The Role of Attention in Perceiving Social Security Contribution Incentives: Evidence from Voluntary Contributions

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November 21, 2025

Abstract

In this paper, I investigate how attention shapes the perception of the implicit contribution incentives provided by public pension systems. I use the unique setting of the Spanish public pension system, where self-employed workers are allowed to voluntarily determine the level of their Social Security contributions. I show that most self-employed workers failed to take advantage of extraordinary Social Security contribution incentives, and often made suboptimal contribution choices. This suggests substantial challenges in perceiving these implicit contribution incentives. Using quasi-experimental variations from pension reforms, I find that stimuli directing workers' attention to the contribution decision increased their responsiveness to implicit contribution incentives. My findings highlight the critical role of attention in perceiving Social Security contribution incentives, and thereby promoting greater efficiency in raising Social Security contributions.

JEL codes: D91, E21, H55.

Keywords: Contribution-Benefit Linkage, Public Pension, Social Security.

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1 Introduction

In most public pension systems, retirees' pension benefits are directly tied to their Social Security contribution (SSC) records. This linkage implies that SSCs provide returns in the form of higher future pension benefits, reducing their distortionary effects compared to standard income taxes (Summers, 1989; Feldstein and Samwick, 1992; Feldstein and Liebman, 2002; Disney, 2004). However, the efficiency gains from these implicit returns critically depend on whether taxpayers perceive them (Blinder et al., 1980). Notably, the returns provided by SSCs are embedded in public pension formulas, raising questions about taxpayers' ability to fully recognize these incentives. In the context of aging populations, SSCs represent an increasing share of national income, reaching to 9% of GDP across OECD countries (OECD, 2022). Therefore, the degree to which taxpayers perceive SSC incentives has substantial implications for economic efficiency (Auerbach and Kotlikoff, 1985).

In this paper, I study how individuals perceive implicit contribution incentives in public pension systems, using the Spanish Social Security system as a natural setting. In Spain, self-employed workers face public pension formulas that mimic the earnings-related formulas used for wage earners. However, while wage earners pay mandatory SSCs based on their labor earnings, self-employed workers are allowed to voluntarily determine the level of their SSCs – within floors and ceilings of €250 and €900/month. This allows for direct observation of their optimization behavior in response to contribution incentives. Critically, pension benefits in Spain are calculated based solely on contributions made in the final years before retirement. This implies that contributions made before a certain age – the *linkage age* – do not affect pension benefits as they are not linked to pension benefits, while those made afterward yield extraordinary returns. By analyzing the optimization of these incentives and how responses interact with behavioral stimuli, I shed light on the role of attention in perceiving implicit SSC incentives.

I begin by providing cross-sectional evidence on the voluntary contribution behavior of self-employed workers in the five years leading up to retirement, a period when contribution incentives are strongest and nearly certain[1]. I study the contributions of two groups facing contrasting in-

[1]Near retirement, few periods are discounted before pension benefit receipt, and pension parameters can be

centives depending on whether their retirement pensions exceeded the minimum level. The group whose retirement pensions exceeded the minimum enjoyed exceptionally high contribution incentives: each additional € of SSCs yielded approximately €3 in present-value pension benefits, corresponding to real rates of return of up to 18%. Despite the clear arbitrage opportunity, the majority of these individuals – between 50% and 70% – overlooked these returns, contributing exactly at the minimum. In contrast, the group who earned minimum retirement pensions received no return for additional contributions, as their pension would remain fixed at the minimum level. Nonetheless, 18% of this group actively increased their contributions in the final year before retirement, effectively leaving money on the table. These patterns suggest systematic deviations from optimal behavior, consistent with misperceptions of contribution incentives.

Next, I provide quasi-experimental evidence on how higher levels of attention to the contribution decision can affect responsiveness to contribution incentives. I focus on an institutional feature of Spain's contribution schedule: an option value arising at a specific age, which I term the *option age*. At this age, a worker's contribution level, as long as exceeding a threshold ($\simeq$€500/month), determines their contribution ceiling in future years[2]. A large option value exists for those planning to make high contributions near retirement, since *option age* contributions could allow extending SSCs for the period when incentives are the greatest[3]. I calculate that the net present value of increasing contributions above the €500/month threshold could potentially be as high as 74,000€[4]. Given its irreversibility and high-stakes, the option value may direct workers' attention to their contribution decision at the *option age*[5].

To analyze the interaction between the option value and SSC incentives, I exploit two pension

considered fixed, with limited prospect for pension reforms.

[2]If contributions at the *option age* exceed the €500/month threshold, the higher level can be maintained thereafter; otherwise, future contributions are capped at €500. This option value recurs annually after the *option age*.

[3]Additionally, the option value was irreversible, explicitly timed and present in annual administrative documents, as the *option value* is described in the government budget's section on self-employed workers' Social Security contribution floors and ceilings.

[4]Nevertheless, fewer than 13% of my sample ended up contributing near the €500/month threshold near retirement, suggesting low option value for most in practice

[5]Models of behavioral inattention (Sims, 2003; Gabaix, 2019 Maćkowiak et al., 2023) assume that individuals have information processing constraints, weighting the benefits of gathering more precise information against the cost of acquiring and processing it. The high stakes of the option value decision may help overcome the general inattention to the contribution decision.

reforms that introduced quasi-experimental variations in these elements. First, the 1993 reform shifted the *option age* from 55 to 50 years, thereby altering the age at which workers faced this high-stake decision, which draws their attention to their contribution choice. Second, the 1997 reform changed the incentive structure by extending the pension benefit calculation window from the final 8 to the final 15 years of contributions. With retirement at the statutory age of 65, this reform shifted the *linkage age* from 57 to 50[6].

I conduct three complementary empirical analyses leveraging these reforms. First, I examine how much contributions increase around the *linkage* and *option age*, based on the different configurations arising from the 1993 and 1997 reforms. I find that before 1997, there was no discernible response to the sharp increase in incentives at the *linkage age*[7]. By contrast, after the 1997 reform, when both ages were aligned at 50, I observe a sharp increase in contributions. Thus, responses to implicit contribution incentives arose only when coupled with the *option age*. Notably, the response primarily occurred at contribution levels below the €500/month threshold, where the option had no real economic implications. This suggests that increased attention, rather than the option's intrinsic value, drove the higher response to the *linkage age*. This finding is consistent with models of attention-limited decision-making (Gabaix, 2019).

In the same setup, I observe a response to the *option age* even in the absence of direct contribution incentives. In periods when the *linkage* and *option age* were not aligned (before 1997), contributions increased at the *option age* rather than the *linkage age* – when direct incentives actually changed. This response suggests that differing attention-levels may have contributed to this contribution behavior.

Second, I use a difference-in-differences (DiD) framework to quantify the dynamic effects of the 1993 and 1997 reforms. I compare the contribution behavior of self-employed workers aged 50–52 (affected) with those aged 40–46 (unaffected) before and after each reform. I estimate that the 1993 reform—which shifted the *option age* from 55 to 50—increased the share of workers aged 50-52 contributing above the minimum by 2.5 percentage points (pp) four years after the reform.

[6]Contribution incentives surged at age 57 before the reform, while the reform anticipated them to age 50.
[7]Before 1997, the *linkage age* (57) did not align with the *option age* (50 or 55); after 1997, both were set at 50.

For the 1997 reform, I estimate the share increased by 10.3 pp five years after the reform. Relative to SSC incentives, these responses imply that 1pp in SSC incentives leads to an increase in the share of 0.03 and 0.08 pp, still pointing to modest responsiveness.

Third, I use the cohort-based eligibility to the option decision after the 1997 reform to examine the effect of aligning contribution incentives with the *option decision*. Individuals born before 1947 had already turned 50 by 1997, and had therefore passed the option decision point, while those born after 1948 were still under 50, and thus exposed to both stronger incentives and the option decision. I find that eligibility for the option value decision raised the probability of contributing above the minimum by 2.84 pp, significantly amplifying the response to the 1997 reform. Again, the response occurred exclusively at contribution levels below the €500/month threshold, where the option had no real economic implications.

Taken together, these findings suggest that individuals face substantial barriers in perceiving the implicit contribution incentives embedded in earnings-related pension systems. Despite extremely high returns to late-career SSCs, most self-employed workers contributed at the statutory minimum, resulting in remarkably low pension benefits. Two factors suggest that such misperception may be even more severe in the broader population. First, self-employed workers exhibit higher levels of financial literacy than wage earners (Struckell et al., 2022). Second, wage earners do not select their SSCs, and thus may pay even less attention to their pension contributions. My findings raise concerns on whether many earnings-related pension systems effectively internalize SSC incentives in labor supply decisions. In response, my findings highlight the critical role of behavioral stimuli in shaping the perception of SSC incentives. Institutional designs that direct higher levels of attention into contribution incentives may improve individuals' ability to perceive them. This could potentially minimize the labor supply distortions associated with Social Security financing.

Related literature. This paper contributes to four main strands of literature. First, it advances our understanding of how the linkage between current SSCs and future pension benefits affects individual behavior. Prior research has examined how future pension entitlements influence pre-retirement labor supply using rule discontinuities (Liebman et al., 2009), structural reforms (French

et al., 2022), and earnings tests (Brinch et al., 2017). Related work has shown that the contribution-benefit link affects reported earnings (Dean et al., 2022) and the incidence of SSCs (Bozio et al., 2025). By focusing on the voluntary optimization of SSCs, this paper adds new evidence on how behavioral frictions affect responses to future pension incentives.

Second, this paper contributes to the literature on the role of perception in shaping behavioral responses to tax and benefit systems. Existing studies have shown that the visibility and complexity of policies can significantly affect behavioral responses, including to consumption taxes (Chetty et al., 2009), income taxes (Abeler and Jäger, 2015; Rees-Jones and Taubinsky, 2020), and benefit take-up (Bhargava and Manoli, 2015). This paper extends that literature by providing novel evidence that attention also mediates responses to implicit incentives in public pension contributions, an area where incentives are particularly opaque.

Third, this paper adds to research on the perceived valuation of social insurance programs. Several recent studies have used voluntary participation settings to estimate how individuals value unemployment insurance (Landais and Spinnewijn, 2021), disability insurance (Cabral and Cullen, 2019; Seibold et al., 2025), and defined-benefit pension schemes for public employees (Fitzpatrick, 2015). This paper extends that approach by studying a setting in which individuals can voluntarily adjust the scale of their contributions to an earnings-related pension scheme. The findings suggest that individuals substantially undervalue the implicit return on these contributions, pointing to the importance of perception and framing in shaping the valuation of social insurance.

Fourth, this paper contributes to the literature on the "annuity puzzle"—the observation that individuals often fail to purchase annuities despite their desirable old-age insurance value (Yaari, 1965; Davidoff et al., 2005; Benartzi et al., 2011). Recent experimental studies have pointed to behavioral explanations, including framing effects (Brown et al., 2008) and cognitive constraints (Brown et al., 2017; Brown et al., 2021), as key barriers to annuity take-up. This paper provides complementary observational evidence on behavioral inattention from a real-world setting in which self-employed workers forgo public pension annuities with present value benefits as high as €3 per €1 contributed, roughly three times the return on actuarially fair annuities.

The rest of this paper is structured as follows. Section 2 presents the institutional details of this study. Section 3 describes the calculation of Social Security contribution incentives in Spain. Section 4 describes the data and Section 5 the empirical strategy. Section 6 presents the estimation results and section 7 discusses them. Finally, Section 8 concludes.

2 Institutional details

This section describes the key characteristics of the Social Security Scheme for Self-Employed Workers (*Régimen Especial de Trabajadores Autónomos*, RETA) in Spain, as well as the pension reforms used in this study. The RETA scheme covers 12% of the Social Security affiliates in Spain, making it the second largest Social Security scheme after the General Social Security Scheme (*Régimen General de la Seguridad Social*, RGSS). Further details on the Spanish pension system can be found in García-Gómez et al. (2018).

2.1 Voluntary contributions under RETA

Self-employed workers in Spain are mandatorily covered by RETA, the Social Security scheme for the self-employed. The main distinctive feature of RETA, relative to other Social Security regimes, is that the self-employed are allowed to choose the level of their contribution bases to Social Security, within annually legislated floors and ceilings. Their contribution choice, expressed in monetary terms, is independent of self-employment incomes, unlike wage earners whose contribution bases represent their labor incomes. Contribution bases determine future contributory pension benefits (disability, survivor and pension benefits), as well as the payment of SSCs. The monthly SSCs are calculated by multiplying contribution bases with a Social Security rate, which was set at 26.5% over the period of study. The resulting minimum contributions were around €250/month (in 2016 prices[8]), while maximum contributions were around €900/month. Self-employed workers can change their contribution bases twice a year by submitting a prespecified form at any Social Security office or online. Additional details on the contribution thresholds and forms for choosing

[8]Throughout the paper, all monetary values are measured in constant 2016 prices.

SSCs under RETA are provided in Appendix A.

2.2 Pension formulas

The pension formulas in Spain mimic an earnings-related pension system and are common across all Social Security schemes, including wage earners and self-employed workers. Upon satisfying the eligibility criteria for a pension, monthly pension benefits are calculated using the following formula[9]:

$$P_{R,n} = \alpha_n \times \beta_R \times BB \tag{1}$$

where $P_{R,n}$ denotes monthly pension benefits when claiming retirement at age R with n contribution years. α_n represents the coefficient for the number of contribution years n, which penalized contribution periods shorter than 35 years. The validation of contribution years for α only depends on contributed period, not on contributed amounts. β_R stands for the coefficient of retirement age R, which penalized early retirement before the statutory retirement age of 65 years. Finally, BB refers to the benefit base, calculated as the average of the contribution bases during the last years before claiming retirement. Additional details on pension formulas are provided in Appendix A.

These formulas imply that SSCs are linked to pension benefits only during the final years before retirement. The specific age at which this linkage begins—the *linkage age*—is determined by the number of years of contributions included in the calculation of the pension benefit base. Together, these institutional features imply that SSCs made before the linkage age do not affect future pension benefits, while contributions made after the *linkage age* give positive pension entitlements.

Two key institutional features about the benefit base are worth noting in case of labor transitions from self-employment. First, the benefit base aggregates contributions across all Social Security regimes, implying that future transitions from self-employment to other regimes have little impact on current contribution incentives[10]. Second, if self-employed workers leave contributory work,

[9] Eligibility to a retirement pension required 15 years of contributions to Social Security, and retirement at least at 60 years of age. Early retirement also required accrued pensions to exceed minimum pensions.

[10] Pension aggregation is undertaken in the most favorable way for the claimant. This can combine contributions for a unified pension, or generate separate pensions from different Social Security regimes. In any case, SSC incentives

these will not be filled by their contributions in earlier periods, making the *linkage age* cutoff sharp.

1997 reform: Change in the *linkage age*. The 1997 pension reform extended the period of contributions considered to calculate pension benefits. Before the reform, the benefit base was calculated as the average of the contribution bases during the last 8 years before retirement. The reform extended this period from the final 8 to the final 15 years before claiming retirement[11]. With retirement at the statutory age of 65 years, the reform changed the *linkage age* of SSCs from 57 to 50 years. This implied that contributions at ages 50 to 56 became linked to pensions after 1997. For comparability, I undertake a DiD approach to compare the contribution behavior of workers aged 50-52 to those aged 40-46, before and after the 1997 reform.

2.3 Option value of contributions

A relevant feature of the RETA scheme is the option value encountered by self-employed workers at a given age, which I label the *option age*. At the *option age*, workers decide whether to maintain the ability to contribute above a specified threshold in subsequent years. Specifically, while the maximum contributions were generally around 900€/month, the contribution ceiling for self-employed workers older than the *option age* was approximately 500€/month. However, if a workers' contributions exceeded the 500€/month threshold at the *option age*, they were allowed to maintain this contribution level for the following year. Beyond the *option age*, maximum contributions were subsequently determined by their previous year's contributions. Consequently, the contributions at the *option age* are key for making high contributions near retirement, when incentives are particularly strong. The rules that gave rise to the option value were aimed at limiting the high contributions only near retirement. Additional details on the option value of contributions are provided in Appendix A.

for self-employed workers are equivalent.

[11] Some marginal adjustments were made to the penalization coefficients for contribution years and early retirement, which are incorporated into the calculation of incentives (see Appendix A.3).

Source of attention. The option value decision is explicit, featuring the government budget every year when the contribution thresholds are updated[12]. By prompting self-employed workers to consider their contributions, the option value decision could attract self-employed workers attention. The presence of a deadline for the decision could further attract workers' attention to this decision (Altmann et al., 2022b). Thus, over and above option incentives, I use this decision as behavioral stimuli in the contribution decision.

1993 reform: Change in the *option age*. The 1993 reform shifted the age at which self-employed workers made the option value decision. Before 1993, self-employed workers made the decision at age 55, while the reform shifted the *option age* to 50 years. To examine how self-employed workers respond to this, I undertake a DiD approach to compare the contribution behavior of workers aged 50-52 to those aged 40-46, before and after the 1993 reform.

3 Social Security contribution incentives

I describe the calculation of contribution incentives for self-employed workers in Spain. I begin by describing the calculation of the direct Social Security contribution incentives offered by public pension formulas after the *linkage age*. Then, we describe the option value incentives determined by the option value decision faced by self-employed workers after the *option age*.

3.1 SSC linkage: Direct contribution incentives

The direct SSC incentives offered by public pension formulas are calculated as the increase in net discounted pension benefits resulting from current additional SSCs[13]. Expressing the future net discounted pension benefits as a percentage of these additional SSCs, I define the implicit net-of-tax rate – or the money's worth – of additional SSCs:

[12] While the Social Security administration does not directly notify individuals about this decision, I verified that self-employed associations send notifications on Social Security regulations, including the option value decision. See Appendix A.4 for sample notifications.

[13] Liebman et al. (2009) labeled this concept as Marginal Social Security Benefits (MSSB).

$$1 - \tau_{a,t} = \frac{\partial SSW_{a,t}}{\partial SSC_{a,t}} = \sum_{s=R}^{\overline{LE}} \frac{\pi_t(s|a)}{(1+r)^{s-a}} \times \frac{\partial P_s}{\partial SSC_{a,t}} \tag{2}$$

where $\tau_{a,t}$ denotes the implicit tax rate of additional SSCs for an individual aged a at time t, $SSC_{a,t}$ stands for the SSCs at time t for someone aged a, $SSW_{a,t}$ represents the Social Security Wealth at time t for someone aged a, r is the discount rate, P_t stands for the pension annuity at time t, $\pi_t(s|a)$ is the survival probability for a person aged a at time t to remain alive at age s, R is the retirement age, $\overline{LE}$ stands for the maximum life expectancy. I further develop this expression with the pension formulas for P_t in Equation 1:

$$1 - \tau_{a,t} = \sum_{s=R}^{\overline{LE}} \frac{\pi_t(s|a)}{(1+r)^{s-a}} \times \alpha_n \beta_R \frac{\partial BB_s}{\partial SSC_{a,t}} \tag{3}$$

where all parameters have already been described. Further details on the calculation of the implicit net-of-tax rate of public pension contributions can be found in Appendix B.

Parameters and assumptions. I use a number of parameters and assumptions to calculate contribution incentives based on Equation 3. First, I calculate the incentives under the pension rules at the time of paying SSCs. Second, I consider a 3% discount rate to calculate the present value of future pension benefits, following the pension literature (Coile et al., 2002; Liebman et al., 2009). Third, I assume that self-employed workers plan to claim retirement at the statutory retirement age of 65 years, implying $\beta_R = 100\%$[14]. Fourth, I use a coefficient for contribution years of $\alpha_n = 92.16\%$, corresponding to the average coefficient for self-employed retirees in 2005. Fifth, I derive conditional survival probabilities $\pi_t(s|a)$ from mortality tables provided by the Spanish Office of National Statistics. Sixth, I assume that there was no disincentive from minimum pensions for my sample of self-employed workers[15]. Seventh, my calculations only consider the incentive from

[14] Throughout the study period, self-employed workers were generally ineligible to early retirement and delaying retirement beyond 65 years offered no bonus. Consequently, most self-employed workers retired at 65 years (see Figure B.1).

[15] Retirees benefiting from a minimum pension top-up would continue to receive the minimum pension even with additional SSCs. To address this possibility, I exclude the 20% with shortest contribution careers by age and cohort. This corresponds to the share of self-employed retirees receiving minimum pensions in 2002-2005 (see column (5) in Table 1).

retirement pension benefits, excluding disability or survivor pensions[16]. Eighth, my measurement of incentives does not consider the value of additional longevity insurance provided by lifetime annuities, underestimating total incentives (Mitchell et al., 1999). Further details and supporting evidence on these parameters and assumptions can be found in Appendix B.2.

Calculated SSC incentives. Tables B.3 and B.4 report the implicit net-of-tax rates of additional SSCs for men and women by single year of age between 1994 and 2002. Consistent with the institutional design, the tables show no incentive to contribute prior to the *linkage age*, but substantial and rapidly increasing incentives thereafter. Following the 1997 reform, an additional euro of SSCs yields more than €1.90 in future pension benefits at ages 50–52, rising to nearly €3 by age 64. The steep age gradient in SSC incentives primarily reflects shorter discounting horizons and higher conditional survival probabilities at older ages.

3.2 Option value incentives

Option value incentives compute how contributions above a given threshold (≃€500/month) extend the ceiling for capitalizing the direct SSC incentives at a later age. The calculation weights the future benefits of accessing the option, with the required payment to access the option.

$$\begin{aligned} OV(C_{a^o t}) &= \frac{NPV(C_{a^o t} - C_t^{opt})}{C_{a^o t} - C_t^{min}} = \\ &= \frac{\sum_{s=1}^{R-a}(C_{a+s} - C_{t+s}^{opt}) \times 1\{C_{a+s} \geq C_{t+s}^{opt}\} \times \pi_t(a^o + s|a^o) \times \frac{(-\tau_{a+s,t})}{(1+r)^s}}{C_{a^o t} - C_t^{min}} \end{aligned} \tag{4}$$

where $OV(C_{a^o t})$ denotes the option value of contributions depending on the level of contributions $C_{a^o t}$ at the *option age* at time t. $NPV(C_{a^o t} - C_t^{opt})$ refers to the net present value of contributing above the option threshold C_t^{opt} ($\simeq$ €500/month) - at time t. C_t^{min} refers to the minimum contribution at time t. $1\{C_{a+s} \geq C_{t+s}^{opt}\}$ refers to the indicator on whether the worker's contributions are above the option threshold s years after. $\pi_t(a^o + s|a^o)$ is the survival probability

[16]Excluding disability or survivor benefits underestimates total SSC incentives. However, no reform affected these benefits during the study period, so their exclusion does not affect the variation in incentives.

s years later for an individual aged a^o at time t. $\tau_{a+s,t}$ refers to the implicit tax rate of SSCs at age $a+s$ at time t.

Assumptions. The calculation relies on the same assumptions outlined for direct contribution incentives. In addition, I assume $1\{C_{a+s} \geq C^{opt}_{t+s}\} = 1$, implying that self-employed workers expect to maintain their current contribution level in future years. This assumption isolates the upper bound of the option value at stake in the contribution decision.

Calculated option incentives. Figure 1 presents the option value of SSCs at age 50 in 1998. Because contributions below €500 per month do not raise the future contribution ceiling, they generate no option value. For contributions exceeding this threshold, the option value per euro of SSC is substantial and increases steeply with the contribution level, reaching €9.54 per euro at €900 per month. The resulting option value therefore represents a high-stakes decision. For example, an individual turning 50 in 1998 who contributes the maximum of €900 per month until retirement would face an option value as high as €74,402[17].

Option value in practice. To assess the option value in practice, I examine the contribution behavior of self-employed workers aged 60–64 during the period 2002–2005. More than 87% of these workers never make contributions approaching the €500 threshold (see Figure A.5). This pattern indicates that, for the vast majority of self-employed workers, the option value embedded in voluntary SSCs may effectively be small.

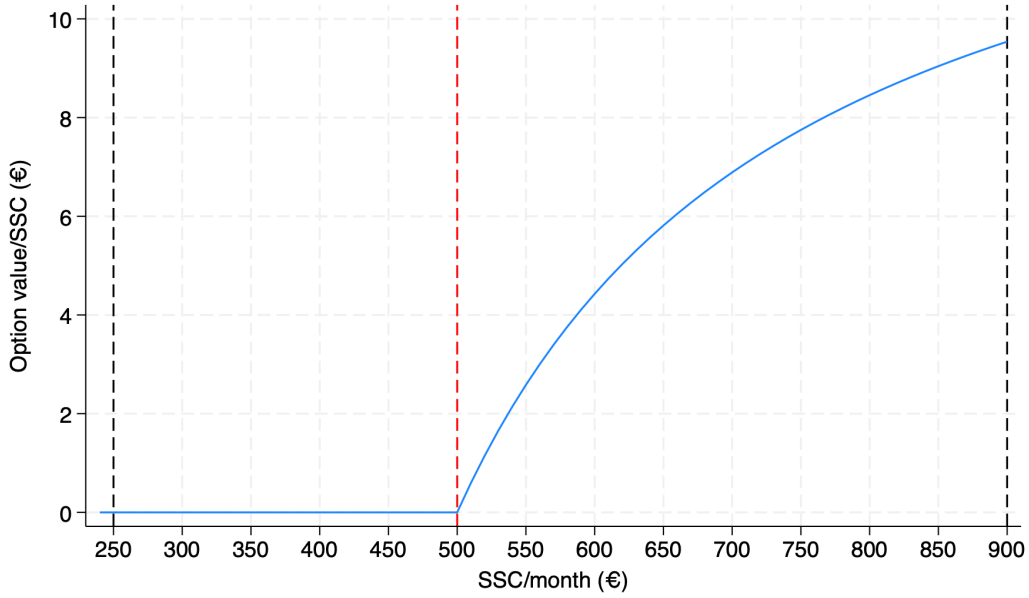
4 Data

The empirical analysis of this study relies on administrative microdata from the 2005 wave of the Continuous Sample of Employment Histories (*Muestra Continua de Vidas Laborales*, MCVL), which is made available for research purposes by the Spanish Ministry of Labor, Migration and Social Security[18]. The MCVL combines administrative Social Security microdata with tax records from

[17] This amount is obtained by multiplying the maximum annual voluntary contributions (€650 per month × 12) by the €9.54 option value per euro of SSC.

