta b/b} = \frac{0.127/0.249}{0.10/0.42} = 2.14.$$

Next, we calculate factual and counterfactual pensions to get the impact of workers' behavioral responses on the government buget (the Δ's). We use the following parameter values: (i) an after-tax DI replacement rate of 70 percent in both periods $t = 0$ and $t = 1$; (ii) a pension appreciation factor $\alpha = 1.1$ over a five-year interval (capturing a 1.9 percent increase per annum in the average

[25] When $\Pi_0^U = 0$ and $\varepsilon_1^s = 0$, only program complementarity in $t = 1$ is at work. In that case we have a standard optimal UI problem in which workers have only the choice between going back to work or drawing UI in period $t = 1$. The r.h.s of formula (8) becomes $\varepsilon_1^c(\Delta_1^c/b)$ with $\Delta_1^c = \tau + b$. The government budget constraint becomes $b(1 - \pi_1^W) = \pi_1^W\tau$ and the Baily-Chetty formula becomes get $(u'(b) - u'(w-\tau))/u'(w-\tau) = \varepsilon_1^c/\pi_1^W$. The slight difference of this formula to the standard case arises from our focus on the extensive margin (unemployment entry: yes/no), while Baily-Chetty look at the duration of unemployment.

[26] Our calibration intends to represent Austrian UI rules around 1990. We assume a net replacement rate of regular UI benefits of 55% and a net replacement rate of UI assistance of around 38.5%, or 70% of regular UI benefits.

pension); and (iii) total payroll taxes, including employee and employer contributions, are about 25% of the gross wage. Table 10 lists the estimated costs from workers' responses, separately for program complementary and program substitution (both in relative terms and in year-2000 Euros).

Table 10: Financial impact of program complementarity and program substitution

	Percent of net wage	In Thousands of Euros (year 2000)
$\Delta_0^c = b + \hat{\tau} + (d + Tp^D) - \mathcal{T}_0$	$0.42 + 0.33 + 0.70 + 2.49 - 2.51 = 1.43$	182
$\Delta_1^c = b + \hat{\tau}$	$0.42 + 0.33 = 0.75$	95
$\Delta_1^s = b + Tp^U - (d + Tp^D)$	$0.42 + 2.74 - 0.70 - 2.49 = -0.03$	-4

Notes: The second column reports the financial effects in units of the net (after-tax wage). Hence $b = 0.42$ denotes the UI benefits replacement ratio; $d = p^D = 0.7$ the DI benefit replacement ratio for individuals reacting to the UI benefits change. In 1990, the conditional lifetime expectation of a 60 year old male individual was about 17.8 years (see Statistik Austria, 2012), which yields $T = 3.56$ capturing the duration of $t = 2$ in terms of 5-year periods. It follows that $Tp^D = 0.7 \times 3.56 = 2.49$ and $Tp^U = \alpha Tp^D = 2.74$. Payroll taxes are recalculated as a fraction of net-wages, hence we get $\hat{\tau} = \tau/(1-\tau) = 0.33$. $\mathcal{T}_0$ denotes the expected net transfer in the counterfactual scenario when a job loser goes back work (rather than retiring early) in $t = 0$. See Appendix A.2 for a comprehensive calibration of this term. The Δ-terms Euro are transferred into year-2000 Euros by multiplying the Δ-terms by 1825 (number of days in a five-year interval) and by 69.4 (the average daily wage in treated regions during the REBP-program, see Table 2).

Table 10 reveals two important findings. First, complementarity effects in $t = 0$ are almost twice as expensive as complementarity effects in $t = 1$. Our calibration shows that each early retiree in $t = 0$ imposes an overall burden on the government budget, both forgone taxes and additional benefits, of 182,000 Euros (baseline-year 2000). This seems to be a rather large number, but one has to keep in mind that complementarity means retiring 10 years prior to normal retirement age. Each additional early retiree in period $t = 1$ imposes an overall burden on the government of 95,000 Euros. Program substitution in $t = 1$ enters negatively, e.g. the government saves money for each retirement pathway change. This may be explained by the transactions costs associated with access to DI (modeled by the disutility κ). Individuals substitute DI for UI even though the latter pays lower benefits because the DI application disutility can be avoided. However, the effect on the government budget is rather small (- 4,000 Euros).