[18] While the 2004 wave is accessible, it is infrequently used for research due to reported errors.

Figure 1: Option value of SSCs at age 50 in 1998



Notes: This figure displays the option value per each € of SSCs, as a function of the selected SSCs per month at the option age. The vertical dashed lines at €250 and €900 indicate the minimum contribution, while the red dashed line at €500 represents the option threshold, after which the future maximum contributions are extended by the option value.
Source: Own calculations.

the Spanish tax administration and population register data. The MCVL provides a random sample of 4% of the affiliates to Spanish Social Security in a given year, including affiliates contributing to Social Security or receiving a contributory pension.

The MCVL provides detailed information on the employment history of sampled affiliates since 1967, including the dates of employment spells, the type of contract, or the Social Security scheme. Importantly, this dataset contains monthly contribution bases to Social Security since 1980, which includes the contribution choices made by self-employed workers. Furthermore, the dataset incorporates socioeconomic variables such as gender, date of birth, nationality, region of residence, and education[19].

Retirees' sample. To undertake our analysis on late years contributions, and look at the contributions when aged 60-64. I select a sample of individuals who claimed retirement at age 65

[19]Since self-employed workers' SSCs are not income-based, information on self-employment incomes is unavailable in this dataset.

years between 2002 and 2005. Among these retirees, two groups of individuals are selected: those who earned minimum pensions and those who earned pensions above the minimum. Those who earned minimum pensions did not have any incentive to contribute above the minimum, while those earning pension above the minimum had very large contribution incentives. Table 1 presents the summary statistics of the retired sample for both groups.

Table 1: Summary statistics for the sample of retirees at age 60-64

	Pension at minimum		Pension above minimum		Full sample	
	Mean (1)	S.D. (2)	Mean (3)	S.D. (4)	Mean (5)	S.D. (6)
Contribution variables						
$1\{C_{iat} > C^L_{iat}\}$ (%)	6.16	(24.04)	31.14	(46.31)	26.01	(43.87)
Real Contr. (2016€)	261.88	(27.60)	315.02	(115.65)	304.11	(106.05)
Characteristics						
Female (%)	65.81	(47.44)	24.65	(43.10)	33.10	(47.06)
Education level (%)						
Primary	60.68	(48.85)	58.48	(49.28)	58.93	(49.20)
Secondary	24.62	(43.09)	25.66	(43.68)	25.45	(43.56)
Superior	10.04	(30.06)	13.48	(34.15)	12.77	(33.38)
N.A.	4.65	(21.07)	2.39	(15.26)	2.85	(16.64)
Small municipality (%)	52.07	(49.97)	49.72	(50.00)	50.20	(50.00)
Tenure years	11.20	(6.54)	17.90	(10.58)	16.53	(10.25)
Contribution years	19.17	(4.16)	33.26	(7.84)	30.37	(9.20)
Coefficient years	62.34	(10.79)	91.05	(11.91)	85.16	(16.47)
Minimum pension (%)	100.00	(0.00)	0.00	(0.00)	20.53	(40.39)
N (obs)	2,729		10,565		13,294	

Notes: This table shows the descriptive statistics of the sample entering the study of the average contributions close to retirement. The sample is comprised of individuals who retired at age 65 between 2002 and 2005, and it includes the observations of these individuals when they were aged 60-64. We divide the sample into two groups depending on whether they earn minimum pensions, and descriptive statistics are also provided for the full sample. I provide mean and standard deviation the probability of making contributions above the minimum and real contributions, as well as demographic and employment variables such as education, gender, a dummy variable on whether municipality of residence has population smaller than 40,000 inhabitants, contributed years at retirement and the coefficient of contribution years entering the calculation of pension benefits. Fractions of categorical variables may not add up due to rounding.
Source: MCVL 2005.

Reforms sample. To estimate the effects of the 1993 and 1997 reforms, I select the sample spanning the period from 1991 to 2002. Specifically, I focus on a sample comprising individuals with Spanish nationality who worked as self-employed during this period. For avoiding minimum pen-

sions contaminating incentives, I exclude the 20% with the shortest contribution periods in each age and cohort cell, which corresponds the share of minimum pension earners among the contemporary retirees (see column 5 in Table 1). The choice of a sample of long-term self-employed workers also ensures the representativeness of my sample of 2005 affiliates for retrospective analysis[20]. Table 2 presents the summary statistics of my sample to estimate the effect of the 1993 and 1997 pension reforms.

5 Empirical strategy

I describe the empirical strategies used to exploit the quasi-experimental variations arising from the 1993 and 1997 pension reforms. The 1993 reform shifted the age at which self-employed workers make the option value decision (*option age*) from 55 to 50 years. The 1997 reform changed the age of the contribution-benefit link (*linkage age*) from 57 to 50 years, increasing contribution incentives in the age range 50-56 years, while leaving contributions in ages younger than 50 unlinked to pension benefits. I use three complementary strategies.

5.1 Dynamic DiD estimation

I implement a dynamic DiD approach to compare the contribution behavior of self-employed workers in age groups affected and unaffected by the 1993 and 1997 reforms over time. For comparability, I designate those aged 50-52 as the treatment group and those aged 40-46 as the control group. The dynamic DiD regression takes the following form:

$$Y_{iat} = \alpha_a + D_t + \sum_{s=\underline{s}}^{\overline{s}} \beta_s (T_a \times D_{R+s}) + \mathbf{X_{iat}}\theta + \varepsilon_{iat} \tag{5}$$

where Y_{iat} represents my two outcomes of interest: $Y_{iat} = \mathbf{1}\{C_{iat} > C^L_{iat}\}$, the indicator variable on whether self-employed worker i of age a contributed above the minimum contribution C^L_{iat} in period t, and the logarithm of the real contributions $Y_{iat} = \ln(C_{iat})$. α_a denotes age dummies

[20] Retrospective use of MCVL data may pose challenges when studying labor transitions or subpopulations with extended periods of inactivity, such as females or non-Spanish nationals (Pérez-Salamero et al., 2016). Appendix C demonstrates the stability of my sample over time using additional waves of the MCVL.

Table 2: Summary statistics for the "reforms sample" from 1991 to 2002

	Control: 40-46 years		Treatment: 50-52 years		Full sample	
	Mean (1)	S.D. (2)	Mean (3)	S.D. (4)	Mean (5)	S.D. (6)
Outcome variables						
$1\{C_{iat} > C^L_{iat}\}$ (%)	2.35	(15.16)	10.01	(30.02)	4.55	(20.85)
Real Contr. (2016€)	251.31	(36.02)	270.92	(82.08)	256.95	(54.21)
Control variables						
Female (%)	16.43	(37.06)	16.73	(37.33)	16.52	(37.13)
Education level (%)						
Primary	38.56	(48.67)	48.92	(49.99)	41.54	(49.28)
Secondary	36.46	(48.13)	30.79	(46.16)	34.83	(47.64)
Superior	23.32	(42.29)	17.83	(38.28)	21.74	(41.25)
N.A.	1.66	(12.78)	2.45	(15.47)	1.89	(13.62)
Economic activity (%)						
Agriculture	1.96	(13.85)	2.44	(15.41)	2.09	(14.32)
Manufacturing	12.56	(33.14)	11.40	(31.79)	12.23	(32.76)
Construction	14.01	(34.71)	11.08	(31.39)	13.17	(33.82)
Retail service	31.88	(46.60)	30.80	(46.17)	31.57	(46.48)
Hospitality	8.61	(28.06)	7.59	(26.48)	8.32	(27.62)
Transport	11.14	(31.46)	11.91	(32.39)	11.36	(31.73)
Estate & Finance	5.76	(23.30)	4.67	(21.09)	5.44	(22.69)
Social service	7.93	(27.02)	8.37	(27.69)	8.05	(27.21)
N.A.	6.15	(24.02)	11.75	(32.20)	7.76	(26.75)
Prov. GDPpc (2016€)	17,386.09	(3,434.79)	17,240.46	(3,385.83)	17,344.24	(3,421.41)
Small municipality (%)	55.03	(49.75)	50.93	(0.500)	53.85	(49.85)
Tenure years	11.68	(5.70)	15.17	(6.99)	12.68	(6.30)
Contribution years	16.46	(3.35)	21.67	(4.64)	17.96	(4.44)
N (obs)	89,997		36,289		126,286	

Notes: This table shows the descriptive statistics of the sample entering the study of the effect of the 1993 and 1997 pension reforms. The data spans the period from 1991 to 2002. The sample is divided between the control (40-46 years) and treatment groups (50-52 years), as well as providing descriptive statistics for the full sample. I provide mean and standard deviation for my two outcome variables, the probability of making contributions above the minimum and real contributions, as well as demographic and employment variables such as categorical variables on education and economic activity, as well as gender, province GDP per capita, a dummy variable on whether municipality of residence has population smaller than 40,000 inhabitants, tenure years in the current affiliation and contributed years at ages over 26 years (since affiliation data is available since 1967). Fractions of categorical variables may not add up due to rounding.
Source: MCVL 2005.

and D_t denotes time dummies. Age is defined on the 1st January of year t, when self-employed workers decide their contributions. T_a represents the treatment group indicator, taking value 1 if $a \in [50, 52]$ and 0 if $a \in [40, 46]$. R indicates the reform year, which can take values 1993 and 1997. $\mathbf{X_{it}}$ includes province, education and industry dummies, a dummy on whether municipality population is above 40,000, tenure and province real GDP per capita. Standard errors are clustered at the individual level.

The coefficient estimate β_s measures the average difference in contributions between treatment

and control groups s years after the reform, relative to the reform year values. The validity of the DiD approach rests on the parallel trends assumption, which posits that the contributions of self-employed workers aged 50-52 and 40-46 would have followed parallel trends in the absence of the pension reforms. Under this assumption, the coefficient β_s identifies the average treatment effect on the treated (ATT). I use the coefficient estimates β_s for negative values of s to test for pre-trends and provide evidence on the plausibility of the parallel trends assumption.

5.2 2SLS semi-elasticity of contribution incentives

I use the dynamic DiD framework to identify the semi-elasticity of contribution incentives using the variation induced by the 1997 reform. I estimate the following 2SLS regression specification:

$$Y_{iat} = \alpha_a + D_t + \sum_{s=-3}^{-1} \gamma_s (T_a \times D_{1997+s}) + \sum_{s=1}^{5} \epsilon_s (1 - \tau_{a1997+s}) + \mathbf{X_{iat}}\theta + \varepsilon_{iat} \tag{6}$$

where τ_{at} represents the implicit tax rate of additional SSCs at age a at time t. I instrument implicit net-of-tax rates $1 - \tau_{at}$ with $T_a \times D_t$ for each $t \in (1998, 2002)$. The identifying assumption of this IV approach is, once again, that the contributions of workers aged 50-52 and 40-46 would have followed parallel trends absent the 1997 reform. ϵ_τ identifies the semi-elasticity of contribution incentives τ years after the 1997 reform[21]. The semi-elasticity can be expressed as the Wald ratio of two dynamic DiD estimates:

$$\widehat{\epsilon_s} = \frac{E\left[Y_{1s}\right] - E\left[Y_{10}\right] - \left[E\left[Y_{0s}\right] - E\left[Y_{00}\right]\right]}{E\left[1 - \tau^d_{1s}\right] - E\left[1 - \tau^d_{10}\right] - \left[E\left[1 - \tau^d_{0s}\right] - E\left[1 - \tau^d_{00}\right]\right]} \tag{7}$$

where $E\left[Y_{gs}\right] = E\left[Y_{iat} | T_a = g, t = 1997 + s\right]$ and $E\left[1 - \tau_{gs}\right] = E\left[1 - \tau_{at} | T_a = g, t = 1997 + s\right]$.

5.3 Cohort-based eligibility effect in 1997 reform

I examine heterogeneous response to the 1997 reform depending on the cohort-based eligibility to make the option value decision after 1997. When the 1997 reform was introduced, cohorts born before 1947 were already 50 years old, so they had already made their option value decision. In

[21] The tax literature typically measures incentives in logarithms to estimate an elasticity. However, implicit net-of-tax rate prior to the reform was 0, which implies that the logarithm is not defined.

contrast, those born in 1948 and later were younger than 50 years and therefore eligible to make the option value decision after the 1997 reform. I estimate the discontinuity of responses to the 1997 reform at the eligibility threshold, controlling for age-specific treatment effects and a linear trend of the dynamic effects after 1997[22]. I classify individuals into quarterly cohorts birth to assess the cohort-based discontinuity. I estimate the following regression:

$$\begin{aligned} Y_{iact} =& \alpha_a + D_t + E_i + \sum_{a=50}^{52} \sum_{q} \gamma_{aq} (\alpha_a \times L_q \times Pre_t^{1997}) + \sum_{a=50}^{52} \gamma_a (\alpha_a \times Post_t^{1997}) + \\ &+ \lambda t \times Post_t^{1997} \times T_i + \mu (E_i \times Post_t^{1997} \times T_i) + \mathbf{X_{iat}} \theta + \varepsilon_{iat} \end{aligned} \tag{8}$$

where Y_{iact} refers to (1) the probability of contributing above the minimum and (2) the probability of contributing above the option threshold for self-employed worker i of age a in period t, who is born in cohort-quarter c^q. D_t refers to time dummies measured in quarters. $Pre_t^{1997} = \mathbf{1}\{t \leq 1997\}$ and $Post_t^{1997} = \mathbf{1}\{t \geq 1998\}$, denote respectively the indicator for the period before and after the 1997 reform. $T_i = \mathbf{1}\{a \in [50, 52]\}$ denotes the indicator of treatment age. $E_i = \mathbf{1}\{c_i^q \geq 1948\}$ denotes the eligibility to the option value decision after 1997. The rest of the variables have already been described. The parameter of interest is μ, which measures the effect of eligibility to make the option value decision after 1997.

6 Results

This section presents the empirical results. First, I present graphical evidence on average contributions by age. Second, I present the DiD estimation results to quantify the response to the 1993 and 1997 pension reforms. Third, I perform a number of robustness checks. Finally, I present the heterogeneity of the estimated responses.

[22] Controlling for age-specific effects and a trend on the treatment effect accounts for the fact that the effect of the 1997 reform is increasing in age and time.

6.1 Graphical evidence

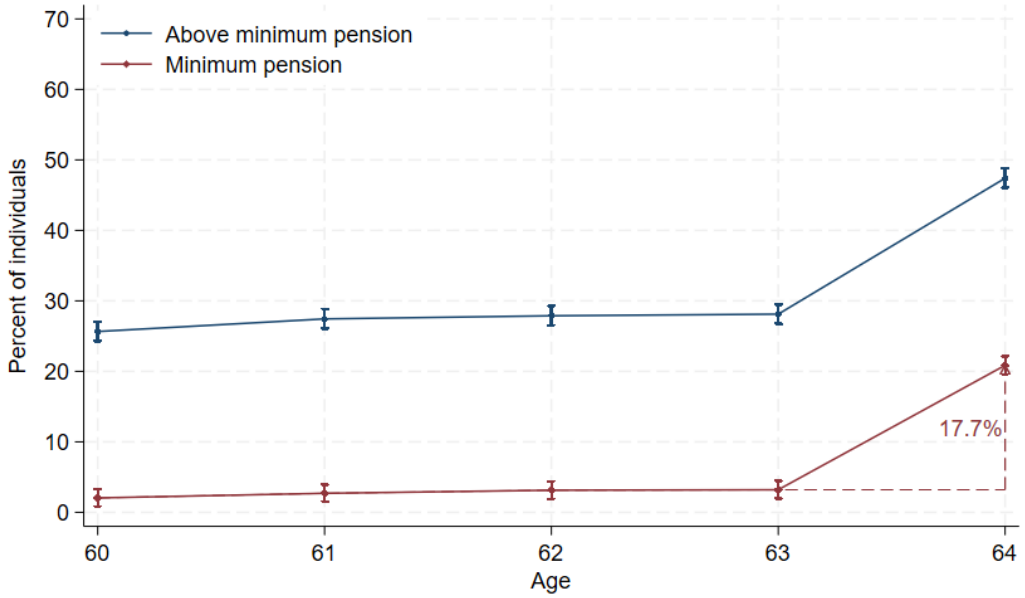
We provide graphical evidence on average contribution behavior by age. We begin with the sample close to retirement, whose returns are most certain. We then focus on the sample of younger individuals affected by the 1993 and 1997 pension reforms.

Contributions near retirement age

I present evidence on the contribution behavior of self-employed workers during the last five years before retirement at 65 years old. Within this age range, the uncertainty around pension returns is minimal, as the potential for future pension reforms impacting their returns is very limited. Figure 2 illustrates the contribution behavior for two groups with contrasting contribution incentives. For self-employed retirees receiving pensions above the minimum, additional SSCs gave exceptional real rates of return ranging from 11% at age 60 to 18% at age 64 (see Tables B.5 and B.6 in Appendix B.4). For self-employed retirees who received minimum pensions at retirement, additional contributions at ages 60-64 yielded no pension return, as any marginal increase in SSCs would still result in the minimum pension.

The figure illustrates that, among those who earned pensions above the minimum, only 25-30% of self-employed workers contributed above the minimum from ages 60 to 63, with the percentage increasing to 47.4% at age 64. This indicates that a majority of self-employed workers are not taking advantage of exceptionally large and certain returns, which clearly outperform alternative savings options, offering an arbitraje opportunity. Among those who received minimum pensions and, consequently, are devoid of SSC incentives, the fraction who contributed above the minimum remained around 3% until age 63. However, 17.7% of them increased their contributions at age 64, making an active decision that leaves money on the table. This observation indicates that a considerable proportion of self-employed workers may not fully grasp their contribution incentives (Gabaix, 2019).

Figure 2: Fraction contributing above the minimum at age 60-64



Notes: This figure displays the fraction of self-employed workers contributing above the minimum at age 60-64 among retirees at 65 years in the period 2002-2005. Age is defined on the 1st January, when most self-employed workers decide their contributions. The blue line represents retirees with more than 30 years of contributions and receiving pensions above the minimum, who enjoy exceptional contribution incentives. The red line those without contribution incentives because they receive the minimum pension.
Source: MCVL 2005.

Contributions around the *option* and *linkage ages*

Figure 3 provides graphical evidence on the contributions of self-employed workers by age for different combinations of the *option age* and the *linkage age*, highlighting the behavior before and after the 1993 and 1997 reforms. The figure offers the following evidence on contributions around the *linkage age* and the *option age*[23] [24]:

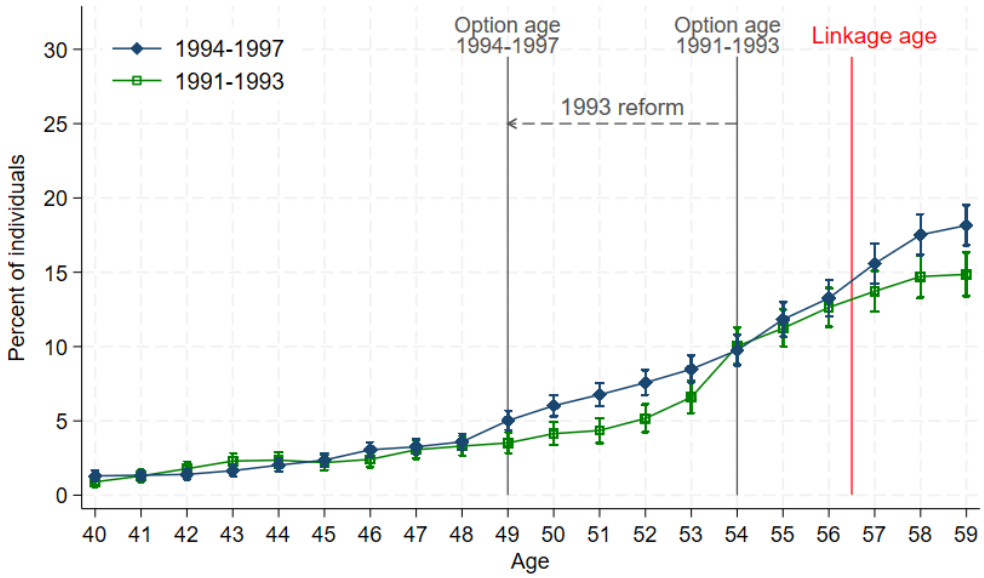
(1) *Linkage age.* The green (1991-1993) and blue (1994-1997) lines in Figure 3a show no increase in contributions at the *linkage age* before 1997 – the *linkage age* did not align with the *option age*. In contrast, the red line (1998-2002) in Figure 3b shows a sharp contribution increase around *linkage age* after the 1997 reform, which aligned the *linkage* and *option age* at 50 years. This shows that self-employed workers only responded to direct contribution incentives when aligned with the

[23] First of all, the figures show that in all three periods, the share of workers contributing above the minimum is always below 25%. This confirms the cross-sectional evidence that contribution levels are generally low.

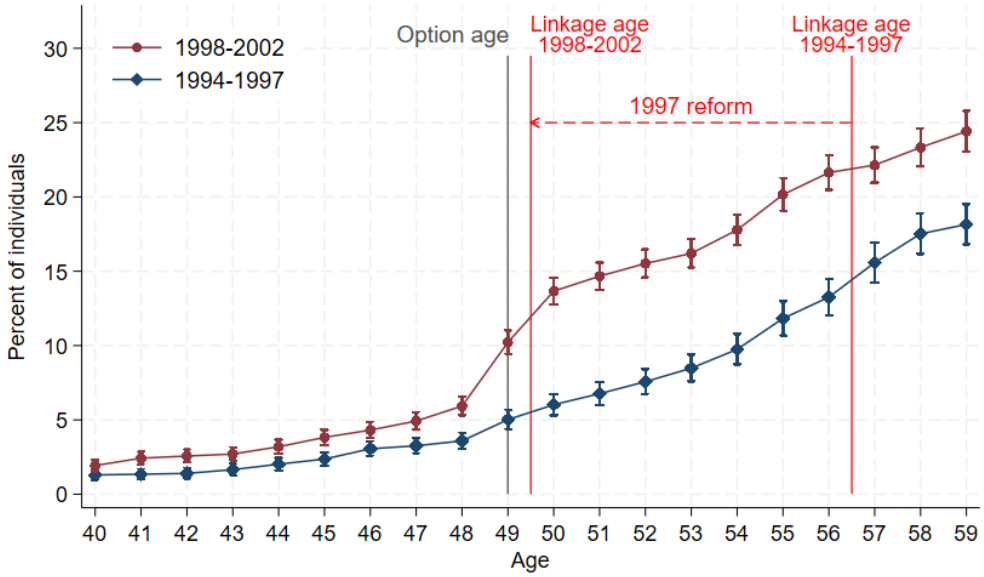
[24] Appendix **??** reports the graphical evidence for average real contributions, and Appendix E reports the DiD estimates by individual year of age, taking the difference between post-reform and pre-reform periods in Figure 3.

Figure 3: Fraction contributing above the minimum by age

(a) 1993 reform



(b) 1997 reform



Notes: This figure shows the probability of contributing above the minimum for self-employed workers by age around the 1993 reform (panel a) and 1997 reform (panel b). I define age on the 1st January of each year, when most self-employed workers decide their contributions. The green lines refer to the 1991-1993 period, the blue lines represent the 1994-1997 period and the red lines refer to the 1998-2002 period. The gray vertical lines represent the age of the option value decision (*option age*) and the vertical red dashed line represents the age at which contributions became linked to pensions (*linkage age*).
Source: MCVL 2005.

option age. Figure D.1 shows the response primarily occurred at contribution levels below the €500/month threshold, where the option had no real economic implications. This suggests that increased attention, rather than the option's intrinsic value, drove the higher response to the *linkage age*. This finding is consistent with models of behavioral inattention (Gabaix, 2019; Bordalo et al., 2022).

(2) *Option age.* The green line (1991-1993) in Figure 3a shows a sharp increase in contributions at age 54, coinciding with the *option age*. The blue line (1994-1997) in Figure 3a shows an increase in contributions at ages 50-53, after the 1993 reform shifted the *option age* from 55 to 50. In contrast, the lines in 3a display no sharp response at the *linkage age* at 57 years. Thus, self-employed workers responded to the *option age*, which mediates contribution incentives, but not to direct contribution incentives themselves. This evidence suggests inattention to implicit contribution incentives and a greater weight on the option value decision (Gabaix, 2019; Bordalo et al., 2022).

6.2 Quasi-experimental evidence

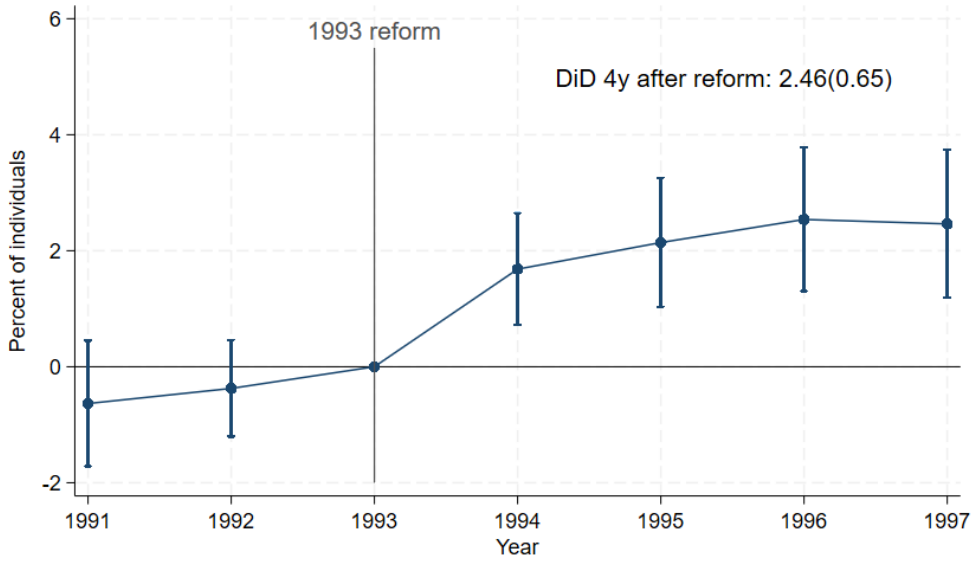
I present the DiD results to quantify the response to the 1993 and 1997 pension reforms. Figure 4 illustrates the dynamic DiD estimates on the probability of contributing above the minimum for the 1993 and 1997 pension reforms. The figure shows well-aligned pre-trends for both reforms, supporting the parallel trends assumption that underlies the DiD strategy.