The weighting factors $\Pi_0^U/(\Pi_0^U + \Pi_1^U)$ and $\Pi_1^U/(\Pi_0^U + \Pi_1^U)$ are almost symmetric with 0.53 and 0.47, respectively.[27] Collecting all r.h.s. terms of equation (8) yields

$$0.53 \times 1.97 \times \frac{1.43}{0.42} + 0.47 \times \left(1.82 \times \frac{0.75}{0.42} - 2.14 \times \frac{0.03}{0.42}\right) = 3.56 + (1.54 - 0.07) \quad = \quad 5.02. \quad (9)$$

Looking at the relative shares provides the following insights. First, complementarity effects are very expensive both because individuals react very strongly to financial incentives and because early

[27] We find an average employment to unemployment transition rate of 3% per annum. This estimate includes all 50-57 years old workers satisfying the sample selection criteria (Section 3) and living in one of the REBP regions during the policy change. The corresponding five year period estimate amounts to $q = 5 \times 3\% = 15\%$ which yields $\Pi_0^U = 4.0\%$ and $\Pi_1^U = 3.6\%$.

retirement in $t = 0$ implies long-lasting (10-year) benefit payments and foregone taxes. Second, complementarity effects in $t = 1$ are half as expensive due to the shorter (5-year) period over which the government budget is affected. Third, program substitution effects mitigate program costs but are quantitatively small. The above calibration let us calculate a hypothetical risk aversion level γ^h that satisfies the local optimality condition

$$\gamma^h = -\frac{\ln(1 + \text{r.h.s. of equation 8})}{\ln RR(b)} = -\frac{\ln(1 + 5.02)}{\ln 0.42} = 2.07. \tag{10}$$

Despite its importance the value of relative risk aversion remains disputed. In particular, a large literature finds that risk aversion is context-specific and varies with the scale of the risk (Chetty and Szeidl (2007), Barseghyan et al. (2011), Einav et al. (2012)). Studies that use labor supply elasticities to estimate risk aversion come closest to our setting. Using 33 sets of estimates of wage and income elasticities, Chetty (2006b) finds that the mean implied risk aversion is 0.71 with a range of 0.15 to 1.78. Since our estimate of risk aversion is above this range ($\gamma = 2.07$), we conclude that the REBP was most likely too generous. This finding seems to be plausible given that UI benefits serve as an important bridge (complementarity effects) for the unemployed to a very generous pension system. Of course, this statement is contingent on the very generous pension system in place, and restricting eligibility or increasing age thresholds may be other valid policies to lower program costs.

7 Conclusion

In this paper, we study how extended unemployment insurance (UI) benefits targeted to older workers affect early retirement and social welfare. Extended durations of UI benefits for older workers are an important element of early retirement schemes in many countries. To identify the impact of the maximum duration of UI benefits on the incidence of early retirement, we exploit the Austrian regional extended benefits program (REBP) that was in place between June 1988 and July 1993. This policy constitutes a large policy intervention extending regular UI benefits to 4 years for workers aged 50+ living in certain regions, while workers in non-REBP regions were eligible to 1 year of regular UI benefits. Our identification strategy is based on a difference-in-differences comparison of individuals in REBP-regions to individuals in non-REBP regions, before, during, and after the program.

We find that the REBP had a dramatic effect on the incidence of early retirement. The probability that an unemployment entrants aged 50-54 (55-57) retires early is 17.0 (10.8) percentage points higher among individuals eligible to the REBP. Among unemployment entrants aged 50-54 *program complementarity* (i.e. sequential take-up of UI and DI) is quantitatively important: of the 17 percentage point increase in early retirement, 12.6 percentage points are associated with increased UI take-up followed by higher DI take-up. Among unemployment entrants aged 55 to 57, both program complementarity (i.e. sequential take-up of UI and retirement benefits) and *program substitution* (i.e. higher UI take-up but lower DI benefit claims) are quantitatively relevant. The

10.8 percentage point increase in excess retirement consists of a 23.1 percentage point increase in individuals staying on UI before claiming regular retirement benefits; and a 12.7 percentage point reduction in individuals claiming DI benefits.