1993 reform: Effect of *option age*

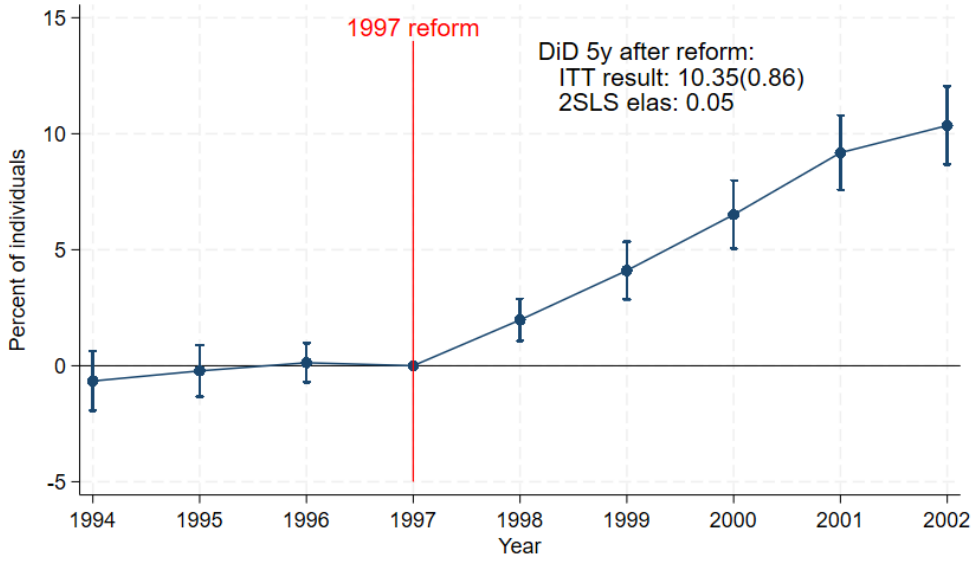
I estimate that the 1993 reform increased the probability of contributing above the minimum by 2.46pp, while real contributions increased by 0.97% over the same period. This indicates that self-employed workers respond to the option value, even in the absence of direct contribution incentives. Therefore, Spanish self-employed workers' contribution decisions appear consistent with models of attention-limited decision-making (Gabaix, 2019; Bordalo et al., 2022).

Figure 4: Dynamic DiD results on the probability of contribution above the minimum

(a) 1993 reform



(b) 1997 reform



Notes: The figure shows the dynamic DiD response of self-employed workers to the 1993 reform (panel a) and the 1997 reform (panel b). The treatment group is represented by self-employed workers aged 50-52 and the control group by those aged 40-46. I define age on the 1st January, when most self-employed workers decide their contributions. The vertical gray line represents the 1993 reform year (panel a) and the vertical red line denotes the 1997 reform year (panel b).
Source: MCVL 2005.

1997 reform: Effect of the *linkage age*

I estimate that the 1997 reform increased the probability of contributing above the minimum by 10.35pp five years after the reform for self-employed workers aged 50-52 years. The equivalent

response in real contributions was 6.67%. Figure 4b shows a gradual response to the reform, possibly reflecting learning and better preparation for increasing contributions. Relative to contribution incentives, I find that responses remain modest. I estimate that for a 1pp increase in the implicit net-of-tax rate, the probability of contributing above the minimum increased by 0.05pp for self-employed workers aged 50-52. For real contributions, the corresponding semi-elasticity is 0.03%. The response is lower compared to the elasticity of saving incentives estimated for self-employed workers using variations in tax incentives to qualified pension plans, which ranged between 0.5 (Selin, 2012) and 2.0 (Power and Rider, 2002). Although responses show a progressive increase over time, the magnitude of contribution responses could be considered modest as it would take many years to reach a substantial semi-elasticity.

1997 reform: Cohort-based eligibility to the option value decision

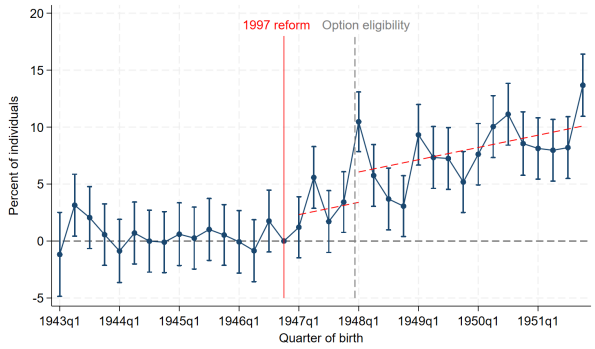
I examine heterogeneous responses depending on the cohort-based eligibility to make the option value decision after the 1997 reform. Figure 5 provides graphical evidence on the dynamic DiD estimates by quarter of birth on probability of contributing above the minimum and above the 50+ maximum, respectively for the self-employed aged 50, 51 and 52. The top panel of the figures illustrates a sharp increase in the probability of contributing above the minimum for cohorts born post-1948, compared to those born pre-1947. In contrast, the bottom panel indicates no increase in the probability of contributing above the 50+ maximum, where the option value extends the range of available contributions. This implies that the response to making the option value decision can be attributed to the behavioral aspect of the decision, rather than to option value incentives.

Table 3 shows that eligibility for the option value decision amplified the responsiveness to the 1997 reform by 2.84pp. However, eligibility for the option value decision had no effect on contributions above the threshold where option value incentives exist, which attributes the response to the increased attention of the decision.

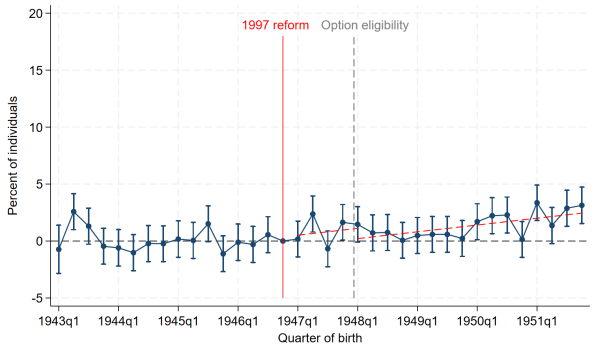
For robustness, I perform the analysis using placebo eligibility cut-offs for cohorts 1947, 1949 and 1950, finding no significant responses. This helps attribute the increase in response to the

Figure 5: Graphical evidence of the effect of eligibility to the option value decision

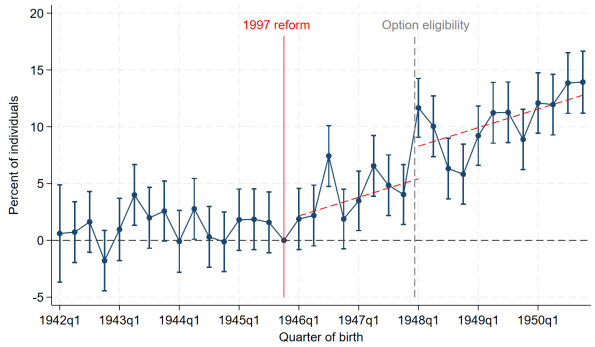
(a) Age 50: Prob. above minimum



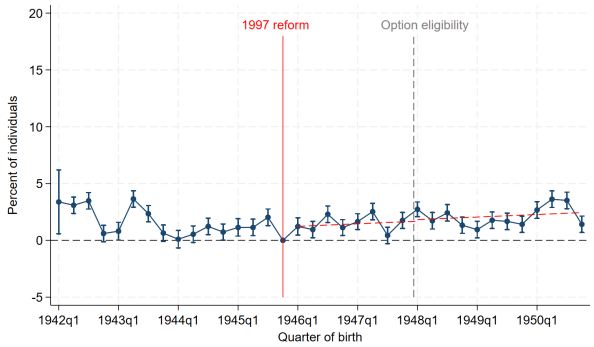
(b) Age 50: Prob. above option threshold



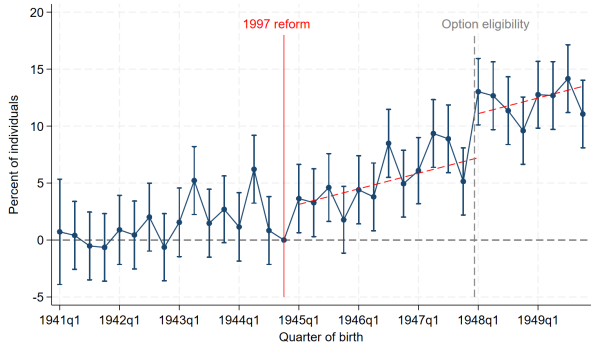
(c) Age 51: Prob. above minimum



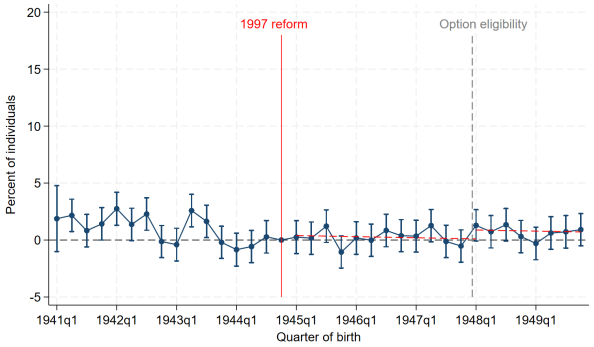
(d) Age 51: Prob. above option threshold



(e) Age 52: Prob. above minimum



(f) Age 52: Prob. above option threshold



Notes: The figure displays dynamic DiD estimates on the effect of the 1997 reform by quarter of birth at age 50, 51 and 52. The control group consists of individuals aged 40-46. The responses are reported for the probability of contributing above the minimum (left panels) and above the threshold providing an option value (right panels). The vertical red line indicates the 1997 reform. The vertical gray dashed line indicates post-1948 cohort, who were eligible to to the option value decision after 1997.
Source: MCVL 2005.

Table 3: Effect of eligibility to the option value on the response to the 1997 reform

	Eligibility: Post-1948	Placebo eligibility		
		Post-1947	Post-1949	Post-1950
	(1)	(2)	(3)	(4)
Prob above min	2.84*	0.08	0.93	0.86
	(1.41)	(1.53)	(1.54)	(1.72)
Prob above option threshold	-0.05	0.15	-0.98	1.03
	(0.68)	(0.70)	(0.70)	(0.85)
N (obs)	97,115	97,115	97,115	97,115

Notes: This table provides the coefficient estimates on the effect of eligibility to the option value decision, which is defined by cohorts born after 1948, on the DiD response to the 1997 pension reform for self-employed aged 50-52 years (column 1). This also provides the results for a placebo eligibility cut-off of cohorts born in 1947 (column 2) 1949 (column 3) and 1950 (column 4). The outcomes of interest are the probability of contributing above the minimum and above the option threshold. Standard errors in parenthesis. * p<0.05, ** p<0.01, *** p<0.001. *Source:* MCVL 2005

option value decision.

6.3 Robustness checks

I assess the robustness of my baseline dynamic DiD results to the 1993 and 1997 reform for alternative specifications, as well as to alternative assumptions for calculating incentives. I first estimate my baseline DiD specification without controls to check the importance of the composition of treatment and control groups. Second, I verify the robustness of my results by extending the age range of the treatment group to include those aged 50-53 and 50-54 years. Third, I restrict the control group to those aged 40-44, ruling out any effect of early retirement, and those aged 42-46, who are closer and more comparable to the treatment group. Table 4 indicates that my estimated results are robust to these specifications.

I then verify the robustness of my 2SLS semi-elasticity of contribution incentives to alternative assumptions for calculating incentives. First, I consider alternative discount rates of 1% and 5% to calculate the present value of future benefits. Second, I apply replacement rates of 70% and 100% to the benefit base, instead of my baseline 92.16% rate. Third, I consider applying the mortality rates of individuals who were 5 years older or younger than my treatment group aged 50-52. Fourth, I consider early retirement at 62 years. Fifth, I assess the robustness to policy

Table 4: Dynamic DiD results on the 1993 and 1997 reform using alternative specifications

	Baseline	No controls	Treatment group		Control group	
			50-53y	50-54y	40-44y	42-46y
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: 1993 reform						
Prob above min. (β_4)	2.46***	2.33***	3.13***	2.96***	2.28***	2.83***
	(0.65)	(0.66)	(0.60)	(0.56)	(0.65)	(0.68)
Pre-trends (p-val)	0.51	0.77	0.96	0.92	0.25	0.73
Log of real contr. (β_4)	0.97*	0.86	1.32**	1.26**	0.86	1.12*
	(0.46)	(0.47)	(0.42)	(0.39)	(0.45)	(0.48)
Pre-trends (p-val)	0.24	0.28	0.62	0.55	0.06	0.36
N (obs)	72,259	72,259	77,971	83,517	56,740	57,538
Panel B: 1997 reform						
Prob above min. (β_5)	10.35***	10.55***	10.66***	10.46***	10.90***	9.98***
	(0.86)	(0.88)	(0.77)	(0.71)	(0.86)	(0.89)
Pre-trends (p-val)	0.55	0.50	0.18	0.06	0.76	0.40
Log of real contr. (β_5)	6.67***	6.80***	6.70***	6.30***	6.93***	6.51***
	(0.55)	(0.56)	(0.48)	(0.44)	(0.55)	(0.56)
Pre-trends (p-val)	0.45	0.45	0.66	0.33	0.32	0.52
N (obs)	97,115	97,115	106,417	115,075	77,200	78,162

Notes: This table provides the dynamic DiD estimates four years after the 1993 reform (panel a) and five years after the 1997 reform (panel b) using alternative specifications. The outcome variables are the probability of contributing above the minimum and the logarithm of real contributions. My baseline specification compares those aged 50-52 to those aged 40-46 (column 1). I further consider including no covariates (column 2), extensions of the treatment group to include those aged 50-53 (column 3) and aged 50-54 (column 4), reducing the control group to those aged 40-44 (column 5) and aged 42-46 (column 6). The coefficient estimates on the log of real contributions are multiplied by 100 to represent percentage points of real contributions. Pre-trends report the p-value of joint significance of the periods before the reform. Standard errors in parenthesis. * p<0.05, ** p<0.01, *** p<0.001.
Source: MCVL 2005

uncertainty, considering that the certainty equivalent of pension benefits under current rule was 57.8%[25] (Luttmer and Samwick, 2018). Table 5 indicates that my estimated semi-elasticities remain qualitatively similar in all cases, pointing to modest responses to contribution incentives.

6.4 Heterogeneity analysis

I assess the heterogeneity of my baseline results depending on available demographic characteristics. Figure 6 shows that the heterogeneity of contribution responses to the 1993 was small, while the heterogeneity to the 1997 reform was somewhat larger. Responses to the 1997 reform were lower for workers living in regions with lower incomes, and increasing in education, municipality size, and

[25] I derive this value from Luttmer and Samwick (2018), who found that US taxpayers aged 50-54 years were willing to accept 57.8% of their pensions under current rule to avoid pension reforms.

Table 5: 2SLS semi-elasticity of contribution incentives under alternative assumptions

	Baseline	Discount rate		Contr. year coef.		Mortality		Early ret.	Policy unc.
		d = 1%	d = 5%	α = 100%	α = 70%	45-47y	55-57y	R = 62y	CE = 57.8%
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A: Prob. above min.									
ϵ_5	0.052	0.032	0.082	0.048	0.070	0.044	0.064	0.059	0.090
Panel B: Log of real contr.									
ϵ_5	0.034	0.021	0.053	0.031	0.045	0.028	0.042	0.038	0.058

Notes: This table provides the semi-elasticities of contribution incentives 5 years after the 1997 reform using alternative assumptions for calculating incentives. The semi-elasticities represent the Wald ratio of the effect of the 1997 reform on contributions, relative to the effect on contribution incentives (see Equation 7). The DiD approach compares those aged 50-52 to those aged 40-46. The outcome variables are the probability of contributing above the minimum and the logarithm of real contributions. The table includes my baseline semi-elasticity (column 1). I further estimate the semi-elasticity for a discount rate of 1% (column 2) and 5% (column 3), replacement rate of 100% (column 4) and 70% (column 5); using the survival probabilities of those aged 45-47 years (column 6) and 55-57 years (column 7) for my target population are those aged 50-52; early retirement at 62 years (column 8); and accounting for policy uncertainty using a certainty equivalent (CE) of 57.8% (column 9).
Source: MCVL 2005

for males compared to females. However, the overall heterogeneity in contribution responses could be considered modest, which aligns with Liebman and Luttmer (2012) finding a low association between demographic characteristics and awareness of pension rules.

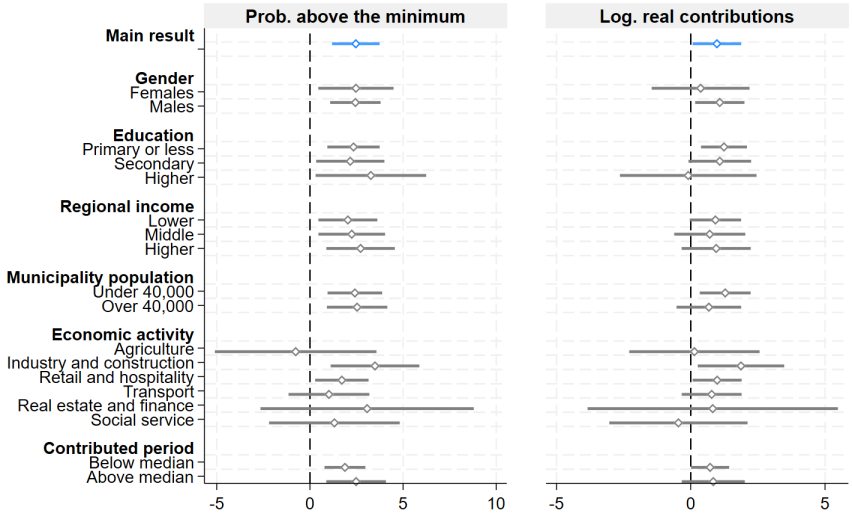
6.5 Evidence on understanding of contribution incentives

I present further evidence that indicates general challenges in perceiving public pension contribution incentives. I use the 2003 reform, which granted eligibility for a 25% reduction in minimum contributions for new self-employed workers younger than 30 and females older than 45 years. Figure 7 shows that more than 45% of the new self-employed workers younger than 30 years did not opt for reduced contributions, while for females older than 45 years, this percentage was as high as 70%[26]. Among those who did not reduce their contributions, the majority of eligible self-employed opted for the ordinary minimum level. The adherence to the ordinary minimum level, acting as a social default, can be attributed to the challenges associated with understanding incentives (Altmann et al., 2022a). Therefore, the limited adoption of reduced minimum contributions could serve as evidence that a significant portion of self-employed workers misunderstand the link between SSCs and pension benefits. Since self-employed workers actively choose their contributions at registra-

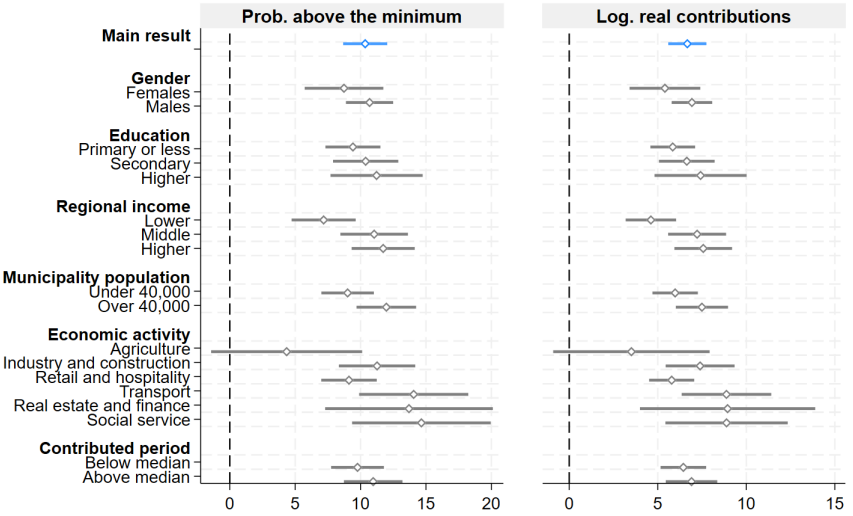
[26]Figure H.1 shows limited learning, since the fraction of self-employed workers opting for reduced contributions remained stable over time.

Figure 6: Heterogeneity of responses to pension reforms

(a) 1993 reform: Option value decision



(b) 1997 reform: Contribution incentives

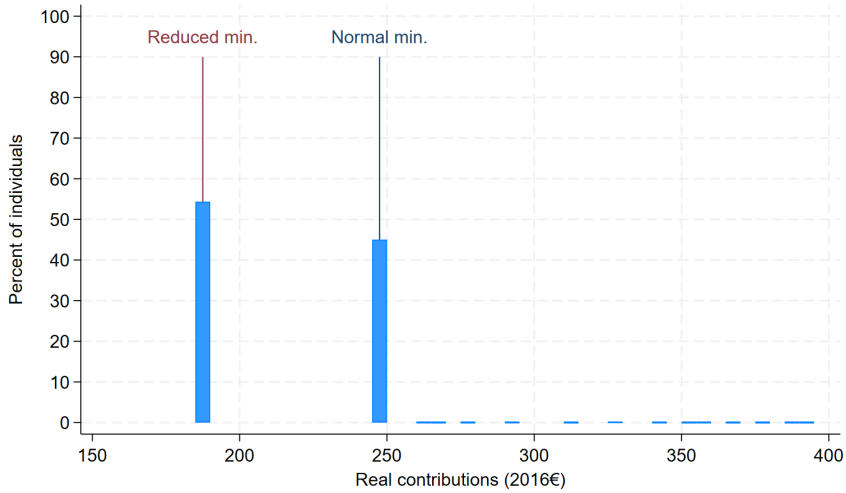


Notes: The figure shows the heterogeneity of responses to the 1993 and 1997 pension reforms for self-employed workers aged 50-52. Coefficient estimates report dynamic DiD effects four years after the 1993 reform (panel a) and five years after the 1997 reform (panel b). The coefficient estimates on the log of real contributions are multiplied by 100 to represent percentage points of real contributions. Heterogeneity by regional income classifies Autonomous Communities by GDP per capita in 1997, resulting in regions with higher income (Balearic Islands, Basque Country, Catalonia, Madrid and Navarre), middle income (Aragon, Asturias, Canary Islands, Cantabria, Castile-Leon, Ceuta, La Rioja, Melilla and Valencian Community) and lower income (Andalusia, Castile La Mancha, Extremadura, Galicia and Murcia).
Source: MCVL 2005.

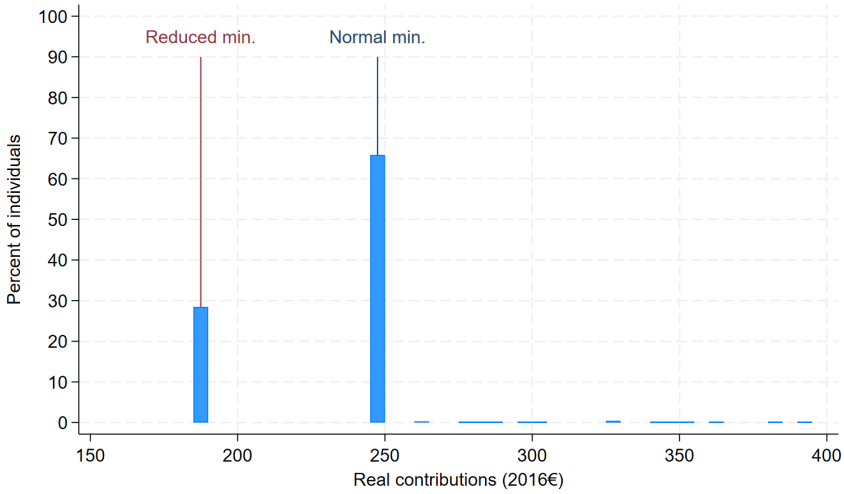
tion, the low responses to the opportunity to reduce contributions may not be explained by inertia (Carroll et al., 2009) or fixed decision costs (Almunia et al., 2020).

Figure 7: Histogram of contributions new self-employed workers eligible to 2003 reform

(a) Aged 30 or less



(b) Females aged 45 or more



Notes: This figure displays the histogram of contributions of eligible new self-employed workers aged less than 30 (panel a) and females aged over 45 (panel b) in 2004. The red vertical line represents the reduced minimum for eligible workers and the blue vertical line represents the normal minimum contributions.
Source: MCVL 2005.

New entrants into self-employment could be expected to be more financially constrained than long-term self-employed workers, making them more predisposed to opting for smaller contributions. Consequently, the estimated contribution reduction to the 2003 reform could be considered as an upper bound relative to my primary sample of long-term self-employed workers.

7 Discussion

Throughout the paper, I provide evidence that highlights the misperception of Social Security contribution incentives among self-employed workers in Spain, as well as the relevance of contextual factors for their perception. First, I explore alternative explanations for the modest responses to contribution incentives among self-employed workers in Spain. Second, I discuss the external validity of my results for broader public pension systems and populations.

7.1 Alternative explanations

I explore alternative explanations for the modest responses to contribution incentives among self-employed workers in Spain. While they may play a role, I discuss that these explanations may not fully explain the modest responses to contribution incentives in this context.

Rational explanations

I discuss rational explanations for low responses to contribution incentives in Spain.

Liquidity constraints. Liquidity constraints (Deaton, 1991) could hinder increased contributions even under large contribution incentives. However, survey data indicates that self-employed workers in Spain have higher mean and median income and wealth compared to wage earners (Bover, 2008). This, along with my focus on long-term self-employed workers, who are expected to have higher income and wealth levels, suggests that liquidity constraints may not be the primary driver of modest responses to contribution incentives. Furthermore, I provide evidence on cases where self-employed workers over-contributed, which contradicts liquidity constraints.

Returns of alternative savings. If alternative savings options were more favorable than public pensions, one would expect self-employed workers to opt for such alternatives. However, the exceptional returns offered by the Spanish pension system, especially close to retirement, make finding more profitable alternative saving options unlikely. Furthermore, self-employed retirees in Spain have low private pension annuities, as described in Appendix I.

Business investments. If self-employed workers needed to finance business investments with potentially better returns, they would not increase their SSCs. However, Moskowitz and Vissing-Jørgensen (2002) find that the returns to entrepreneurial investment in single privately held firms are lower and more risky than alternative assets. Additionally, I show very low contributions close to retirement, when business investments are less likely, and the returns offered by SSCs are enormous and certain.

Uncertainty. The return of SSCs at age 50-52 may be influenced by future pension reforms and labor market decisions, introducing some degree of uncertainty. However, I find that responses to contribution incentives were modest even close to retirement, when uncertainty was minimal and SSC returns were exceptionally large. Additionally, further pension reforms did not affect contribution incentives until 2013[27].

Behavioral explanations

I also discuss behavioral explanations for the observed responses to contribution incentives.

Present bias. Present bias (Thaler and Benartzi, 2004) might prevent self-employed workers from increasing contributions due to the time gap between the age of contributions and retirement. However, I provide evidence on two case studies where self-employed workers leave money on the table, which contradicts present bias.

Inertia. Default options have been found to play a crucial role in saving decisions (Madrian and Shea, 2001; Carroll et al., 2009; Chetty et al., 2014). However, I provide evidence of two case studies in which self-employed workers leave money on the table through active decisions. First, 17.7% of self-employed workers aged 64 actively increased contributions in the absence of SSC incentive. Second, a considerable fraction of new self-employed workers did not reduce contributions, even if this would not have affected their future benefits.

[27]The 2011 reform gradually increased the period of contributions considered for calculating pensions from 15 to 25 years, based on the year of retirement between 2013 and 2022.

Cognitive uncertainty. The complexity of the decision to provide for retirement could potentially attenuate responses to contribution incentives (Enke and Graeber, 2023, Enke et al., 2024). However, in the context of the contribution decision of self-employed workers, the extraordinary returns offered by the Spanish pension system offer a dominant strategy, a case where cognitive uncertainty is recognized to play a limited role.

7.2 External validity

My findings provide valuable insights for understanding the perception of contribution incentives in broader populations and pension systems. First, the pension formulas for self-employed workers in Spain are identical to those for wage earners and comparable to earnings-related pension systems in other countries. This includes countries with earnings-related pension systems calculating pensions based on the last years of earnings (e.g. Costa Rica, Uruguay, or Colombia), best years of earnings (e.g. United States, Austria, France, Lithuania, Portugal, or Slovenia) or lifetime earnings (e.g. Belgium, Canada, Germany, Finland, Greece, Japan, Korea, Turkey, Hungary, or Czech Republic) (OECD, 2023).

These results also offer valuable insights into the perception of public pension contribution incentives for broader population groups. First, I focus on self-employed workers, recognized as one of the most financially literate groups (Struckell et al., 2022). Second, SSC incentives may be even less salient for the general population, as they do not need to make a contribution decision as the Spanish self-employed do, potentially paying less attention to contribution incentives. Third, I concentrate my analysis on long-term self-employed workers, who possess the highest incentives and are presumed to have the greatest contribution capacity. This suggests that the level of misperception of contribution incentives may be even more pronounced among the broader population.

Furthermore, my findings contribute to understanding behavioral responses to SSCs in settings where workers are required to pay SSCs based on their income. The degree of perception of SSC incentives is a critical parameter for understanding labor supply responses to SSCs (Auerbach and Kotlikoff, 1985). My evidence showing that workers face challenges in perceiving SSC incentives,

coupled with the observation that contextual factors can shape this perception, has relevant implications for taxpayers making SSCs based on their labor earnings.

8 Conclusion

This paper explores the role of attention on the perception of contribution incentives in public pension systems. My empirical approach uses the unique context in Spain, where self-employed workers can voluntarily choose their SSCs, coupled with quasi-experimental variations in contribution incentives arising from pension reforms.

My findings indicate that self-employed workers gave modest responses to the exceptional contribution incentives in Spain. My results also highlight that behavioral stimuli play a significant role on the workers' contribution behavior, highlighting the role of attention for perceiving implicit contribution incentives. A notable observation is that a substantial portion of self-employed workers made suboptimal contribution choices, over-contributing when SSC gave no pension return. These results reveal that taxpayers face challenges in understanding the contribution incentives embedded in contributory public pension systems.

While providing valuable insights, this study has some limitations that future research should aim to further develop. First, data constraints preclude an exploration of the role of income in shaping responses to contribution incentives. Furthermore, the lack of data hinders the study of the substitution dynamics between pension contributions and other forms of savings for self-employed workers in Spain. Finally, pension reforms in Spain offer stimuli pointing attention to the timing of the linkage between contributions and pensions, but not to the magnitude of SSC incentives in Spain. In moving forward, addressing these limitations will contribute to a more nuanced understanding of the factors shaping the perceived valuation of SSC incentives.

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Appendix to

The Role of Attention in Perceiving Social Security Contribution Incentives: Evidence from Voluntary Contributions

Ander Iraizoz

November 21, 2025

This Appendix serves as a supplementary resource to the institutional details outlined in Section 2 (Appendix A), sample letters sent by self-employed associations to self-employed workers containing information on their Social Security contribution (SSC) decisions (Appendix A.4), complements to the methodology to calculate Social Security contribution incentives (Appendix B), complementary details on the sample selection (Appendix C), additional results on the response to the 1993 reform (Appendix F), additional results on the response to the 1997 pension reforms (Appendix G), additional results on the response to the 2003 reform (Appendix H), and details on private pensions by levels of public pensions for self-employed retirees (Appendix I).

A Institutional details

This appendix provides additional details on the Special Scheme for Self-Employed Workers (RETA), as well as describing the changes in pension formulas introduced by the 1997 pension reform.

A.1 Voluntary contributions under RETA

Figure A.1 provide a sample of the form for changing contributions for self-employed workers covered under RETA in 2010. The form had four sections. The first section covered the personal identification of the worker. The second section covered the selection of the new contribution base. The third section specified the future automatic increases of this contribution base. Finally, the bank details for the payment of Social Security contributions was provided.

A.2 Contribution and pension thresholds under RETA

The RETA scheme regulates the Social Security provisions for self-employed workers in Spain. One of its noteworthy features is the provision that allows self-employed workers to autonomously select their contribution bases to Social Security, within annually legislated maximum and minimum limits. Table A.1 provides an overview of the maximum and minimum contribution bases under RETA, along with the Social Security contribution (SSC) rates between 1994 and 2002.

A.3 Pension formulas and the 1997 reform

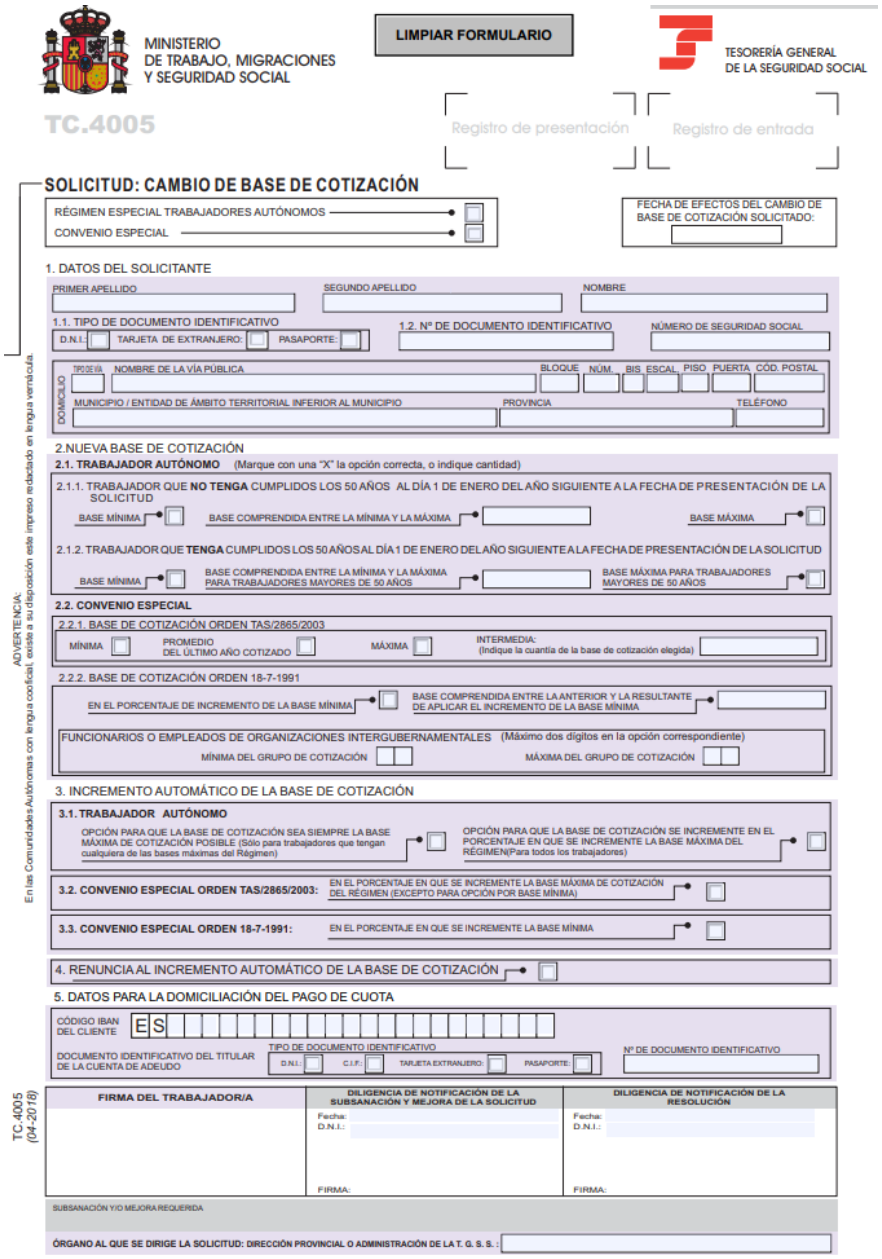
This section describes the pension formulas and the 1997 pension reform. This describes the background and the precise formulation of pension formulas before and after the 1997 reform.

Background

The 1997 pension reform was implemented in July 1997[1]. The primary objective of the reform was fiscal consolidation and it was applied to all Social Security schemes in Spain. Therefore, the reform was not designed with a specific focus on self-employed workers. Importantly, the reform left most

[1]Law 24/1997, of 15th July, of Consolidation and Rationalization of the Social Security system.

Figure A.1: Form for changing self-employed workers' contribution base under RETA


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SOLICITUD: CAMBIO DE BASE DE COTIZACIÓN

RÉGIMEN ESPECIAL TRABAJADORES AUTÓNOMOS

CONVENIO ESPECIAL

FECHA DE EFECTOS DEL CAMBIO DE BASE DE COTIZACIÓN SOLICITADO:

1. DATOS DEL SOLICITANTE

PRIMER APELLIDO | SEGUNDO APELLIDO | NOMBRE

1.1. TIPO DE DOCUMENTO IDENTIFICATIVO

D.N.I. | TARJETA DE EXTRANJERO: | PASAPORTE:

1.2. Nº DE DOCUMENTO IDENTIFICATIVO

NÚMERO DE SEGURIDAD SOCIAL

DOMICILIO

TIPO DE VÍA | NOMBRE DE LA VÍA PÚBLICA | BLOQUE | NÚM. | BIS | ESCAL. | PISO | PUERTA | CÓD. POSTAL

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2.NUEVA BASE DE COTIZACIÓN

2.1. TRABAJADOR AUTÓNOMO (Marque con una "X" la opción correcta, o indique cantidad)

2.1.1. TRABAJADOR QUE NO TENGA CUMPLIDOS LOS 50 AÑOS AL DÍA 1 DE ENERO DEL AÑO SIGUIENTE A LA FECHA DE PRESENTACIÓN DE LA SOLICITUD

BASE MÍNIMA | BASE COMPRENDIDA ENTRE LA MÍNIMA Y LA MÁXIMA | BASE MÁXIMA

2.1.2. TRABAJADOR QUE TENGA CUMPLIDOS LOS 50 AÑOS AL DÍA 1 DE ENERO DEL AÑO SIGUIENTE A LA FECHA DE PRESENTACIÓN DE LA SOLICITUD

BASE MÍNIMA | BASE COMPRENDIDA ENTRE LA MÍNIMA Y LA MÁXIMA PARA TRABAJADORES MAYORES DE 50 AÑOS | BASE MÁXIMA PARA TRABAJADORES MAYORES DE 50 AÑOS

2.2. CONVENIO ESPECIAL

2.2.1. BASE DE COTIZACIÓN ORDEN TAS/2865/2003

MÍNIMA | PROMEDIO DEL ÚLTIMO AÑO COTIZADO | MÁXIMA | INTERMEDIA: (Indique la cuantía de la base de cotización elegida)

2.2.2. BASE DE COTIZACIÓN ORDEN 18-7-1991

EN EL PORCENTAJE DE INCREMENTO DE LA BASE MÍNIMA | BASE COMPRENDIDA ENTRE LA ANTERIOR Y LA RESULTANTE DE APLICAR EL INCREMENTO DE LA BASE MÍNIMA

FUNCIONARIOS O EMPLEADOS DE ORGANIZACIONES INTERGUBERNAMENTALES (Máximo dos dígitos en la opción correspondiente)

MÍNIMA DEL GRUPO DE COTIZACIÓN | MÁXIMA DEL GRUPO DE COTIZACIÓN

3. INCREMENTO AUTOMÁTICO DE LA BASE DE COTIZACIÓN

3.1. TRABAJADOR AUTÓNOMO

OPCIÓN PARA QUE LA BASE DE COTIZACIÓN SEA SIEMPRE LA BASE MÁXIMA DE COTIZACIÓN POSIBLE (Sólo para trabajadores que tengan cualquiera de las bases máximas del Régimen)

OPCIÓN PARA QUE LA BASE DE COTIZACIÓN SE INCREMENTE EN EL PORCENTAJE EN QUE SE INCREMENTE LA BASE MÁXIMA DEL RÉGIMEN(Para todos los trabajadores)

3.2. CONVENIO ESPECIAL ORDEN TAS/2865/2003: EN EL PORCENTAJE EN QUE SE INCREMENTE LA BASE MÁXIMA DE COTIZACIÓN DEL RÉGIMEN (EXCEPTO PARA OPCIÓN POR BASE MÍNIMA)

3.3. CONVENIO ESPECIAL ORDEN 18-7-1991: EN EL PORCENTAJE EN QUE SE INCREMENTE LA BASE MÍNIMA

4. RENUNCIA AL INCREMENTO AUTOMÁTICO DE LA BASE DE COTIZACIÓN

5. DATOS PARA LA DOMICILIACIÓN DEL PAGO DE CUOTA

CÓDIGO IBAN DEL CLIENTE E S

DOCUMENTO IDENTIFICATIVO DEL TITULAR DE LA CUENTA DE ADEUDO

TIPO DE DOCUMENTO IDENTIFICATIVO: D.N.I. | C.I.F. | TARJETA EXTRANJERO: | PASAPORTE:

Nº DE DOCUMENTO IDENTIFICATIVO

FIRMA DEL TRABAJADOR/A	DILIGENCIA DE NOTIFICACIÓN DE LA SUBSANACIÓN Y MEJORA DE LA SOLICITUD	DILIGENCIA DE NOTIFICACIÓN DE LA RESOLUCIÓN
	Fecha: D.N.I.: FIRMA:	Fecha: D.N.I.: FIRMA:

SUBSANACIÓN Y/O MEJORA REQUERIDA

ÓRGANO AL QUE SE DIRIGE LA SOLICITUD: DIRECCIÓN PROVINCIAL O ADMINISTRACIÓN DE LA T. G. S. S. :

ADVERTENCIA:
En las Comunidades Autónomas con lengua cooficial, existe a su disposición este impreso redactado en lengua vernácula.

TC.4005
(04-2016)

Notes: The figure provides the form that the self-employed need to provide in order to change their contribution base in 2010. The form has four sections. First, personal identification. Second, the selection of the new contribution base. Third, the future automatic increase of this contribution base. Four, bank details for the payment of Social Security contributions.
Source: Social Security General Treasury.

of the remaining parameters in the pension system unchanged, including the Social Security rate, retirement age, or disability and survivor benefits.

Table A.1: Social Security parameters under RETA

	SSC rate (%)	Monthly contribution bases (€)			Annual retirement pensions 65+ (€)		
		Minimum	Maximum		Minimum		Maximum
			age < 50	age ≥ 50	Dep. spouse	No dep. spouse	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1994	27.0	940.60	3,508.82	1,834.87	680.57	578.40	2,998.72
1995	26.5	943.43	3,469.40	1,810.41	678.80	576.93	2,990.87
1996	26.5	942.92	3,467.54	1,803.70	678.45	576.64	2,989.17
1997	26.5	965.52	3,488.96	1,823.26	682.64	580.20	3,007.61
1998	26.5	985.00	3,497.99	1,843.87	684.43	581.75	3,015.45
1999	26.5	986.79	3,480.66	1,854.47	687.05	584.01	3,026.93
2000	26.5	977.77	3,432.54	1,843.42	708.09	601.30	3,046.44
2001	26.5	962.68	3,379.88	1,803.91	702.02	596.14	3,020.28
2002	26.5	952.39	3,376.43	1,784.40	707.44	600.74	3,043.57

Notes: This table describes the main parameters under RETA between 1994-2002. This includes SSC rates (column 1), monthly minimum contribution base (column 2) and maximum base under RETA, which differs below age 50 (column 3) and above age 50 (column 4). The table also provides monthly minimum retirement pension benefits for those aged above 65, which depend on whether retirees have a dependent spouse (column 5) or not (column 6), along with maximum pension (column 7). Values are reported in real values terms in 2016 euros. Contributions are paid in 12 monthly payments, while pension benefits are received in 14 payments. Pension benefits are reported in equivalent values of 12 monthly pension payments.
Source: Spanish General Government Budget 1994-2002.

Public pension formulas

Upon satisfying the eligibility criteria for a pension, monthly pension benefits are calculated using the following formula[2]:

$$P_{R,n} = \alpha_n \times \beta_R \times BB \tag{1}$$

where $P_{R,n}$ denotes monthly pension benefits when claiming retirement at age R with n contribution years. α_n represents the coefficient for the number of contribution years n, which penalized contribution periods shorter than 35 years. β_R stands for the coefficient for retirement age R, which penalized early retirement before the statutory retirement age of 65 years. BB refers to the benefit base, calculated as the average of the contribution bases during the last years before claiming retirement. Monthly pension benefits are bounded by maximum and minimum pensions. I describe the three components of pension formulas before and after the 1997 reform.

[2]Eligibility to a retirement pension required 15 years of contributions to Social Security, and retirement at least at 60 years of age. Early retirement also required accrued pensions to exceed minimum pensions.

Benefit base. The 1997 pension reform extended the calculation period for the benefit base from the last 8 to the last 15 years. The computation of the benefit base in both the pre- and post-1997 pension systems is expressed as follows:

$$BB_t^{1985} = \frac{1}{112}\left(\sum_{i=1}^{24} CB_{t-i} + \sum_{i=25}^{96} CB_{t-i}\frac{CPI_{t-25}}{CPI_{t-i}}\right) \qquad BB_t^{1997} = \frac{1}{210}\left(\sum_{i=1}^{24} CB_{r-i} + \sum_{i=25}^{180} CB_{r-i}\frac{CPI_{r-25}}{CPI_{r-i}}\right)$$

where BB_t^{1985} represents the benefit base for retirees at time t in the system between 1985 and 1997, CB_{t-i} denotes the contribution base made i periods before retirement date t, CPI_{t-i} stands for the Consumer Price Index (CPI) i months before the retirement date t and BB_t^{1997} represents the benefit base in the post-1997 pension system. The division of 96 months of contributions by 112 accounts for taxpayers paying SSCs 12 times a year, while pensioners receive 14 annual pension payments at retirement. The increase in the number of years of contributions was implemented gradually based on the year of retirement, considering 9, 10, 11, 12, 13, and 15 years for retirement in 1997, 1998, 1999, 2000, 2001, and 2002 onward.

Coefficient for contribution years. The 1997 pension reform increased the penalization for insufficient contribution years from 2% to 3% for those retiring with contribution years between 15 and 25. The coefficient for contribution years before and after the 1997 reform is expressed as follows:

$$\alpha_n^{1985} = \begin{cases} 0 & \text{if } n < 15 \\ 0.6 + 0.02(n-15) & \text{if } 15 \le n < 35 \\ 1 & \text{if } n \ge 35 \end{cases} \qquad \alpha_n^{1997} = \begin{cases} 0 & \text{if } n < 15 \\ 0.5 + 0.03(n-15) & \text{if } 15 \le n < 25 \\ 0.8 + 0.02(n-25) & \text{if } 25 \le n < 35 \\ 1 & \text{if } n \ge 35 \end{cases}$$

where α_n^{1985} refers to the coefficient for contribution years for individuals retiring between 1985 and 1997 with n years contributed to Social Security and α_n^{1997} for individuals retiring after 1997 with n contribution years.

Coefficient for retirement age. The 1997 pension reform reduced the penalization for early retirement from 8% to 7% for those retiring with contribution years above 40. The formulas for the coefficient of retirement age before and after the 1997 pension reform are expressed as follows:

$$\beta_R^{1985} = \begin{cases} 0 & \text{if } R < 60 \\ 1 - 0.08(65 - R) & \text{if } 60 \leq R < 65 \\ 1 & \text{if } R \geq 65 \end{cases} \qquad \beta_{R,n}^{1997} = \begin{cases} 0 & \text{if } R < 60 \\ 1 - 0.08(65 - R) & \text{if } 60 \leq R < 65 \text{ and } n < 40 \\ 1 - 0.07(65 - R) & \text{if } 60 \leq R < 65 \text{ and } n \geq 40 \\ 1 & \text{if } R \geq 65 \end{cases}$$

where β_R^{1985} represents the retirement age coefficient for individuals retiring between 1985 and 1997 with age R and $\beta_{R,n}^{1997}$ represents the coefficient for individuals retiring after 1997 with age R and n years contributed to Social Security.

A.4 Option value decision

This section describes the main regulations giving rise to the option value decision and its implications in terms of incentives and salience.

Description. Above some age, which I term the *option age*, the maximum ceiling of contributions for following years depends on current contributions. Specifically, the maximum ceiling for contributions was substantially smaller compared to the regular maximum contribution base, with precise values for these thresholds are provided Table A.1. However, if self-employed workers chose a contribution base above this reduced threshold right before the *option age*, they would be able to choose a contribution base as large as their previous years' contribution base. In subsequent years, their contribution base could only be increased in line with the growth rate of the maximum contribution base. Therefore, if self-employed workers would like to contribute above the reduced ceiling when they are older than the *option age*, they should have decided to increase their contributions before reaching the *option age*.

I describe how maximum contributions depend on the contributions at the *option age* and

beyond. We can define three possible cases depending on the contribution choice at the *option age* are considered in respective panels in Figure A.2:

(a) **Contributions equal or below the option threshold** ($C_{a^o t} \leq C_t^{opt}$): If self-employed workers chose a contribution equal or below the option threshold of around €500/month at the *option age*, the maximum contribution until retirement will be the option threshold - around €500/month.

(b) **Contributions above the option threshold, kept in future years** ($C_{a^o t+s} = C_{a^o t} > C_t^{opt}$ for all $s \in [1, R - a^o]$): If self-employed workers chose a contribution above the option threshold of around €500/month at the *option age*, the maximum contribution starting from the following year will be their chosen contribution. Panel (b) shows that if they kept this contribution level in subsequent years, they could keep this level until retirement.

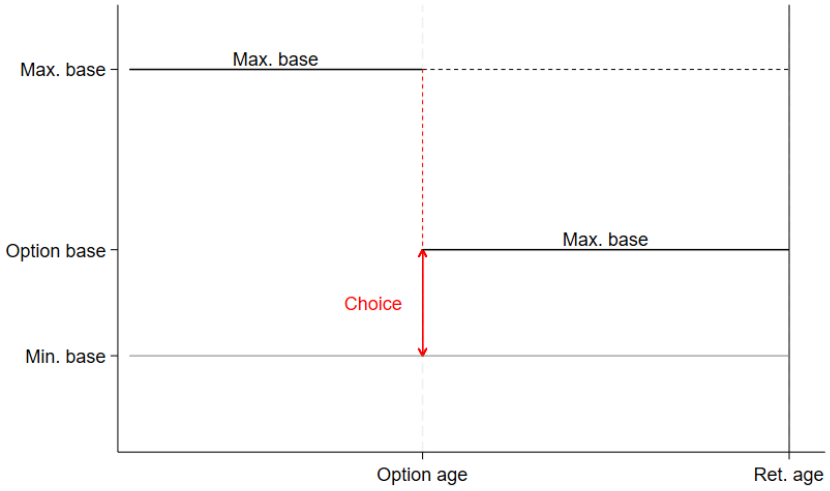
(c) **Contributions above the option threshold, decreased in future years** ($C_{a^o t} > C_t^{opt} \geq C_{a^o t+s} =$ for some $s \in [1, R - a^o]$): If self-employed workers chose a contribution above the option threshold of around €500/month at the *option age*, the maximum contribution starting from the following year will be their chosen contribution. Panel (c) shows that if they decreased this contribution level in some year in the future, their maximum contribution would also be reduced for subsequent years. If their contribution ever came below the option threshold, then the option threshold - around €500/month - would be the maximum contribution until retirement.