Our empirical estimates help to explore whether extending UI benefits for older workers was a socially optimal policy. We set up a simple early retirement model and implement the sufficient statistics approach proposed by Chetty (2006a). Our model captures both program complementarity and program substitution effects and establishes a simple rule for optimality of more generous UI benefits for older job losers. Using our empirical estimates, we conclude that, extending UI benefits for the elderly is welfare-improving only if the degree of risk aversion exceeds 2.07. This estimate is higher than most previous estimates that use labor supply elasticities to identify risk aversion (Chetty, 2006b). We therefore conclude that the REBP was most likely a suboptimal policy.

We think that our analysis is of general interest. On the one hand, policy makers in many countries implemented early retirement schemes. These schemes are not only very costly but also highly controversial. In many countries reforms are debated or under way to reduce the generosity of these schemes. Austria provides an interesting case study because early retirement schemes were used disproportionately to mitigate labor market problems of older workers. Moreover, the REBP provides an interesting example to understand labor supply reactions caused by strong interventions in retirement schemes. On the other hand, the Austrian early retirement system works qualitatively similar than in most other countries. In particular, in many countries eligibility criteria for DI benefits are relaxed for older workers and potential UI benefit durations are extended above certain age thresholds. This suggests that our results are relevant also for other countries whose retirement systems have similar features.

From a policy perspective, our study suggests that policy reforms aiming at increasing the effective retirement age should take particular care to carefully consider the entire set of welfare programs that impact the (early) retirement decision. A policy mix that allows for simultaneous and coordinated reforms in UI and DI programs to tackle the unemployment-disability margin, together with complementary measures that induce firms to hire and retain older workers are the most promising route for policy reforms.

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A Pensions

A.1 Definition of disability and old-age pension expenditures

N denotes government expenditures (DI and old-age pensions, but *not* UI benefits). N and can be subdivided into three components $\{N_t\}_{t=0,1,2}$, where N_t denotes total expenditures in period t or later, that arises from a worker retiring in t. Let E_t be the expectation of d, conditional on retirement in t. There are Π_0^U individuals who retire in $t = 0$. They cause total pension expenditures

$$N_0 = \Pi_0^U \mathrm{E}_0((1+T)d \mid \theta \geqslant \hat{\theta}_0(d))\cdot$$

There are $\Pi_1^D + \Pi_1^U$ individuals who retire in $t = 1$. They cause DI- and pension expenditures

$$N_1 = \Pi_1^D \mathrm{E}_1((1+T)d \mid \theta \geqslant \hat{\theta}_1(d), d \geqslant \hat{d}) + \Pi_1^U \mathrm{E}_1(\alpha T d \mid \theta \geqslant \hat{\theta}_1(d), d < \hat{d}).$$

Finally, there are Π_1^W individuals who retire not before $t = 2$. These workers can be divided into three groups: (i) Π_1^{W1}, workers displaced at the beginning of $t = 1$ who return to work, (ii) Π_1^{W2}, workers displaced in $t = 0$ who return to work in $t = 0$ and continue to work in $t = 1$, and (iii) Π_1^{W3}, workers without displacement in $t = 0$ and $t = 1$. Workers in Π_1^{W1} and Π_1^{W2} tend to have a lower d because they self-selected themselves into work because of both low DI pensions d and low adjustment costs θ. The sum of old-age pensions that accrue to the government by all three subgroups is

$$N_2 = \Pi_1^{W1} \mathrm{E}_1(\alpha T d \mid \theta < \hat{\theta}_1(d)) + \Pi_1^{W2} \mathrm{E}_0(\alpha T d \mid \theta < \hat{\theta}_0(d)) + \Pi_1^{W3} \mathrm{E}_0(\alpha T d).$$

Notice that workers without a previous displacement (third term) are not subject to previous self-selection. Hence, the mean E_0 is unconditional.

A.2 Calibration of $\mathcal{T}_0$

The expected financial burden to the government of a job loser who goes back work (rather than retiring early) in $t = 0$ equals (see proof in Appendix Lemma B.3)

$$\mathcal{T}_0 = q(\hat{\pi}^D(d_0 + Tp_0^D) + \hat{\pi}^U(b + Tp_0^U) + \hat{\pi}^W(Tp_0^W - \tau)) + (1-q)(Tp_0^W - \tau). \tag{11}$$

The first component captures government expenditures caused by individuals retiring in $t = 1$ through claiming DI-benefits; the second term captures expenditures caused by early retirees who claim UI benefits in $t = 1$; and the third term captures expenditures caused by workers retiring not until the regular retirement age $t = 2$. To calculate $\mathcal{T}_0$, we set the probability of job loss $q = 0.15$ (see footnote 27). We estimate $\hat{\pi}^i$ by the observed take-up probabilities of 55-57 year old job losers living in REBP regions. This yields $\hat{\pi}^D = 0.33$, $\hat{\pi}^U = 0.58$, and $\hat{\pi}^W = 0.09$. Moreover we use $T = 3.56$, $d = p^D = 0.7$, and $p^U = p^W = \alpha d = 0.77$, see Table 10.

B Proofs

B.1 Lemma 2

Proof. Set the value of working $(W_0 - \theta_0)$ equal to the value of early retirement (R_0) to obtain the threshold value $\hat{\theta}_0$. Differentiation of $\hat{\theta}_0$ with respect to d yields

$$\partial\hat{\theta}_0/\partial d = q(\partial \mathrm{E}_\theta V_1/\partial d) + (1-q)\alpha T u'(\alpha d) - (1+T)u'(d).$$

To calculate $\mathrm{E}_\theta V_1$, we need to distinguish two cases (see Lemma 1).

Case 1 $(d < \hat{d})$: This is the subset of job losers who strictly prefer to retire through UI rather than DI in $t = 1$. The back-to-work probability equals to $F(\hat{\theta}_1)$ while early retirement occurs with probability $1 - F(\hat{\theta}_1)$. The expected marginal utility corresponds to the sum of the marginal utility of continuing work and the marginal utility of retiring through UI, weighted by their respective take-up probabilities

$$\partial \mathrm{E}_\theta V_1/\partial d = F(\hat{\theta}_1)(\partial W_1/\partial d) + (1 - F(\hat{\theta}_1))(\partial U_1/\partial d),$$

with $\partial W_1/\partial d = \partial U_1/\partial d = \alpha T u'(\alpha d)$. Collecting $\partial\hat{\theta}_0/\partial d$-terms, and noting that $u'(\alpha d) < u'(d)$ and $1 - (\alpha - 1)T \geq 0$, we get $\partial\hat{\theta}_0/\partial d < -u'(d)(1 - (\alpha - 1)T) < 0$.

Case 2 $(d > \hat{d})$: This is the subset of job losers who strictly prefer to retire through DI rather than UI in $t = 1$. The same reasoning as above yields[28]

$$\partial \mathrm{E}_\theta V_1/\partial d = F(\hat{\theta}_1)(\partial W_1/\partial d) + (1 - F(\hat{\theta}_1))(\partial D_1/\partial d),$$

with $\partial W_1/\partial d = \alpha T u'(\alpha d)$ and $\partial D_1/\partial d = (1+T)u'(d)$. Collecting $\partial\hat{\theta}_0/\partial d$-terms and again using $1 - (\alpha - 1)T \geq 0$ yields $\partial\hat{\theta}_0/\partial d < -(1 - q(1 - F_1(\hat{\theta}_1)))u'(d)(1 - (\alpha - 1)T) < 0$. □

B.2 Proposition 2

Proof. Differentiation of $\hat{\theta}_0$ with respect to b yields $\partial\hat{\theta}_0/\partial b = q \cdot (\partial \mathrm{E}_\theta V_1/\partial b) - u'(b)$. As in Lemma 2, there are two cases. *Case 1* $(d < \hat{d})$ we obtain $\partial \mathrm{E}_\theta V_1/\partial b = (1 - F(\hat{\theta}_1))(\partial U_1/\partial b)$ which represents the marginal utility gains of retirement weighted by the probability to retire early. Welfare effects due to switching behavior are second order because individuals optimize in $t = 1$ (Envelope Theorem). Hence, $\hat{\theta}_0(d)$ decreases in b because $0 < q < 1$ and $0 \leq F(\hat{\theta}_1) \leq 1$. *Case 2* $(d > \hat{d})$ yields $\partial \mathrm{E}_\theta V_1/\partial b = 0$ as the UI pathway is never chosen and therefore $\partial\hat{\theta}_0/\partial b = -u'(b)$. □

[28] There is one subtle difference to Case 1: the threshold $\hat{\theta}_1$ becomes a function of d over the domain $d > \hat{d}$. However, utility effects due to changes in the threshold $\hat{\theta}_1$ are second-order because individuals optimize over pathway choices (Envelope Theorem).