Information and salience

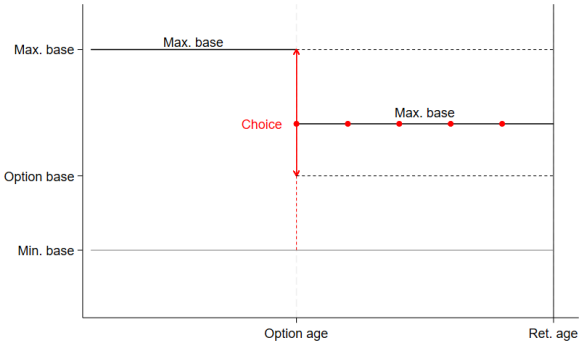
The decision features in the government budget every year when the contribution thresholds are updated. I verified that self-employed associations forward notifications on the updates on Social Security regulations, including the option value decision. Therefore, by prompting self-employed workers to consider their contributions, the option value decision could act as a reminder. Figure A.3 displays a sample notification informing the conditions of the option value decision. Figure

Figure A.2: Maximum contribution base depending on contributions at the *option age*

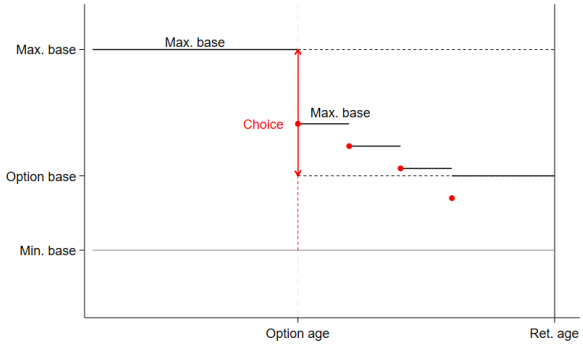
(a) Contribution base ≤ option threshold



(b) Contribution base > option threshold



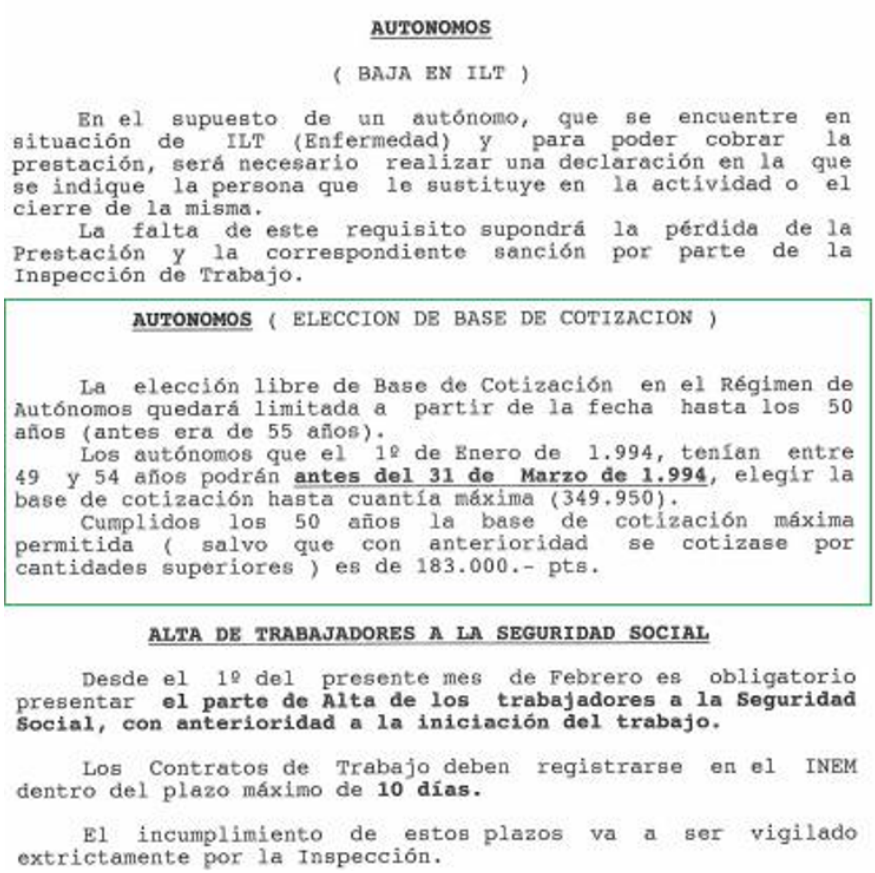
(c) Contribution base > option threshold



Notes: The figure shows the the maximum contributions depending on the contributions at the *option age*. Panel (a) shows the maximum contribution base when self-employed workers chose a contribution base equal or below the option base at the *option age*. In this case, the maximum contribution past the *option age* would be the option base at around 500€/month. Panels (b) and (c) display the maximum contribution base when self-employed workers chose a contribution base above the option base at the *option age*. They show how the maximum contribution base differs depending on future choices.

A.4 displays a table of contribution limits, which shows the differences in contribution thresholds by age.

Figure A.3: Extract from a letter with information for self-employed in 1994.



AUTONOMOS

(BAJA EN ILT)

En el supuesto de un autónomo, que se encuentre en situación de ILT (Enfermedad) y para poder cobrar la prestación, será necesario realizar una declaración en la que se indique la persona que le sustituye en la actividad o el cierre de la misma.

La falta de este requisito supondrá la pérdida de la Prestación y la correspondiente sanción por parte de la Inspección de Trabajo.

AUTONOMOS (ELECCION DE BASE DE COTIZACION)

La elección libre de Base de Cotización en el Régimen de Autónomos quedará limitada a partir de la fecha hasta los 50 años (antes era de 55 años).

Los autónomos que el 1º de Enero de 1.994, tenían entre 49 y 54 años podrán **antes del 31 de Marzo de 1.994**, elegir la base de cotización hasta cuantía máxima (349.950).

Cumplidos los 50 años la base de cotización máxima permitida (salvo que con anterioridad se cotizase por cantidades superiores) es de 183.000.- pts.

ALTA DE TRABAJADORES A LA SEGURIDAD SOCIAL

Desde el 1º del presente mes de Febrero es obligatorio presentar **el parte de Alta de los trabajadores a la Seguridad Social, con anterioridad a la iniciación del trabajo.**

Los Contratos de Trabajo deben registrarse en el INEM dentro del plazo máximo de **10 días.**

El incumplimiento de estos plazos va a ser vigilado extrictamente por la Inspección.

Notes: This figure displays an extract from the letter received by self-employed that are part of a Self-employed Association in 1994. The green rectangle indicates the part of the letter where this informs about the change of the option value from 55 years to 50 years. The translation to English: *"The free choice of the contribution bases under the Social Security scheme for the self-employed will be limited from the age of 50 years (it was previously 55 years). The self-employed aged 49-54 years on the 1st January 1994 will be able to choose their contribution base up to the maximum contribution base (349,500 pesetas) by the 31st March 1994. Once aged 50 years, the maximum contribution base will be 183,000 pesetas (except for those who were contributing by larger contribution bases)."*
Source: Self-employed association for hairdressers in Navarre.

Figure A.4: Extract from a letter with information for self-employed in 2009.



➢ **Cotizaciones año 2.009.**

RÉGIMEN ESPECIAL DE TRABAJADORES AUTONOMOS

Base de Cotización		Tipo de cotización	Cuota con I.T.	Bonificación reducción
Máxima	3.166,20 €	29,90%	946,69 €	
Máx. 50 años	1.649,40 €		493,17 €	30% cuota mínima (30 meses) hombres 30 años, mujeres 35 años. Importe 74, 51€
Mínima	833,40 €	(26,50% + 3,30% por IT + 0,10% riesgo maternidad y lactancia	249,18 €	50% cuota mínima (60 meses). Alta inicial minusválidos. Importe: 124,18€
Mínima venta ambulante	714,00 €		217,64 €	
Mínima 60 años	458,40 €		145,12 €	100% cuota mínima. (12 meses) mujeres reincorporadas despues del parto.
	885,30 €		264,70 €	
Accidentes de Trabajo y Enfermedad Profesional, tarifa establecida en Disp. Final 13ª Ley 2/2008				

➢ **Salario mínimo interprofesional para el 2.009**: R.D. 2128/2008 de 26 de Diciembre (B.O.E. día 30) Incremento 2008/2009:4%; Anual: 8736,00€; Mensual: 624,00€; Diario: 20,80€.

➢ **Convenio de Peluquerías 2.009.** El pasado 31 de Diciembre de 2.008 venció la vigencia del convenio colectivo para nuestro sector. A día de hoy no tenemos todavía noticias de cuándo ni en qué términos vamos a iniciar las negociaciones para el futuro. En cuanto tengamos las primeras noticias os iremos informando,

➢ **REAL DECRETO 1975/2008, de 28 de noviembre, sobre las medidas urgentes a adoptar en materia económica, fiscal, de empleo y de acceso a la vivienda.**

«Artículo 3. Plan extraordinario para la contratación indefinida de trabajadores desempleados con responsabilidades familiares.

1. Los empleadores que, desde la fecha de entrada en vigor de este precepto hasta el día 31 de diciembre de 2010, contraten indefinidamente a tiempo completo a trabajadores desempleados con responsabilidades familiares, tendrán derecho a una bonificación en la cuota empresarial a la Seguridad Social de 125 euros/mes (1.500 euros/año) o, en su caso, de su equivalente diario, por trabajador contratado, durante dos años. A estos efectos, podrán utilizar cualquier modalidad de contratación indefinida prevista en el ordenamiento tanto ordinaria como de fomento de la contratación indefinida.

2. A efectos de lo establecido en este artículo, se considerará que el trabajador tiene responsabilidades familiares si tiene uno o más hijos a su cargo. Si la tenencia de cargas familiares no consta en la Oficina Pública de Empleo, podrá acreditarse en el momento de la contratación.

➢ **Reducción del 50% de la cotización a la Seguridad social en los supuestos de cambio de trabajo por riesgo durante el embarazo o lactancia natural, así como en los supuestos de enfermedad profesional (Disposición adicional 7ª)**

a) En los casos de riesgo durante el embarazo o lactancia natural prevé una reducción del 50% de la cuota empresarial por contingencias comunes si se destina a la trabajadora a un puesto de trabajo o función diferente y compatible con su estado durante el tiempo que dure dicho cambio de puesto.

b) En los casos de enfermedad profesional se prevé que el cambio de puesto de trabajo en la misma empresa u otra a un puesto compatible con la enfermedad profesional exista una reducción del 50% de la cotización empresarial por contingencias comunes, pero precisa el desarrollo reglamentario.

III.- VARIACIÓN DE DATOS EN LA SEGURIDAD SOCIAL PARA EL 2.009.

Recordamos a aquellos socios que deseen variar sus datos (Base de Cotización del Régimen Especial de Autónomos para el año 2.009, Opciones Incapacidad Temporal, etc.) que podrán hacerlo, siempre que así lo soliciten de la Tesorería General de la Seguridad Socia **antes del 1 de Abril,** con efectos del 1 de Julio del ejercicio vigente. Cualquier variación deberán de realizarlo por escrito ante dicha Tesorería. No obstante, si alguien necesita asesoramiento, puede dirigirse directamente a las oficinas de la Asociación.

IV.- Cursos SUBVENCIONADOS para AUTÓNOMOS y TRABAJADORES POR CUENTA AJENA para el ejercicio 2009 y 2.010 en Navarra Adelantaros mediante estas líneas que desde estas oficinas se está trabajando con la administración para programar cursos de reciclaje subvencionados al 100% para nuestro sector. Las Cosas están cambiando mucho y en estos momentos no tenemos calendario de programación. En cuanto sepamos noticias os iremos informando. En el caso de que no saliera formación subvencionada intentaríamos programarla otro tipo de formación.

V.- TALLER CON CREATIVE NAILS: (subvencionado para el socio y trabajadores de los socios).

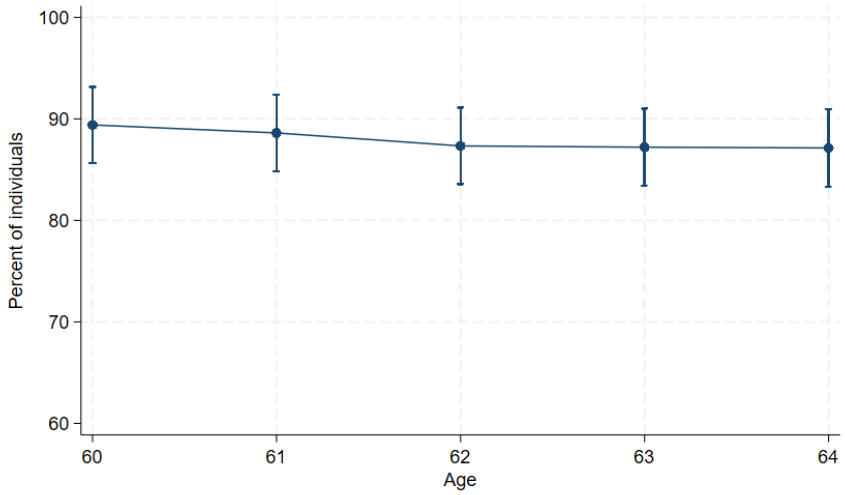
Lugar: Escuela de Peluquería y Moda. (plaza San Rafael 5 bajo) Pamplona
Fechas: Finales Marzo principios Abril (pendiente de confirmación según grupo).
Plazas: Limitadas.
Imparte: Creative Nails, número uno a nivel internacional.
Inscripciones: Avda. de Zaragoza 27, Tfno 948249419.
Contenido y desarrollo del curso: **MANICURA SPA MÁS MANICURA FRANCESA PERMANENTE** por la mañana, y por la tarde **PEDICURA SPA MÁS REALCE UÑA PIE.**

Sin otro particular atentamente,

Fdo.

Notes: This figure displays an extract from the letter received by self-employed that are part of a Self-employed Association in 2009. The green rectangle indicates the part of the letter where the maximum and minimum contribution bases are announced, which include the values of maximum contribution bases from the age of 50 years, the SSC rate and the resulting SSCs.
Source: Self-employed association for hairdressers in Navarre.

Figure A.5: Fraction contributing below the option threshold at age 60-64



Notes: This figure displays the proportion of self-employed workers contributing below de option threshold of approximately 500€/month at age 60-64 among retirees at 65 years in the period 2002-2005. Age is defined on the 1st January, when most self-employed workers decide their contributions.
Source: MCVL 2005.

B Social Security contribution incentives

This appendix provides details on the calculation of Social Security contribution incentives for self-employed workers in Spain.

B.1 Methodology

I present the methodology for calculating the implicit net-of-tax rate of public pension contributions for self-employed workers in Spain. The implicit net-of-tax rate of public pension savings is determined as the net discounted value of the discounted pension benefits offered by additional contributions to the public pension system. This takes the following form:

$$1-\tau_{a,t}=\frac{\partial SSW_{a,t}}{\partial SSC_{a,t}}(r)=\sum_{s=R}^{\overline{LE}}\frac{\pi_t(s|a)}{(1+r)^{s-a}}\times\frac{\partial P_s}{\partial SSC_{a,t}} \tag{2}$$

where $\tau_{a,t}$ denotes the tax rate of saving through the public pension system for an individual aged a at time t, $SSC_{a,t}$ stands for the SSCs at time t for someone aged a, $SSW_{a,t}$ represents the Social Security Wealth at time t for someone aged a, P_t stands for the pension annuity at time t, $\pi_t(s|a)$ is the survival probability for a person aged a at time t to remain alive at age s, R is the retirement age, $\overline{LE}$ stands for the maximum life expectancy. I further develop $\frac{\partial P_t}{\partial SSC_{a,t}}$ based on the pension formulas in the Spanish pension system:

$$\frac{\partial P_t}{\partial SSC_{a,t}}=\begin{cases}\alpha_n\times\beta_{R,n}\times\frac{w_{a,t}}{T\times\tau} & \text{if } a\in(R-T,R) \text{ and } P_t\in(\underline{P}_t,\overline{P}_t)\\ 0 & \text{otherwise}\end{cases} \tag{3}$$

where α_n stands for the coefficient of contribution years, $\beta_{R,n}$ stands for the coefficient of retirement age, $w_{a,t}$ stands for the weight of each contribution base of age a at time t[3], T stands for the number of years of contributions entering the calculation of the benefit base and τ stands

[3]The benefit base in the Spanish pension system can be expressed as

$$BB_t=\frac{1}{T}\sum_{a=R-T}^{R}w_aCB_{a,t}$$

for the SSC rate, $\underline{P}_t$ and $\overline{P}_t$ stand for the minimum and maximum statutory pensions respectively. Equation 3 shows that an increase in the payment of SSCs only leads to an increase in pension benefits if SSCs are made within the last T years before retirement and if pension benefits are within maximum and minimum limits.

B.2 Parameters and assumptions

A number of parameters and assumptions are used to calculate contribution incentives for self-employed workers in Spain.

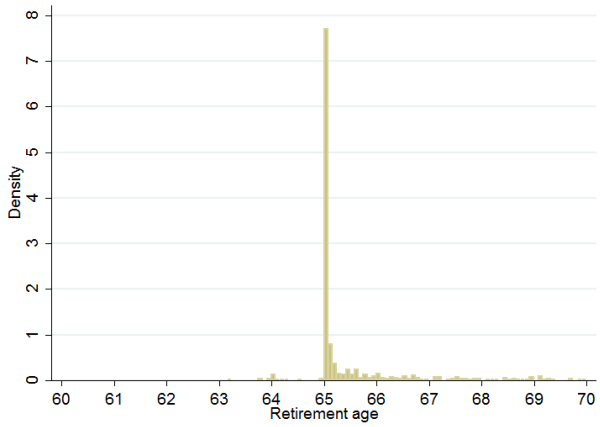
Conditional survival probabilities - $\pi_t(s|a)$. Conditional survival probabilities by cohort, age, and gender are extracted from mortality tables provided by the Spanish Office of National Statistics (Instituto Nacional de Estadística, 2019a; Instituto Nacional de Estadística, 2019b).

Retirement age at 65 years old. It is assumed that self-employed workers plan to retire at the normal retirement age of 65 years old. Figure B.1 illustrates the histograms of retirement age for self-employed workers, revealing that the majority retire at age 65. Additionally, it is assumed that self-employed workers contribute until retirement. Self-employed have incentives to do this. First, self-employed workers faced legal restrictions for early retirement. Second, retirement beyond the normal retirement age of 65 did not offer any bonus until 2003.

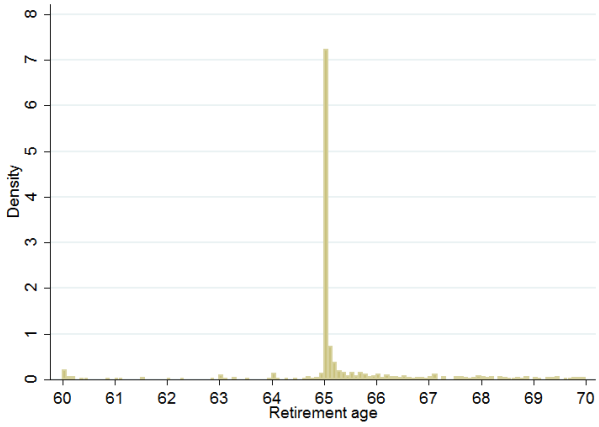
Coefficient for contribution years. The coefficient for contribution years is derived from self-employed workers retiring in 2005, which is approximately the anticipated retirement age for those aged 50-52 years between 1994 and 1997. The penalization for insufficient contribution years was 5.3% and 20.7%, respectively, for males and females receiving a pension above the minimum in 2005. This results in an average coefficient of contribution age of 92.16%.

Figure B.1: Retirement age for Spanish self-employed workers between 1997-2002

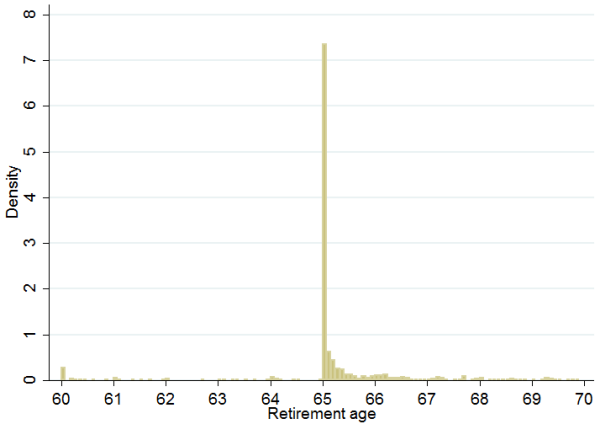
(a) 1997



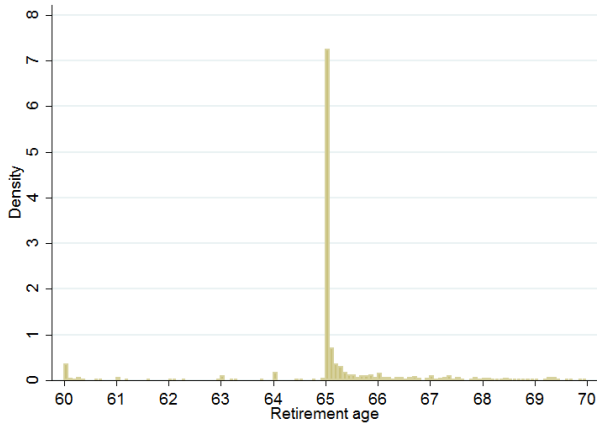
(b) 1998



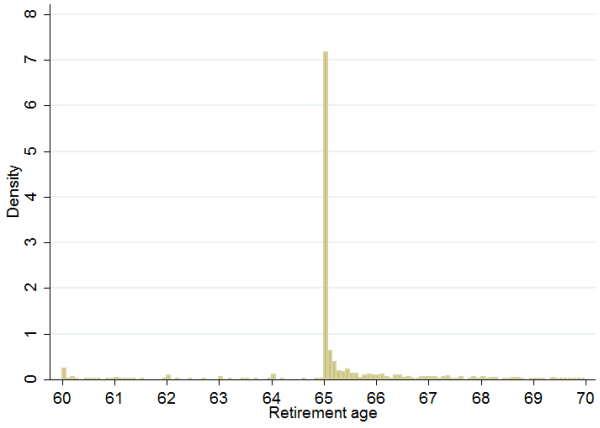
(c) 1999



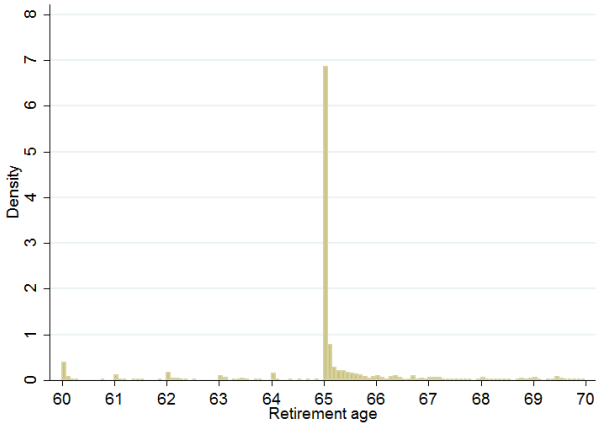
(d) 2000



(e) 2001



(f) 2002



Notes: The figure displays the histogram of retirement ages for self-employed workers retiring in 1997 (panel a), 1998 (panel b), 1999 (panel c), 2000 (panel d), 2001 (panel e) and 2002 (panel f).
Source: MCVL 2005.

No disincentive of minimum pensions. If pensions accrued by self-employed workers fall below the minimum pension threshold, increasing their contributions to Social Security would still result in receiving the minimum pension. Consequently, minimum legal pensions may act as a disincentive for self-employed workers to contribute more to Social Security. This potential disincentive is particularly relevant for self-employed workers facing a substantial penalization coefficient for insufficient contribution years, possibly leading to a "minimum pension trap"[4]. Figure B.2 illustrates the ratio between minimum pensions and contributions under RETA remained low and stable during the study period 1994-2002, ranging from 60-65% for those without a dependent spouse and 70-75% for those with a dependent spouse[5]. To address the potential disincentive posed by minimum pensions during the study period, I focus on a sample of long-term self-employed workers, excluding the bottom 20% with the shortest careers, which approximately represents the proportion of self-employed retirees receiving minimum pensions in 2005. Table B.1 reveals a significant gender disparity in the contribution years for self-employed workers retiring in 2005, which explains why females constitute a small share of my final sample.

Table B.1: Contribution years of self-employed workers retiring in 2005 in Spain

	Average contr. years	Fraction in contribution years range (%)		
		15-25 years	25-35 years	> 35 years
	(1)	(2)	(3)	(4)
Males	34.1	16.0	31.3	52.7
Females	23.5	62.4	29.0	8.6
Total	30.5	31.8	30.5	37.7

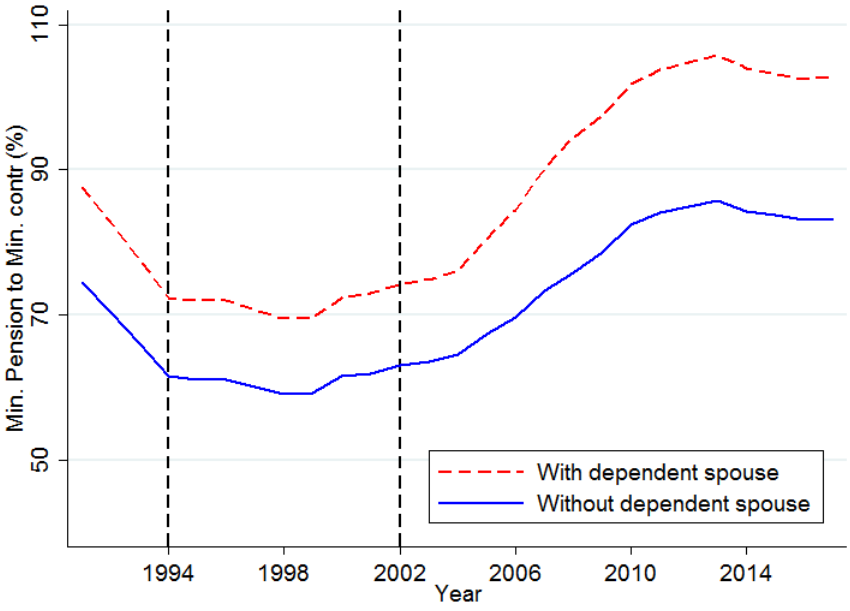
Notes: This table provides information on the contribution periods of individuals receiving a pension under the RETA scheme and retiring in 2005. The information is provided for males, females and all self-employed workers. The table includes information on average years contributed at retirement, as well as the fraction of self-employed retirees in ranges of contribution years between 15 and 25 years, 25 and 35 years and over 35 years of contributions at retirement.
Source: MCVL 2005.