B.3 Lemma 3

First, we assume that $d\tau/db$ does not generate an increase in the mass of individuals claiming DI rather than returning to work; see discussion in footnote (23). Second, the elasticities ε_1^s and ε_1^c capture pathway changes holding the $t = 1$ inflow of displaced workers fixed (more precise definition). A detailed proof can be found in the Mathematical Appendix.

Proof. Differentiation of the budget constraint (5) with respect to b yields

$$(\varphi + \Pi_0^W + \Pi_1^W)\frac{d\tau}{db} + \tau\frac{d(\Pi_0^W + \Pi_1^W)}{db} = \Pi_0^U + \Pi_1^U + b\frac{d(\Pi_0^U + \Pi_1^U)}{db} + \frac{dN}{db}. \tag{12}$$

In a first step, we calculate the marginal pension expenditures dN/db (pensions see Appendix A.1). Deriving N_0 with respect to b yields

$$dN_0/db = \Pi_0^U(\varepsilon_0^c/b)(1+T)d_0 \tag{13}$$

which are additional pension expenditures $(1+T)d_0$ caused by more early retirees in $t = 0$. Deriving $N_1 + N_2$ with respect to b yields

$$\begin{aligned} d(N_1 + N_2)/db \;=\; & \Pi_1^U(\varepsilon_1^s/b)(Tp_1^U - d_1 - Tp_1^D) \\ & -\Pi_0^U(\varepsilon_0^c/b)(q(\hat{\pi}^D(d_0 + Tp_0^D) + \hat{\pi}^U Tp_0^U + \hat{\pi}^W Tp_0^W) + (1-q)Tp_0^W) \end{aligned} \tag{14}$$

which are additional DI and old-age pension expenditures caused by the change in the number of (early) retirees in $t = 1$ and $t = 2$. $\hat{\pi}^D$ denotes the fraction of DI pension take-up in $t = 1$ of individuals who react to program complementarity effects in $t = 0$. $\hat{\pi}^U$ and $\hat{\pi}^W$ capture the unemployment and work margin. The above formula shows two channels affecting total pension expenditures accruing from retirement in $t = 1, 2$. The first term captures the costs of program substitution (change in DI plus old-age pension expenditures) form retirees that use UI instead of DI to retire early. The second term captures the fact that, when there are more retirees in $t = 0$, there are fewer retirees in $t = 1$ and $t = 2$ which reduces the government expenditures $N_1 + N_2$.

In the second step, we calculate the additional UI expenditures caused by labor supply responses

$$d(\Pi_0^U + \Pi_1^U)/db \times b = \Pi_0^U(\varepsilon_0^c/b)(1 - q\hat{\pi}^U)b + \Pi_1^U((\varepsilon_1^c + \varepsilon_1^s)/b)b. \tag{15}$$

Again, the first term captures net costs due to early retirement in $t = 0$ including savings due to non-retirement in $t = 1$, captured by $q\hat{\pi}^U$. The second term represents additional UI benefits expenditures due to substitution and complementarity effects in $t = 1$. Applying the same procedure:

$$d(\Pi_0^W + \Pi_1^W)/db \times \tau = -\Pi_0^U(\varepsilon_0^c/b)(1 - q(1 - \hat{\pi}^W))\tau - \Pi_1^W(\varepsilon_1^c/b)\tau. \tag{16}$$

Finally, insert equations (13) to (16) into (12) to obtain (7) with $\Delta_0^c = b + \tau + d_0 + Tp_0^D - \mathcal{T}_0$, $\Delta_1^c = b + \tau$, $\Delta_1^s = b + Tp_1^U - d_1 - Tp_1^D$, and (11). □