Progressive taxes. Contribution incentives are calculated post-tax, so I account for the effect of progressive income taxes. Pension benefits are liable for income taxes, but SSCs are also deduced

[4]See Sánchez-Martın (2019) for detailed information of this disincentive for Spain between 2008 and 2016.

[5]Conde-Ruiz and González (2016) highlighted the erosion of the contributory nature of the Spanish pension system due to the increasing minimum pension-to-minimum contribution ratio since the mid-2000s.

Figure B.2: Ratio of minimum pensions to minimum contribution bases under RETA



Notes: The figure shows the minimum pension as a fraction of the minimum contribution base under RETA. The vertical dashed line in 1994 and 2002 indicate the beginning and end of the period of study respectively. The red dashed line refers to the ratio for self-employed workers with a dependent spouse, while the blue line refers to self-employed workers without a dependent spouse.
Source: Presupuestos Generales del Estado, 1991-2016.

from income tax payments, except for the group presenting objective income tax declarations. Table B.2 describes the calculation of the fiscal effect of progressive taxes. The calculation balances the average deduction rate when paying SSCs with the marginal tax paid when receiving pension benefits. I calculate that progressive taxes induce a penalization of 4% for males, while it provides a bonus of 0.19% for females.

Survivor and disability benefits. My calculations exclusively consider contribution incentives provided by old-age pensions. Although SSCs also give rise to disability and survivor benefits, there were no reforms in these benefits during the study period 1994-2002. Consequently, while contribution incentives may be underestimated in levels, the impact of the 1997 reform is accurately represented.

Discount rates. Expected future benefits are discounted with a 3% rate of return, which is the benchmark rate of return used in studies calculating the present value of pension benefits (Coile et al., 2002; Liebman et al., 2009). For comparison, Figure B.3a displays the 10-year bond real

Table B.2: Effect of progressive income taxes on contribution incentives for aged 50-52 (%)

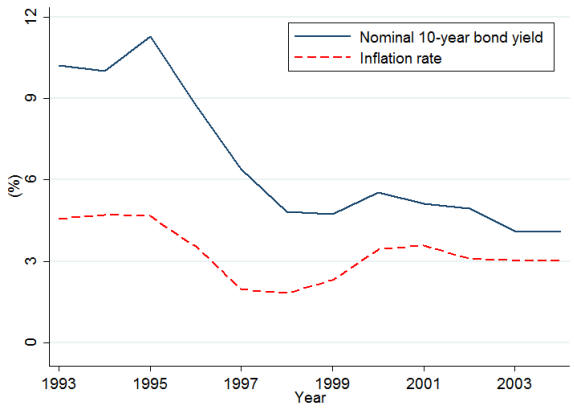
	Age 50-52			Age 65-75	Net effect
	Share deducing SSCs	Marginal tax rate	Deduction rate	Marginal tax rate	
	(1)	(2)	(3)	(4)	(5)
Males	78.33	32.36	25.35	29.35	-4.00
Females	67.18	33.15	22.27	22.08	0.19
Total	75.69	32.45	24.56	26.60	-2.04

Notes: This table describes the variables for the calculation of the effect of progressive taxes on contribution incentives. Column (1) describes the share of self-employed under the direct estimation method, who receive an income tax deduction for their SSCs, column (2) describes the average marginal tax rate of self-employed workers aged 50-52, column (3) describes the mean reduction rate, which results from multiplying columns (1) and (2). Column (4) describes the average marginal tax rate at retirement, and column (5) describes the resulting fiscal effect. All values are presented in percentages.
Source: Panel de Declarantes del IRPF 1999-2016.

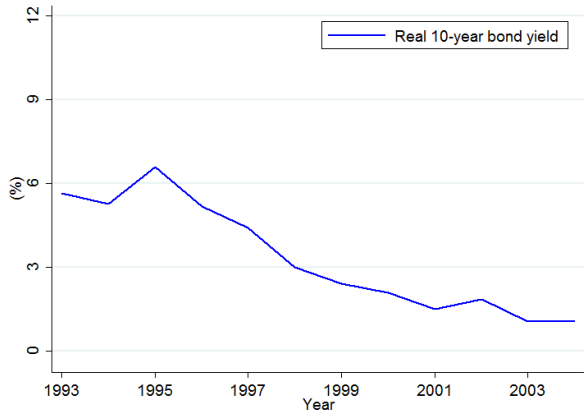
interest rate in Spain, which was around 1.5% after 1998.

Figure B.3: Rate of return of the 10-years bond in Spain

(a) Nominal rate of return



(b) Real rate of return



Notes: The figure displays the nominal 10-year bond yield in Spain and the inflation rate (panel a) and the real 10-year bond yield in Spain (panel b) between 1993 and 2004. The real 10-year bond yield is computed subtracting the inflation rate to the nominal 10-year bond yield.
Source: European Central Bank (ECB) and Instituto Nacional de Estadística (INE).

B.3 Implicit net-of-tax rate by age between 1994 and 2002

Table B.3 and B.4 describe the implicit net-of-tax rates for males and females by individual year of age between 1994 and 2002.

Table B.3: Implicit net-of-tax rate by age for males between 1994 and 2002 (%)

	≤ 49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
1994	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	408.9	423.1	437.2	451.3	464.8	483.8	497.6	518.3
1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	419.4	433.0	448.3	463.8	479.1	494.1	514.8	530.4
1996	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	423.3	436.0	450.6	466.8	483.5	499.8	516.2	538.5
1997	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	425.2	439.9	453.6	469.3	486.5	504.3	521.8	539.8
1998	0.0	185.1	192.6	196.7	203.8	209.0	215.3	225.2	230.8	235.6	244.0	251.7	300.9	338.2	382.8	436.2
1999	0.0	187.4	191.6	199.3	203.7	211.1	216.7	223.4	233.6	239.7	245.0	253.9	262.2	313.7	353.1	400.0
2000	0.0	188.4	193.9	198.3	206.4	211.1	218.9	224.9	231.9	242.7	249.1	255.0	264.6	273.4	327.4	369.2
2001	0.0	189.1	194.9	200.7	205.4	213.9	218.9	227.0	233.4	240.8	252.2	259.0	265.5	275.8	285.3	342.0
2002	0.0	190.3	195.7	201.8	207.9	212.9	221.7	227.1	235.6	242.5	250.3	262.1	269.6	276.6	287.7	298.0

Notes: This table shows the average implicit net-of-tax rate by age when expected benefits using a 3% discount rate for male self-employed workers between 1994 and 2002. The incentive calculations refer to the age in January, when self-employed workers make their contribution decisions.
Sources: MCVL 2005.

Table B.4: Implicit net-of-tax rate by age for females between 1994 and 2002 (%)

	≤ 49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
1994	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	446.8	460.3	473.2	486.2	501.0	515.3	529.8	546.8
1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	457.0	470.6	485.1	498.8	512.6	528.3	543.8	559.5
1996	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	459.8	472.3	486.5	501.8	516.0	530.6	547.1	563.4
1997	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	461.3	475.2	488.4	503.1	519.1	533.8	549.6	566.8
1998	0.0	201.8	208.5	213.9	220.5	226.5	233.2	241.2	247.8	254.3	262.0	269.4	320.2	358.2	402.0	455.5
1999	0.0	202.5	208.3	215.1	220.8	227.6	233.9	240.8	249.1	256.0	262.8	270.9	278.6	331.5	370.6	416.3
2000	0.0	203.2	209.0	215.0	222.1	228.0	235.0	241.6	248.7	257.4	264.6	271.7	280.1	288.4	343.1	383.9
2001	0.0	203.3	209.6	215.7	221.9	229.2	235.4	242.7	249.5	257.0	265.9	273.6	281.0	289.8	298.5	355.3
2002	0.0	203.8	209.8	216.3	222.7	229.1	236.7	243.1	250.7	257.8	265.5	274.8	283.0	290.8	299.9	309.0

Notes: This table shows the average implicit net-of-tax rate by age when expected benefits using a 3% discount rate for female self-employed workers between 1994 and 2002. The incentive calculations refer to the age in January, when self-employed workers make their contribution decisions.
Sources: MCVL 2005.

B.4 Marginal Internal Rate of Return (MIRR)

This appendix presents the methodology for computing the Marginal Internal Rate of Return (MIRR) and its measurement between 1994 and 2002 in Spain. The MIRR represents the rate of return ρ that balances the cost of the payment of an additional SSC with the increase in Social Security Wealth (SSW) that this payment gives rise to[6]:

$$\frac{\partial SSC_t}{\partial CB_{a,t}} = \frac{\partial SSW_{a,t}}{\partial CB_{a,t}}(\rho_{a,t}) \tag{4}$$

where $\rho_{a,t}$ refers to the MIRR for an individual with age a at time t, SSC_t refers to the SSCs paid at time t, $CB_{a,t}$ stands for the Contribution Base at time t for someone aged a and $SSW_{a,t}$ represents the Social Security Wealth at time t for someone aged a. Developing the expression of the $SSW_{a,t}$ and given $\frac{\partial SSC_t}{\partial CB_{a,t}} = \tau_t$:

$$\tau_t = \sum_{s=R}^{\overline{LE}} \frac{\pi_t(s|a)}{(1+\rho_{a,t})^{s-a}} \frac{\partial P_s}{\partial CB_{a,t}} \tag{5}$$

where P_t stands for the initial pension, $\pi_t(s|a)$ is the survival probability for a person aged a to remain alive at age s, R is the retirement age, $\overline{LE}$ stands for the maximum life expectancy.

MIRR in period 1994 and 2002. Table B.5 describes the MIRR for males by individual year of age between 1994 and 2002 and Table B.6 describes the MIRR for females by individual year of age between 1994 and 2002. This applies the methodology presented above and the assumptions presented in Appendix B. The sensitivity of my baseline calculation of the MIRR to alternative assumptions is provided in Appendix B.5.

[6]The MIRR for pension systems has already been calculated by Kitces (2018) for the US, or by Sánchez-Martın (2019) for Spain.

Table B.5: Average MIRR by age for males between 1994 and 2002 (%)

	≤ 49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
1994	-	-	-	-	-	-	-	-	13.1	14.3	15.7	17.6	20.0	23.3	28.7	38.1
1995	-	-	-	-	-	-	-	-	13.1	14.3	15.8	17.6	20.0	23.4	28.7	38.2
1996	-	-	-	-	-	-	-	-	13.2	14.3	15.8	17.6	20.1	23.5	28.7	38.4
1997	-	-	-	-	-	-	-	-	13.2	14.4	15.8	17.7	20.1	23.6	28.8	38.4
1998	-	5.7	6.0	6.2	6.6	6.9	7.3	7.9	8.4	9.0	9.8	10.8	13.7	16.8	21.6	30.2
1999	-	5.7	5.9	6.3	6.6	7.0	7.4	7.9	8.5	9.1	9.8	10.8	12.0	15.6	19.9	27.3
2000	-	5.7	6.0	6.3	6.6	7.0	7.4	7.9	8.4	9.2	9.9	10.8	12.1	13.7	18.4	24.8
2001	-	5.7	6.0	6.3	6.6	7.0	7.4	7.9	8.5	9.1	10.0	11.0	12.1	13.7	15.9	22.7
2002	-	5.8	6.0	6.3	6.7	7.0	7.5	7.9	8.5	9.2	10.0	11.0	12.2	13.7	16.0	19.3

Notes: This table shows the average MIRR for male self-employed workers by age in period 1994-2002. The MIRR is provided at the beginning of the year, when contributions are decided.
Sources: MCVL 2005.

Table B.6: Average MIRR by age for females between 1994 and 2002 (%)

	≤ 49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
1994	-	-	-	-	-	-	-	-	13.0	14.1	15.4	17.0	19.2	22.1	26.5	34.1
1995	-	-	-	-	-	-	-	-	13.1	14.3	15.6	17.3	19.4	22.5	26.9	34.8
1996	-	-	-	-	-	-	-	-	13.2	14.3	15.6	17.3	19.5	22.5	27.0	34.8
1997	-	-	-	-	-	-	-	-	13.2	14.3	15.6	17.3	19.5	22.5	27.0	34.8
1998	-	5.9	6.2	6.5	6.8	7.2	7.6	8.0	8.6	9.2	9.9	10.7	13.4	16.2	20.3	27.6
1999	-	5.9	6.2	6.5	6.8	7.2	7.6	8.0	8.6	9.2	9.9	10.8	11.8	15.1	18.8	25.0
2000	-	5.9	6.2	6.5	6.8	7.2	7.6	8.0	8.6	9.2	9.9	10.8	11.9	13.3	17.4	22.8
2001	-	5.9	6.2	6.5	6.8	7.2	7.6	8.1	8.6	9.2	10.0	10.8	11.9	13.3	15.2	20.9
2002	-	6.0	6.2	6.5	6.8	7.2	7.6	8.1	8.6	9.2	9.9	10.9	11.9	13.3	15.2	17.9

Notes: This table shows the average MIRR for female self-employed workers by age between 1994 and 2002. The MIRR is provided at the beginning of the year, when contributions are decided.
Sources: MCVL 2005.

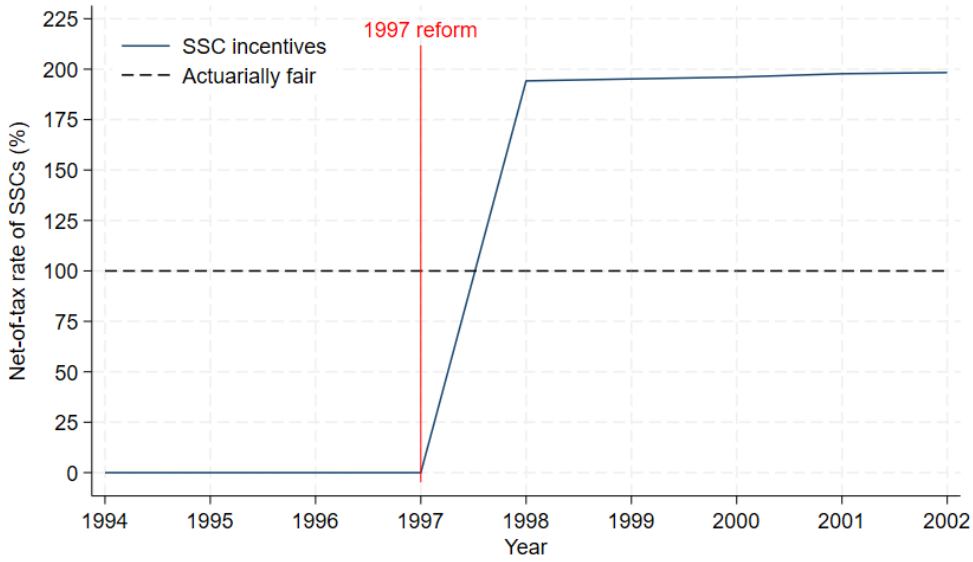
B.5 Contribution incentives for 1997 reform

This appendix

B.6 Baseline incentives

Figure B.4 illustrates the change in incentives resulting from the 1997 reform for self-employed workers aged 50-52. Before 1997, the implicit net-of-tax rate of additional SSCs was 0% as SSCs were not linked to pension benefits. However, following the 1997 reform, the implicit net-of-tax rate increased to 198.3% by 2002. This implies that additional SSCs nearly doubled the present value offered by actuarially fair markets, dominating alternative savings options[7]. Therefore, these incentives would suggest large responses to the 1997 reform. The implicit net-of-tax rates by age for the period 1994-2002 can be found in Appendix B.3 and the sensitivity of my calculation of incentives in Appendix B.5.

Figure B.4: Contribution incentives for self-employed workers aged 50-52



Notes: This figure shows the implicit net-of-tax rate of additional SSCs for self-employed workers aged 50-52 between 1994 and 2002. The black dashed line represents 100%, which is the implicit net-of-tax rate offered by annuities discounted at 3%. The red vertical line in 1997 denotes the reform year.
Source: MCVL 2005.

[7]The real rate of return of additional SSCs rose to 6.08% for workers aged 50-52 after the 1997 reform (see Appendix B.4). Prior studies argued that delaying retirement claiming was optimal in the US, which provided Social Security annuities with a 3% real rate of return (Coile et al., 2002; Altig et al., 2023).

B.7 Sensitivity to alternative assumptions

This subsection presents the sensitivity of the baseline calculation of SSC incentives induced by the 1997 reform for self-employed workers aged 50-52. I examine alternative assumptions for five key parameters: (1) the discount rate, (2) the coefficient on contribution years applying to the benefit base, (3) mortality rates at each age, (4) early retirement and (5) perceived policy uncertainty. Figure B.5 provides graphical evidence on the sensitivity of incentives for those aged 50-52 around the 1997 pension reform.

(1) Discount rate. I consider how the use of different rates of discount affect the current value of future pension benefits. While my baseline calculation of incentives entails a 3% discount rate, I re-calculate contribution incentives using discount rates of 1% and 5%. Figure B.5a illustrates that incentives for those aged 50-52 decrease to around 125% when a 5% discount rate is used, while this increases over 300% when using a discount rate of 1%.

(2) Coefficient on contribution years. I consider the the sensitivity of contribution incentives to the coefficient on contribution years α_n. To assess its impact, I calculate incentives for coefficients of 70% and 100%, compared to the baseline coefficients of 94.8% for males and 79.3% for females[8]. Figure B.5b illustrates that decreasing the coefficient on contribution years to 70% results in an implicit net-of-tax rate around 150%, while an increase to 100% yields incentives of 215%.

(3) Mortality rates. Mortality rates influence contribution incentives because they determine the expected length of pension annuity receipt. The sensitivity analysis involves applying different mortality profiles to my main group of interest aged 50-52, considering the profile of those five years younger (aged 45-47) and older (aged 55-57). Figure B.5c illustrates that applying mortality rates of those five years older decreases the implicit net-of-tax rate to 155%, while applying mortality rates of those 5 years younger increases the rate to 240%.

(4) Early retirement. I consider the effect early retirement at 62 years on contribution incentives, compared to retirement at age of 65 years. On the one hand, early retirement involves a

[8]These values are derived from the average penalization on contribution periods for self-employed retirees in 2005.

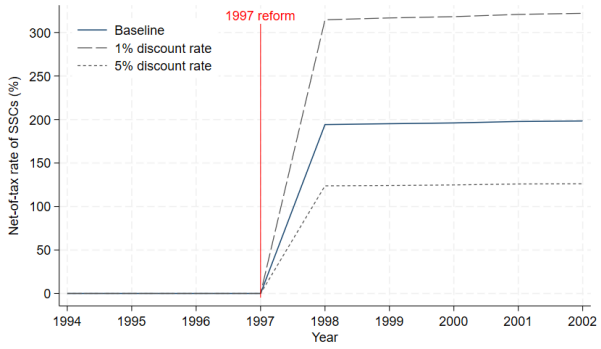
penalization of 8% for each year of early retirement and an additional 2% per year for shorter contribution years below 35 years. On the other hand, early retirees earn pension benefits for additional years as they claim before. Figure B.5d illustrates that early retirement at age 62 slightly reduced the implicit net-of-tax rate to 175%.

(5) Perceived policy uncertainty. The possibility of reforms cutting the generosity of public pensions could decrease the value of expected future benefits. To account for the impact of policy uncertainty, I follow Luttmer and Samwick (2018), who found that US taxpayers aged 50-54 years were willing to accept 57.8% of the pensions under current rule to avoid future pension reforms[9]. Figure B.5e illustrates that accounting for policy uncertainty decreases the implicit net-of-tax rate to around 115%. However, it is worth mentioning that Luttmer and Samwick (2018) derived their results in 2011, when the consequences of population aging were more noticeable than in my study period 1994-2002. Consequently, contribution incentives under the considered policy uncertainty may be considered a lower bound of incentives.

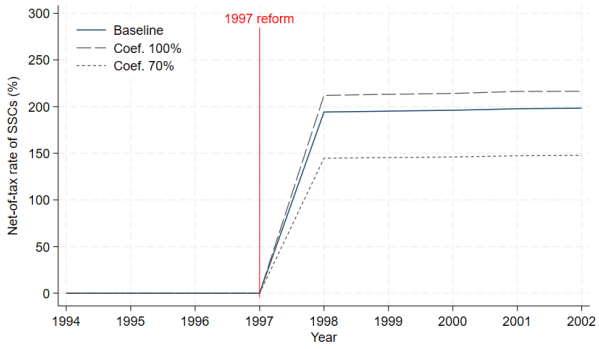
[9]US taxpayers aged 50-54 expected to receive 67.7% of the pensions under current rule and they would be willing to pay a premium of 9.9% to eliminate policy uncertainty.

Figure B.5: Sensitivity of contribution incentives for self-employed aged 50-52

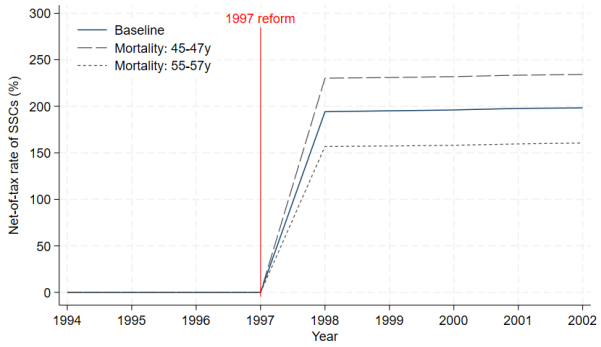
(a) Discount rate



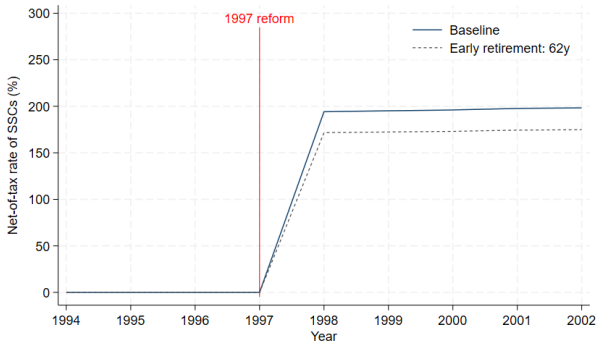
(b) Coef. of contribution years



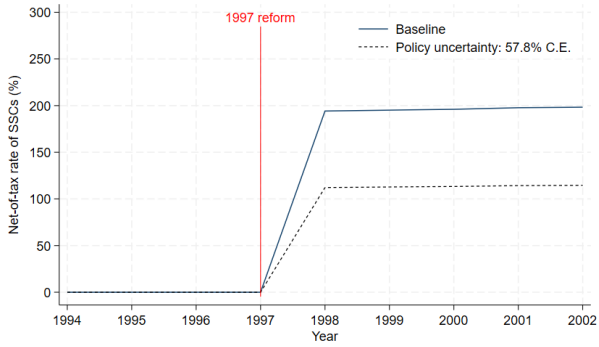
(c) Mortality rates



(d) Early retirement at 62y



(e) Policy uncertainty (C.E. = 57.8%)



Notes: The figure shows of the net present value offered by SSCs for self-employed workers aged 50-52 under alternative parameters for the calculation of incentives. These consider sensitivity to (panel a) discount rates, (panel b) contribution years coefficients, (panel c) mortality rates, (panel d) early retirement at age 62, and (panel e) perceived policy uncertainty, where individuals have a certainty equivalent of 57.8% of the pensions under current rule. The short-dashed lines represent the lower bound of incentives and the long dashed lines represent the upper bound of incentives. The red vertical line in 1997 denotes the reform year.
Source: MCVL 2005.

C Sample selection

This appendix presents evidence on the stability of my primary sample. This study uses data from the 2005 wave of the MCVL, which is representative of individuals affiliates to the Spanish Social Security in 2005. To study the effect of the 1997 reform, I use the MCVL data retrospectively between 1994 and 2002. I define a population that is likely to maintain an ongoing relationship with the Spanish Social Security. Therefore, I focus on a sample of individuals with Spanish nationality working as self-employed between 1994 and 2002. In addition to this, I exclude the 20% with shortest contribution periods per each age and cohort cell. Table C.1 illustrates that the sample size per block of age and year remains stable throughout the period 1994-2002. To further validate the representativeness of my sample, I apply the same sample selection criteria to the 2007 wave. As shown in Table C.2, the number of observations using the 2007 wave aligns closely with the 2005 wave. This alignment supports that individuals with Spanish nationality working as self-employed between 1994 and 2002 maintain an ongoing relationship with the Spanish Social Security over time.

Table C.1: Number of observations by age and year in my sample. MCVL 2005

	40	41	42	43	44	45	46	47	48	49	50	51	52	Total
1994	1080	1055	1107	1070	1168	1237	1136	1110	1154	1075	1055	904	776	13927
1995	1035	1078	1057	1104	1067	1163	1248	1126	1107	1147	1068	1045	900	14145
1996	1154	1029	1081	1053	1106	1064	1161	1240	1120	1104	1143	1063	1042	14360
1997	1044	1153	1033	1075	1061	1104	1066	1159	1243	1117	1102	1142	1059	14358
1998	1048	1042	1149	1032	1073	1053	1095	1064	1158	1235	1118	1102	1137	14306
1999	1034	1047	1039	1150	1023	1076	1059	1098	1058	1152	1237	1118	1096	14187
2000	1067	1035	1045	1041	1152	1022	1074	1047	1099	1060	1148	1233	1115	14138
2001	1015	1064	1035	1041	1040	1149	1028	1072	1048	1094	1056	1148	1232	14022
2002	961	1012	1063	1028	1040	1034	1146	1019	1066	1039	1084	1050	1141	13683
Total	9438	9515	9609	9594	9730	9902	10013	9935	10053	10023	10011	9805	9498	127126

Notes: This table shows the sample size of each year of age between 40 and 52 years and year block between 1994 and 2002 in the selected sample in this study. This consists of those with Spanish nationality who worked as self-employed between 1994 and 2002. This also includes those who left self-employment to claim a retirement pension. This excludes the 20% of the self-employed with the shortest contribution histories within each age and year block.
Source: MCVL 2005.

Table C.2: Number of observations by age and year in my sample. MCVL 2007

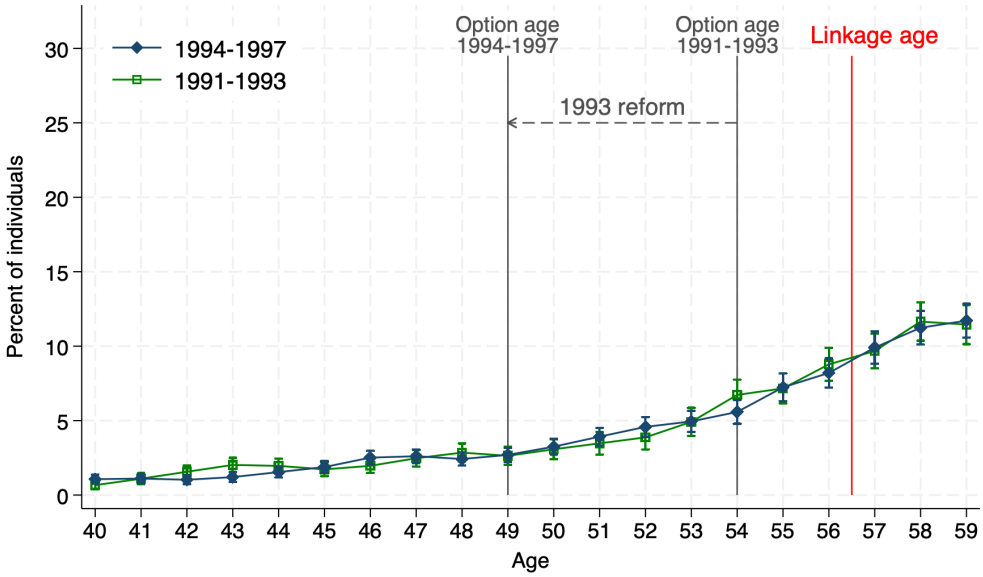
	40	41	42	43	44	45	46	47	48	49	50	51	52	Total
1994	1076	1049	1094	1057	1160	1234	1125	1104	1140	1054	1034	897	775	13799
1995	1025	1072	1052	1090	1054	1155	1236	1118	1101	1133	1051	1030	893	14010
1996	1146	1021	1076	1047	1095	1052	1153	1230	1113	1096	1130	1046	1027	14232
1997	1035	1145	1023	1069	1053	1091	1049	1151	1231	1111	1095	1127	1042	14222
1998	1034	1033	1140	1020	1067	1047	1085	1052	1150	1230	1107	1092	1124	14181
1999	1021	1033	1031	1141	1020	1070	1047	1087	1045	1144	1227	1106	1089	14061
2000	1058	1023	1032	1030	1145	1018	1068	1040	1088	1047	1140	1224	1103	14016
2001	1010	1055	1022	1032	1029	1142	1020	1068	1041	1082	1044	1140	1221	13906
2002	959	1007	1054	1015	1026	1023	1139	1015	1060	1032	1073	1037	1133	13573
Total	9364	9438	9524	9501	9649	9832	9922	9865	9969	9929	9901	9699	9407	126000

Notes: This table shows the sample size of each year of age between 40 and 52 years and year block between 1994 and 2002 using the same criteria for sample selection as in this study, using the 2007 wave of MCVL instead of the 2005 wave. This consists of those with Spanish nationality who worked as self-employed between 1994 and 2002. This also includes those who left self-employment to claim a retirement pension. This excludes the 20% of the self-employed with the shortest contribution histories within each age and year block.
Source: MCVL 2007.

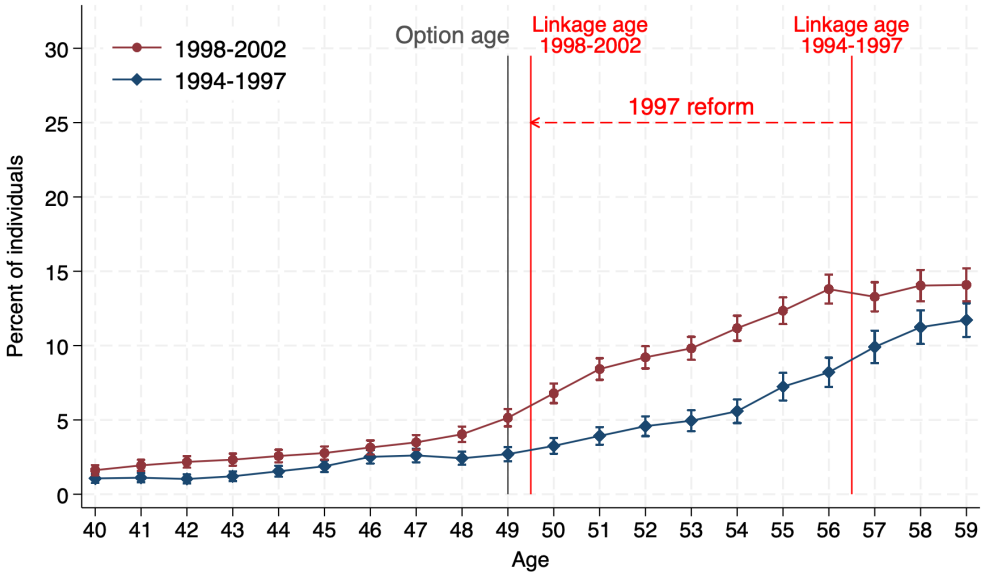
D Additional results: Additional graphical evidence by age

Figure D.1: Fraction contributing above the minimum and below the option threshold by age

(a) 1993 reform



(b) 1997 reform

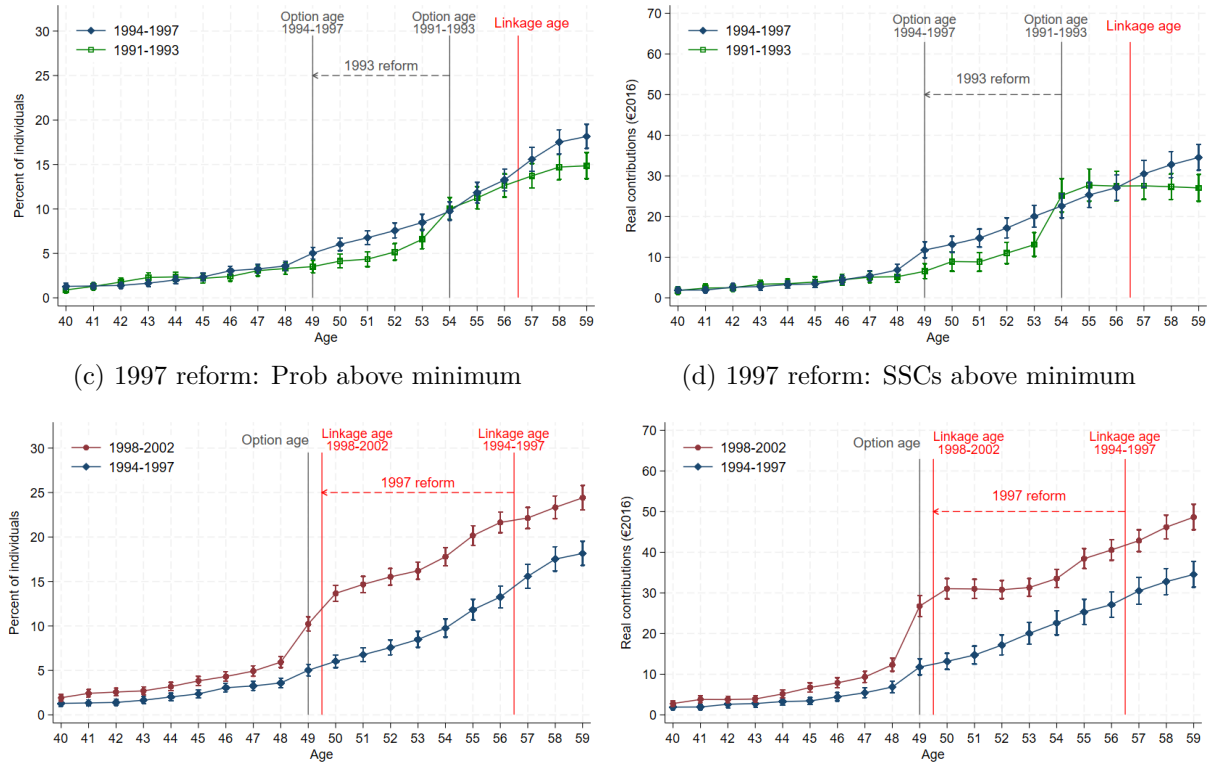


Notes: This figure shows the probability of contributing above the minimum and below the option threshold for self-employed workers by age around the 1993 reform (panel a) and 1997 reform (panel b). I define age on the 1st January of each year, when most self-employed workers decide their contributions. The green lines refer to the 1991-1993 period, the blue lines represent the 1994-1997 period and the red lines refer to the 1998-2002 period. The gray vertical lines represent the age of the option value decision (*option age*) and the vertical red dashed line represents the age at which contributions became linked to pensions (*linkage age*).
Source: MCVL 2005.

Figure D.2: Fraction contributing above the minimum by age

(a) 1993 reform: Prob above minimum

(b) 1993 reform: SSCs above minimum



(c) 1997 reform: Prob above minimum

(d) 1997 reform: SSCs above minimum

Notes: This figure shows the average contribution behavior of self-employed workers by age around the 1993 and 1997 reforms. The outcomes are the fraction contributing above the minimum around the 1993 (panel a) and 1997 reforms (panel c), as well as real Social Security contributions (SSC) above the minimum around the 1993 (panel b) and 1997 reforms (panel d). I define age on the 1st January of each year, when most self-employed workers decide their contributions. The green lines refer to the 1991-1993 period, the blue lines represent the 1994-1997 period and the red lines refer to the 1998-2002 period. The gray vertical lines represent the age of the option value decision (*option age*) and the vertical red dashed line represents the age at which contributions became linked to pensions (*linkage age*).
Source: MCVL 2005.

E Additional results: DiD estimation by age

This appendix provides difference-in-differences results on the effect of the 1993 and 1997 pension reforms by individual year of age. This provides graphical evidence on the age ranges where the effects of reforms are concentrated.

Empirical strategy. I use a DiD approach to estimate the effects of the reforms by individual year of age. The DiD regression by age takes the following form:

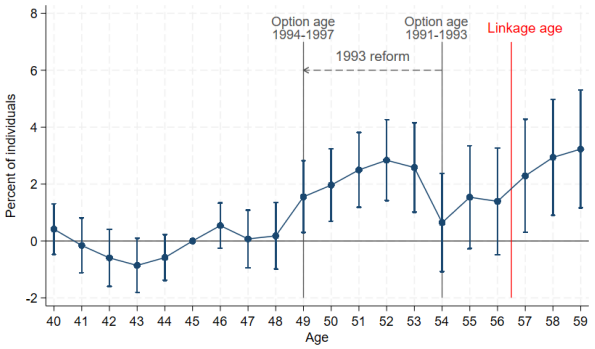
$$Y_{iat} = \alpha_a + D_t + \sum_{a=40}^{\bar{a}} \rho_a \alpha_a \times Post_t + \mathbf{X_{iat}}\theta + \varepsilon_{iat} \tag{6}$$

where Y_{iat} represents my two outcomes of interest: $Y_{iat} = \mathbf{1}\{C_{iat} > C^L_{iat}\}$, the indicator variable on whether self-employed worker i of age a contributed above the minimum contribution C^L_{iat} in period t, and the logarithm of the real contributions $Y_{iat} = \ln(C_{iat})$. α_a denotes age dummies, where age 45 is omitted, and D_t denotes time dummies. $Post_t$ represents the post-reform indicator, taking value 1 if $t \in [1994, 1997]$ and 0 if $t \in [1991, 1993]$ for the 1993 reform, while for the 1997 reform it takes value 1 if $t \in [1998, 2002]$ and 0 if $t \in [1994, 1997]$. $\mathbf{X_{it}}$ includes province, education and industry dummies, a dummy on whether municipality population is above 40,000, tenure, and province real GDP per capita. Standard errors are clustered at the individual level.

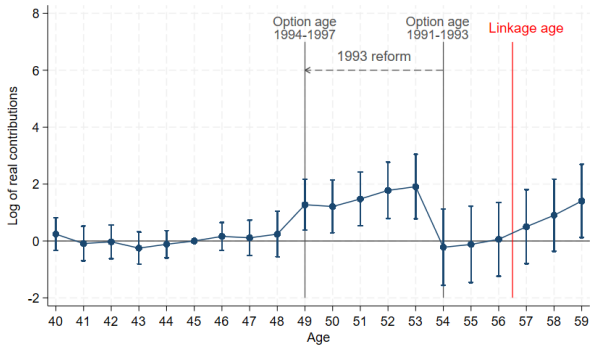
Contributions at ages younger than 49 years remained unaffected by the 1993 and 1997 reforms. The parallel trends assumption posits that contributions at ages affected by the reforms would have followed the same trend as contributions at age 45 in the absence of the reforms.

Figure E.1: DiD response to the 1993 reform by age

(a) Prob. above minimum



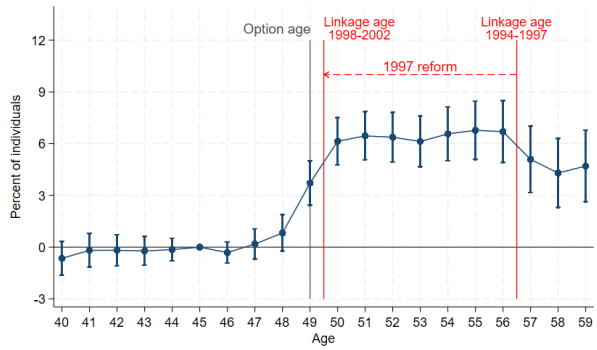
(b) Log of real contributions



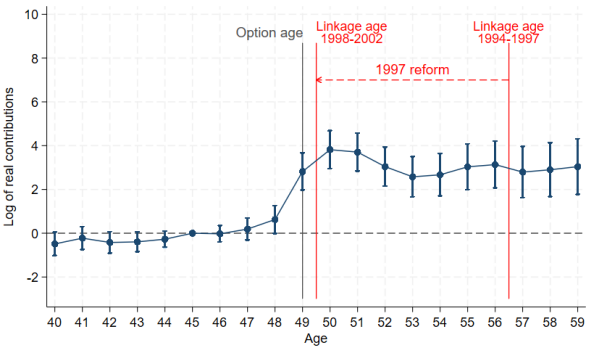
Notes: This figure shows DiD estimates on the effect of the 1993 reform by age. This compares the probability of contributing above the minimum (panel a) and on the log of real contributions (panel b), in period 1994-1997 compared to 1991-1993, relative to the difference at age 45. The gray vertical line represents the age of the option value decision (*option age*) and the vertical red line represents the age at which contributions became linked to pensions (*linkage age*). The coefficient estimates on the log of real contributions are multiplied by 100 to represent percentage points of real contributions.
Source: MCVL 2005.

Figure E.2: DiD response to the 1997 reform by age

(a) Prob. above minimum



(b) Log of real contributions



Notes: This figure shows DiD estimates on the effect of the 1997 reform by age. This compares the probability of contributing above the minimum (panel a) and on average real contributions (panel b), in period 1998-2002 compared to 1994-1997, relative to the difference at age 45. The gray vertical line represents the age of the option value decision (*option age*) and the vertical red line represents the age at which contributions became linked to pensions (*linkage age*). The coefficient estimates on the log of real contributions are multiplied by 100 to represent percentage points of real contributions.
Source: MCVL 2005.

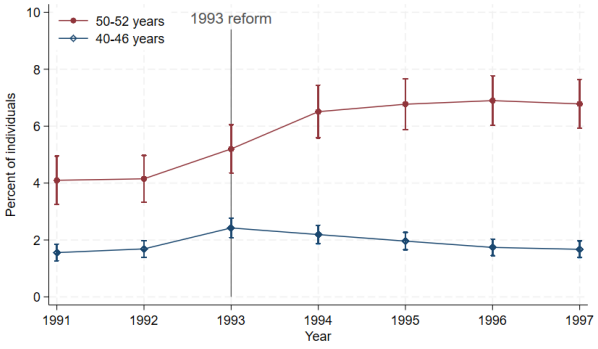
F Additional results: 1993 reform

This appendix presents additional results on the response to the 1993 pension reform. The reform changed the age of the option value decision from age 55 to 50. My DiD approach compares the average contribution behavior of those aged 50-52, whose contributions reflect their option value decision after the 1993 reform, with those aged 40-46.

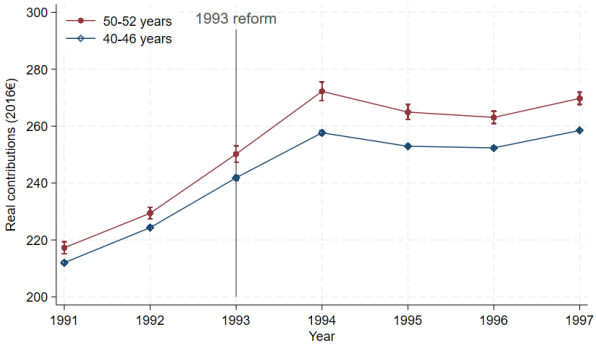
Graphical evidence. Figure F.1 offers graphical evidence on the average contribution behavior of the treatment (age 50-52) and control groups (age 40-46) to support the validity of the DiD approach in studying the effect of the 1993 reform. Before 1994, the contribution behavior of those aged 50-52 and 40-46 followed similar evolutions, supporting the plausibility of the parallel trends assumption. After the 1993 reform, the contribution behavior of self-employed workers aged 50-52 making contributions above the minimum increased from 5% to 7% between 1993 and 1997. In contrast, the fraction remained around 2% for those aged 40-46 years. Average real contributions increased for both groups followed a parallel evolution before the 1993 reform, reflecting increases in minimum contributions. After 1994, the contributions of those aged 50-52 increased more than those of aged 40-46.

Figure F.1: Contributions of aged 50-52 and 40-46 between 1991-1997

(a) Prob. above minimum



(b) Real contributions



Notes: This figure shows the fraction of self-employed workers contributing above the minimum (panel a) and of average real contributions (panel b) between 1991 and 1997. I define age on the 1st January of each year, when most self-employed workers decide their contributions. The red lines refer to the treatment group (50-52 years), while blue lines represent average values of the control group (40-46 years). The vertical gray line in 1993 denote the reform year.
Source: MCVL 2005.

Full dynamic DiD results. Table F.1 provides the full dynamic DiD responses to the 1993 pension reform for alternative specifications. I estimate that the 1993 reform increased the probability of those aged 50-52 contributing above the minimum by 2.46 percentage points, while real contributions increased by 0.97% over the same period. No significant pre-trends are observed in the run-up to the 1993 reform, supporting for the parallel-trends assumption. The table also shows that the effects are similar across specifications.

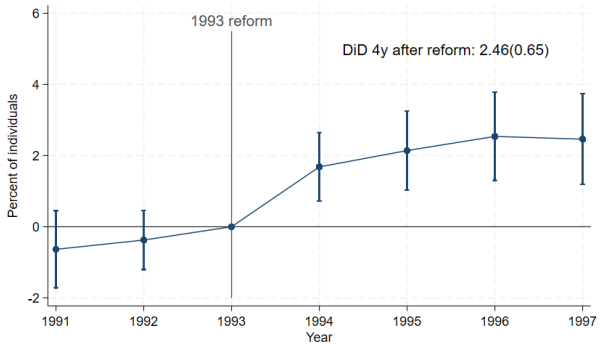
Table F.1: Dynamic DiD results for the 1993 reform using alternative specifications

	Baseline	No controls	Treatment group		Control group	
			50-53y	50-54y	40-44y	42-46y
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Prob above min.						
β_{-2}	-0.63	-0.24	-0.09	-0.05	-0.91	-0.44
	(0.55)	(0.55)	(0.51)	(0.48)	(0.57)	(0.58)
β_{-1}	-0.37	-0.31	0.01	0.08	-0.60	-0.28
	(0.42)	(0.43)	(0.40)	(0.39)	(0.43)	(0.44)
β_1	1.68**	1.54**	1.86***	1.61***	1.88***	1.81***
	(0.49)	(0.50)	(0.39)	(0.38)	(0.50)	(0.50)
β_2	2.14***	2.03***	2.33***	1.85***	2.22***	2.44***
	(0.57)	(0.58)	(0.49)	(0.45)	(0.58)	(0.58)
β_3	2.54***	2.38***	2.84***	2.60***	2.48***	2.80***
	(0.63)	(0.65)	(0.54)	(0.51)	(0.64)	(0.65)
β_4	2.46***	2.33***	3.13***	2.96***	2.28***	2.83***
	(0.65)	(0.66)	(0.60)	(0.56)	(0.65)	(0.68)
Pre-trends (p-value)	0.51	0.77	0.96	0.92	0.25	0.73
Panel B: Log of real contr.						
β_{-2}	-0.60	-0.42	-0.33	0.00	-0.87*	-0.51
	(0.41)	(0.40)	(0.39)	(0.38)	(0.41)	(0.42)
β_{-1}	-0.53	-0.51	-0.30	-0.25	-0.72*	-0.47
	(0.32)	(0.32)	(0.31)	(0.31)	(0.32)	(0.33)
β_1	1.48***	1.37**	1.52***	1.30***	1.44***	1.54***
	(0.36)	(0.36)	(0.29)	(0.29)	(0.36)	(0.37)
β_2	1.06**	0.97*	1.28***	0.95**	0.95*	1.22**
	(0.39)	(0.39)	(0.34)	(0.32)	(0.39)	(0.40)
β_3	0.89*	0.76	1.27***	1.14**	0.75	0.96*
	(0.44)	(0.45)	(0.38)	(0.36)	(0.44)	(0.46)
β_4	0.97*	0.86	1.32**	1.26**	0.86	1.12*
	(0.46)	(0.47)	(0.42)	(0.39)	(0.45)	(0.48)
Pre-trends (p-value)	0.24	0.28	0.62	0.55	0.06	0.36
N (obs)	72,259	72,259	77,971	83,517	56,740	57,538

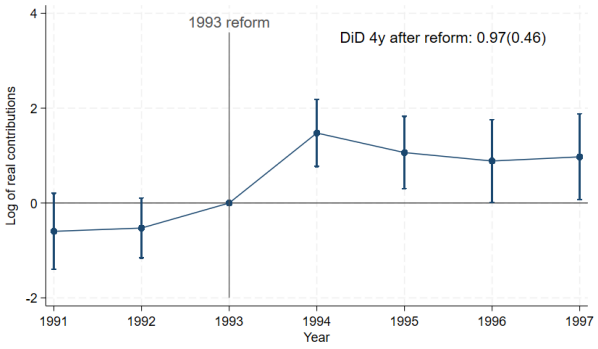
Notes: This table provides the dynamic DiD estimates of contribution response to the 1993 pension reform using alternative specifications. The outcome variables are the probability of contributing above the minimum (Panel A) and the logarithm of real contributions (Panel B). My baseline specification compares those aged 50-52 years to those aged 40-46 using the specification in Equation 5 (column 1). I consider the regressing Equation 5 without covariates (column 2), extensions of the treatment group to include those aged 50-53 (column 3) and aged 50-54 (column 4), reducing the control group to those aged 40-44 (column 4) and aged 42-46 (column 5). Pre-trends report the p-value of joint significance of the pre-reform coefficients. Standard errors in parenthesis. * p<0.05, ** p<0.01, *** p<0.001.
Source: MCVL 2005

Figure F.2: Dynamic DiD results on the 1993 reform

(a) Prob. above minimum



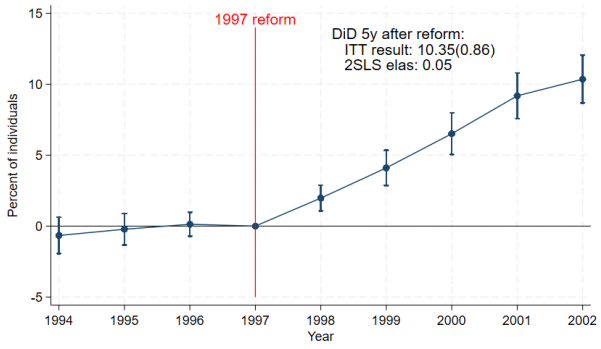
(b) Log of real contributions



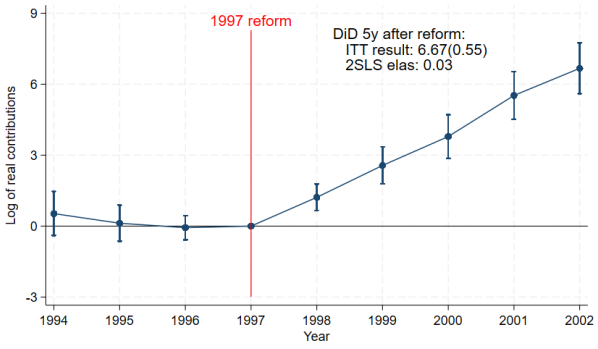
Notes: The figure shows the dynamic DiD response of self-employed workers aged 50-52 to the 1993 reform, which changed in the age of the option value from 55 to 50 years. The figure provides results on the probability of contributing above the minimum (panel a) and the log of real contributions (panel b) between 1991 and 1997. The treatment group is represented by self-employed workers aged 50-52 and the control group by those aged 40-46. I define age on the 1st January, when most self-employed workers decide their contributions. The vertical gray line in 1993 denotes the reform year. The coefficient estimates on the log of real contributions are multiplied by 100 to represent percentage points of real contributions.
Source: MCVL 2005.

Figure F.3: Dynamic DiD results on the 1997 reform

(a) Prob. above minimum



(b) Log of real contributions



Notes: The figure shows the dynamic DiD response of self-employed workers aged 50-52 to the 1997 reform, which changed in the age when contributions became linked to pension benefits from 57 to 50 years. The figure provides results on the probability of contributing above the minimum (panel a) and the log of real contributions (panel b) between 1994 and 2002. The treatment group is represented by self-employed workers aged 50-52 and the control group by those aged 40-46. I define age on the 1st January, when most self-employed workers decide their contributions. The vertical red line in 1997 denotes the reform year. The coefficient estimates on the log of real contributions are multiplied by 100 to represent percentage points of real contributions.
Source: MCVL 2005.

G Additional results: 1997 reform

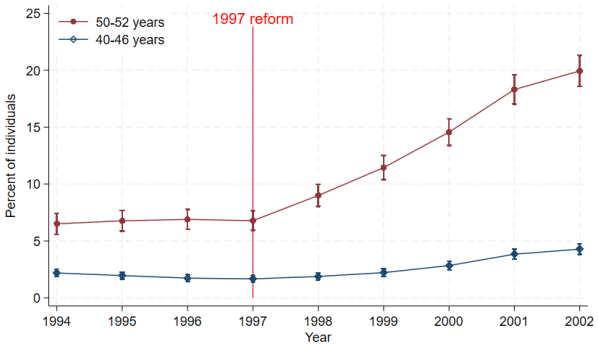
This appendix presents additional results on the response to the 1997 reform. The DiD approach compares self-employed workers' contributions at age 50-52 to those at age 40-46.

G.1 Baseline results

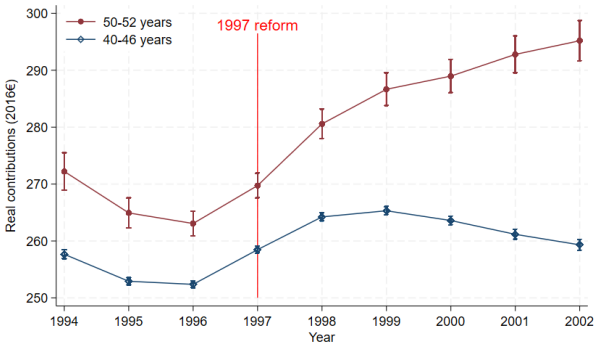
Graphical evidence. Figure G.1 offers graphical evidence on the average contributions of treatment (age 50-52) and control groups (age 40-46) before and after the 1997 reform. Before the reform, the contribution behavior of both groups remained small, stable and parallel, supporting the parallel trends assumption. After the 1997 reform, the contributions of treatment and control groups substantially diverged. The fraction of self-employed workers aged 50-52 contributing above the minimum gradually increased from 7% to 20% by 2002, while the fraction remained below 5% for those aged 40-46. Average real contributions for both groups followed a parallel evolution before the 1997 reform, substantially diverging afterward.

Figure G.1: Contributions of aged 50-52 and 40-46 between 1994-2002

(a) Prob. above minimum



(b) Real contributions



Notes: This figure shows the fraction of self-employed workers contributing above the minimum (panel a) and of average real contributions (panel b) between 1994 and 2002. I define age on the 1st January of each year, when most self-employed workers decide their contributions. The red lines refer to the treatment group (50-52 years), while blue lines represent average values of the control group (40-46 years). The vertical red line in 1997 denotes the reform year.
Source: MCVL 2005.

Full dynamic DiD results. Table G.1 provides the full dynamic DiD responses to the 1997 pension reform for alternative specifications. Five years after the 1997 reform, the fraction of self-

employed workers aged 50-52 who contributed above the minimum increased by 10.35 percentage points, while real contributions increased by 6.67% during the same period.

Table G.1: Dynamic DiD results for the 1997 reform using alternative specifications

	Baseline	No controls	Treatment group		Control group	
			50-53y	50-54y	40-44y	42-46y
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Prob above min.						
β_{-3}	−0.66	−0.79	−1.15*	−1.23*	−0.28	0.91
	(0.66)	(0.67)	(0.54)	(0.48)	(0.66)	(0.67)
β_{-2}	−0.22	−0.30	−0.73	−1.00*	0.04	0.30
	(0.57)	(0.58)	(0.46)	(0.42)	(0.57)	(0.58)
β_{-1}	0.13	0.05	−0.25	−0.33	0.25	0.02
	(0.43)	(0.44)	(0.35)	(0.32)	(0.44)	(0.44)
β_1	1.97***	2.00***	1.52***	1.63***	1.99***	2.00***
	(0.47)	(0.48)	(0.39)	(0.34)	(0.47)	(0.48)
β_2	4.10***	4.11***	3.58***	3.70***	4.19***	3.95***
	(0.63)	(0.64)	(0.53)	(0.47)	(0.64)	(0.65)
β_3	6.51***	6.61***	5.95***	5.56***	6.51***	6.35***
	(0.75)	(0.77)	(0.64)	(0.57)	(0.76)	(0.77)
β_4	9.18***	9.36***	8.38***	8.43***	9.70***	8.86***
	(0.82)	(0.84)	(0.73)	(0.66)	(0.82)	(0.85)
β_5	10.35***	10.55***	10.66***	10.46***	10.90***	9.98***
	(0.86)	(0.88)	(0.77)	(0.71)	(0.86)	(0.89)
Pre-trends (p-value)	0.548	0.504	0.177	0.058	0.756	0.397
Panel B: Log of real contr.						
β_{-3}	0.53	0.50	0.25	0.08	0.60	0.45
	(0.47)	(0.48)	(0.38)	(0.33)	(0.48)	(0.48)
β_{-2}	0.12	0.11	−0.04	−0.24	0.13	0.13
	(0.39)	(0.40)	(0.32)	(0.27)	(0.39)	(0.39)
β_{-1}	−0.07	−0.11	−0.05	−0.13	0.08	−0.13
	(0.26)	(0.27)	(0.22)	(0.19)	(0.26)	(0.26)
β_1	1.22***	1.23***	0.85***	0.76***	1.25***	1.26***
	(0.28)	(0.29)	(0.24)	(0.21)	(0.29)	(0.29)
β_2	2.57***	2.60***	2.00***	1.89***	2.61***	2.50***
	(0.40)	(0.41)	(0.32)	(0.29)	(0.40)	(0.41)
β_3	3.79***	3.86***	3.55***	3.03***	3.79***	3.67***
	(0.47)	(0.48)	(0.38)	(0.33)	(0.47)	(0.48)
β_4	5.52***	5.64***	4.94***	4.88***	5.75***	5.37***
	(0.51)	(0.53)	(0.45)	(0.40)	(0.51)	(0.53)
β_5	6.67***	6.80***	6.70***	6.30***	6.93***	6.51***
	(0.55)	(0.56)	(0.48)	(0.44)	(0.55)	(0.56)
Pre-trends (p-value)	0.450	0.447	0.665	0.330	0.323	0.519
N (obs)	97,115	97,115	106,417	115,075	77,200	78,162

Notes: This table provides the dynamic DiD estimates of contribution response to the 1997 pension reform using alternative specifications. The outcome variables are the probability of contributing above the minimum (Panel A) and the logarithm of real contributions (Panel B). My baseline specification compares those aged 50-52 years to those aged 40-46 years using the specification in Equation 5 (column 1). The coefficient estimates on the log of real contributions are multiplied by 100 to represent percentage points of real contributions. I consider the regressing Equation 5 without covariates (column 2), extensions of the treatment group to include those aged 50-53 years (column 3) and 50-54 years (column 4), reducing the control group to those aged 40-44 years (column 4) and 42-46 years (column 5). Pre-trends report the p-value of joint significance of the 3 lags of the reform. Standard errors in parenthesis. * p<0.05, ** p<0.01, *** p<0.001.
Source: MCVL 2005

Table G.2: 2SLS results on the semi-elasticity of contribution incentives

	Baseline	Discount rate		Contr. year coef.		Mortality		Early ret.	Policy unc.
		d = 1%	d = 5%	α = 100%	α = 70%	45-47y	55-57y	R = 62y	CE = 57.8%
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A: Prob above min.									
ϵ_{t+1}	0.010	0.006	0.016	0.009	0.014	0.009	0.013	0.011	0.018
ϵ_{t+2}	0.021	0.013	0.033	0.019	0.028	0.018	0.026	0.024	0.036
ϵ_{t+3}	0.033	0.020	0.052	0.030	0.045	0.028	0.041	0.038	0.057
ϵ_{t+4}	0.046	0.029	0.073	0.042	0.062	0.039	0.058	0.053	0.080
ϵ_{t+5}	0.052	0.032	0.082	0.048	0.070	0.044	0.064	0.059	0.090
Panel B: Log of real contr.									
ϵ_{t+1}	0.006	0.004	0.010	0.006	0.008	0.005	0.008	0.007	0.011
ϵ_{t+2}	0.013	0.008	0.021	0.012	0.018	0.011	0.016	0.015	0.023
ϵ_{t+3}	0.019	0.012	0.030	0.018	0.026	0.016	0.024	0.022	0.033
ϵ_{t+4}	0.028	0.017	0.044	0.026	0.037	0.024	0.035	0.032	0.048
ϵ_{t+5}	0.034	0.021	0.053	0.031	0.045	0.028	0.042	0.038	0.058

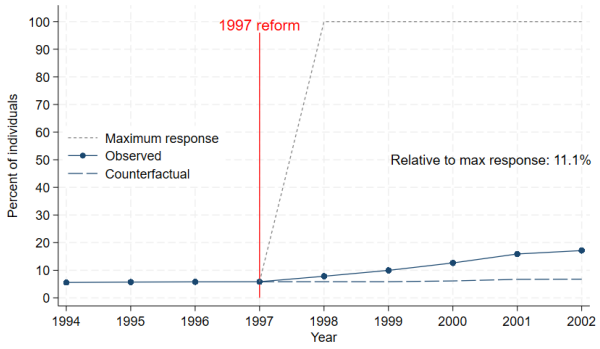
Notes: This table provides the 2SLS results on the semi-elasticity of contribution incentives after the 1997 reform using alternative measurements of incentives. The semi-elasticity represents the Wald ratio of the DiD contribution response to the 1997 reform, divided by the effect on contribution incentives. My DiD compares self-employed workers aged 50-52 to those aged 40-46. The outcome variables are the probability of contributing above the minimum (Panel A) and the logarithm of real contributions (Panel B). The table includes my baseline semi-elasticity (column 1). I further estimate the semi-elasticity for a discount rate of 1% (column 2) and 5% (column 3), replacement rate of 100% (column 4) and 70% (column 5); using the survival probabilities of those aged 45-47 (column 6) and aged 55-57 (column 7), while my target population are aged 50-52; retirement at 62 years (column 8); and accounting for policy uncertainty using a certainty equivalent (CE) of 57.8% (column 9).
Source: MCVL 2005

Responses to 1997 reform relative to benchmarks. I compare the responses to the 1997 reform with respect to relevant benchmarks. First, I estimate that the response to the reform was only 11.1% of the maximum response in the probability of contributing above the minimum and 3.8% in real contributions. This rules out the possibility that the small responses came from reaching maximum ceilings. Second, I show the 1997 reform only reduced the gap between the contributions of self-employed workers and wage earners by 12.5% in the probability of contributing above the minimum and 8.1% in real contributions[10]. This indicates that self-employed workers made contributions below their contribution capacity.

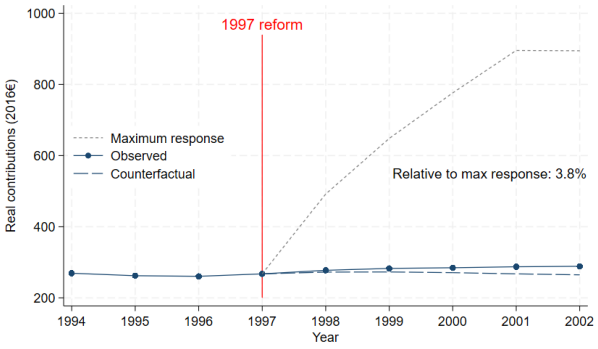
[10]Self-employed workers in Spain on average have larger income and wealth than wage-earners (Bover, 2008), making wage earners' contributions a relevant benchmark.

Figure G.2: Response to 1997 reform relative to the maximum contribution response

(a) Prob. above minimum



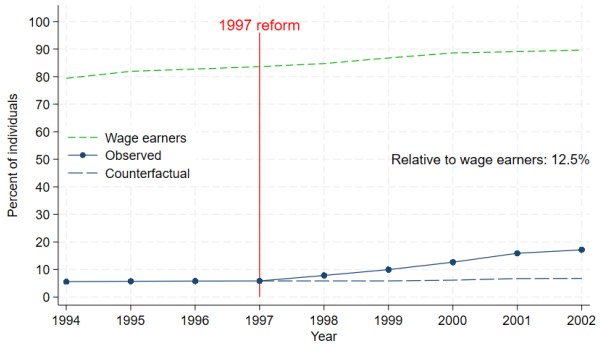
(b) Real contributions



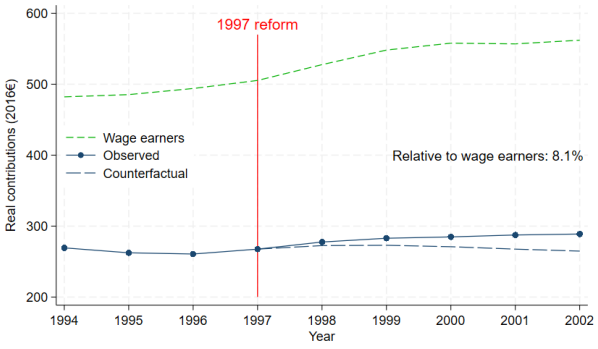
Notes: This figure displays the response to the 1997 reform of self-employed workers aged 50-52 relative to the maximum contribution response for the probability of contributing above the minimum (panel a) and real contributions (panel b). Counterfactual outcomes are calculated subtracting the dynamic DiD estimates in Figure F.3 to their observed contributions. The blue lines represent observed outcomes, dashed blue lines represent counterfactual outcomes, while gray short dashed lines represent the maximum response. The vertical red line in 1997 indicates the reform year.
Source: MCVL 2005.

Figure G.3: Response to 1997 relative to wage earners

(a) Prob. above minimum



(b) Real contributions



Notes: The figures display the contribution response for the probability or contributing above the minimum (panel a) and real contributions measured in 2016€ (panel b) of self-employed workers aged 50-52 years relative to the contribution response to catch up with the contributions of wage earners. The blue lines represent observed outcomes, dashed blue lines represent counterfactual outcomes, while green dashed lines represent the wage earners' contributions. The vertical red line in 1997 indicates the reform year.
Source: MCVL 2005.

G.2 Effect of eligibility to the option value decision

This appendix provides evidence on the effect of making the option value decision at the time when contributions are becoming linked to pension benefits. For this, I exploit the cohort-based eligibility to make the option value decision after the 1997 pension reform. Self-employed workers born in 1947 and before were already 50 years old in 1997, making them ineligible to make the option value decision after 1997. However, those born after 1948 were younger than 50 years in 1997 and therefore eligible to fully adjust their option value decisions once the reform was approved. Table G.3 shows the birth cohorts by age and year, highlighting eligibility cut-off to make option value decision after 1997.

Table G.3: Cohorts of self-employed entering treatment and control groups

	40	41	42	43	44	45	46	47	48	49	50	51	52
1994	1953	1952	1951	1950	1949	1948	1947	1946	1945	1944	1943	1942	1941
1995	1954	1953	1952	1951	1950	1949	1948	1947	1946	1945	1944	1943	1942
1996	1955	1954	1953	1952	1951	1950	1949	1948	1947	1946	1945	1944	1943
1997	1956	1955	1954	1953	1952	1951	1950	1949	1948	1947	1946	1945	1944
1998	1957	1956	1955	1954	1953	1952	1951	1950	1949	1948	1947	1946	1945
1999	1958	1957	1956	1955	1954	1953	1952	1951	1950	1949	1948	1947	1946
2000	1959	1958	1957	1956	1955	1954	1953	1952	1951	1950	1949	1948	1947
2001	1960	1959	1958	1957	1956	1955	1954	1953	1952	1951	1950	1949	1948
2002	1961	1960	1959	1958	1957	1956	1955	1954	1953	1952	1951	1950	1949

Notes: This table shows the cohorts of self-employed workers entering the treatment and control groups between 1994 and 2002. The control group, consisting of self-employed workers aged 40-46, is shaded in light blue. The treatment group, consisting of those aged 50-52, is shaded in light red before the 1997 reform. After 1998, the treatment group is shaded in red for cohorts born in 1947 and before, while they are shaded in darker red for cohorts born in 1948 and after, who were eligible to fully adjust their decisions for the option value.

Empirical strategy. I study the discontinuity in DiD responses to the 1997 reform for those born pre-1947 and post-1948. I estimate the discontinuity of responses to the 1997 reform controlling for age-specific effects and a linear trend of the dynamic treatment effect after 1997. The regression specification takes the following form:

$$\begin{aligned} Y_{iact} =& \alpha_a + D_t + \sum_{\tau=1}^{15} \gamma_{-\tau} T_a \times D_{1997-\tau} + \sum_{a=50}^{52} \gamma_a \mathbf{1}\{age_{it} = a\} \times \mathbf{1}\{t \geq 1998\} + \delta \mathbf{1}\{c_i \geq 1948\} + \\ &+ \lambda t \times \mathbf{1}\{t \geq 1998\} T_a + \mu \mathbf{1}\{c_i \geq 1948\} \times \mathbf{1}\{t \geq 1998\} + \mathbf{X_{iat}}\theta + \varepsilon_{iat} \end{aligned} \tag{7}$$

where Y_{iact} refers to my two outcomes of interest, which are $Y_{iact} = \mathbf{1}\{C_{iact} > C_t^L\}$, the indicator variable on whether self-employed worker i of age a born in cohort c contributed above the minimum contribution C_t^L in period t, and $Y_{iact} = \mathbf{1}\{C_{iact} > C_t^{M50}\}$, the indicator variable on whether self-employed worker i of age a born in cohort c contributed above the 50+ maximum contribution C_t^{M50} in period t. α_a refers to age dummies, and D_t refers to time dummies measured in quarters, T_a refers to the treatment group indicator, which takes value of 1 if $a \in [50, 52]$ and value of 0 if $a \in [40, 46]$. $\mathbf{X_{it}}$ refers to the set of controls, which include province dummies, education level dummies, industry of the economic activity, whether individuals live in municipalities above 40,000 people, tenure and real GDP per capita at the province level. Standard errors are clustered at the individual level. The parameter of interest is μ, which measures the effect of the eligibility to make the option value decision at the same time when contributions became linked to pension benefits.

H Additional results: 2003 reform

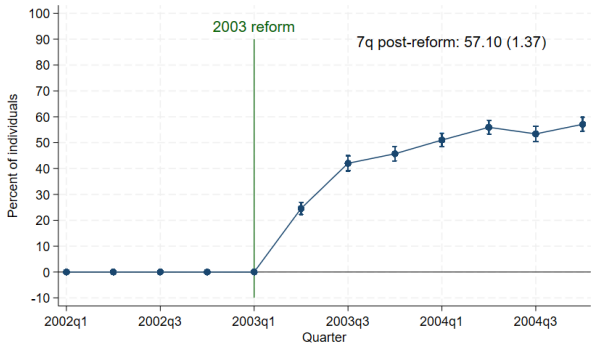
This appendix provides additional evidence on the response to 2003 reform. This describes the sample, the dynamic response to the reform, and the responses of female new self-employed workers aged over 50.

Sample selection and summary statistics. I use contribution data for the period 2002-2004 for entrants into self-employment for the first time at an age younger than 30 or older than 45 for females, who are eligible to reduce their contributions following the reform. Table H.1 presents the summary statistics for new self-employed between 2002 and 2004 for estimating the effect of the 2003 reform.

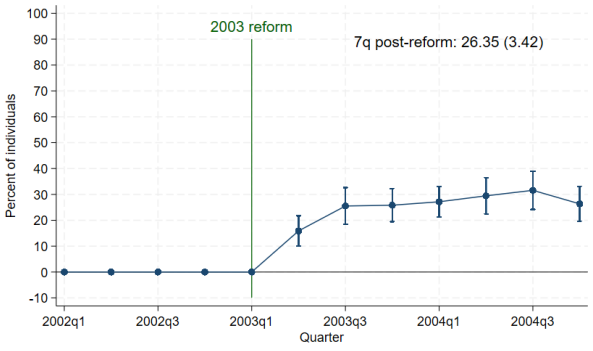
Evolution of responses over 2002-2004. Figure H.1 displays the fraction of new self-employed workers contributing at the reduced minimum by quarter between 2002 and 2004. While some increase in responses is observed over time, the increase can be considered modest, particularly for females aged 45 or more.

Figure H.1: Fraction of new self-employed workers contributing by the reduced minimum

(a) Aged 30 or less



(b) Females aged 45 or more



Notes: This figure displays the fraction of new self-employed workers contributing below the reduced minimum for those aged less than 30 years (panel a) and females aged over 45 years (panel b). The vertical green line represents the 2003 reform.
Source: MCVL 2005.

Responses for females older than 50 years. This appendix also provides evidence on the response of new self-employed workers aged above 50 depending on their potential contribution years

Table H.1: Summary statistics for new self-employed between 2002 and 2004

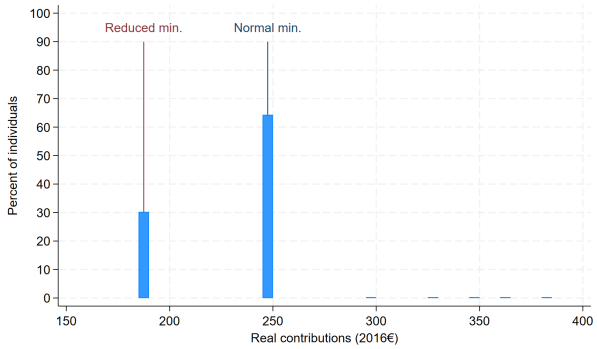
	Eligible: 18-30 years		Eligible: 45-64 years		All eligible	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Outcome variables						
$1\{C_{iat} < C^L_{iat}\}$	28.612	(15.612)	16.366	(37.006)	27.201	(44.500)
Real Contr. (2016€)	248.730	(35.309)	271.905	(87.039)	251.393	(44.996)
Control variables						
Female	0.356	(0.478)	1.000	(0.000)	0.431	(0.495)
Education level						
Primary	0.139	(0.346)	0.339	(0.473)	0.163	(0.369)
Secondary	0.411	(0.492)	0.326	(0.469)	0.401	(0.490)
Superior	0.423	(0.494)	0.275	(0.447)	0.405	(0.491)
N.A.	0.026	(0.159)	0.058	(0.233)	0.030	(0.171)
Economic activity						
Agriculture	0.016	(0.126)	0.034	(0.181)	0.018	(0.134)
Manufacturing	0.062	(0.242)	0.056	(0.231)	0.062	(0.241)
Construction	0.179	(0.383)	0.064	(0.246)	0.166	(0.372)
Retail service	0.203	(0.403)	0.293	(0.455)	0.214	(0.410)
Hospitality	0.100	(0.300)	0.172	(0.377)	0.108	(0.310)
Transport	0.042	(0.202)	0.024	(0.152)	0.040	(0.197)
Estate & Finance	0.136	(0.343)	0.187	(0.390)	0.142	(0.349)
Social service	0.110	(0.313)	0.104	(0.305)	0.110	(0.312)
N.A.	0.148	(0.355)	0.063	(0.243)	0.138	(0.345)
Small municipality	0.527	(0.499)	0.443	(0.496)	0.517	(0.500)
Contribution years	3.217	(3.289)	7.778	(9.090)	3.748	(4.709)
N (obs)	14,567		1,882		16,449	

Notes: This table shows the descriptive statistics for the sample entering the study of the effect of the 2003 reform. This include new self-employed eligible to decrease their contributions aged 18-30 years and females aged over 45 years. I provide mean and standard deviation for my two outcome variables, the probability of contributing below the ordinary minimum and real contributions, as well as demographic and employment variables such as categorical variables on education and economic activity, as well as gender, a dummy variable on whether municipality of residence has population smaller than 40,000 inhabitants and contribution years. Fractions of categorical variables may not add up due to rounding.
Source: MCVL 2005.

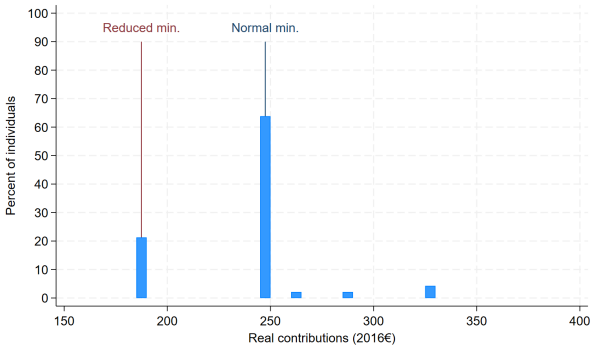
at retirement. In this manner, I consider the group of self-employed workers whose contributions could be potentially linked to pension benefits. Figure H.2 shows the histogram for females aged over 50 years categorized by the length of contribution periods, which determines whether minimum pensions override contribution incentives. Among the self-employed with expected contributed periods above 30 years, whose contributions are likely to count for pensions, 21.73% of self-employed reduce their contributions. In contrast, among those with expected contribution periods shorter than 25 years and therefore without pension incentives, only 31.54% reduce their contributions. The reduction in contributions is relatively small, considering that these contributions do not count for pension benefits.

Figure H.2: Histogram of contributions for female new self-employed aged ≥50 years in 2004

(a) Expected cont. years < 25



(b) Expected cont. years > 30

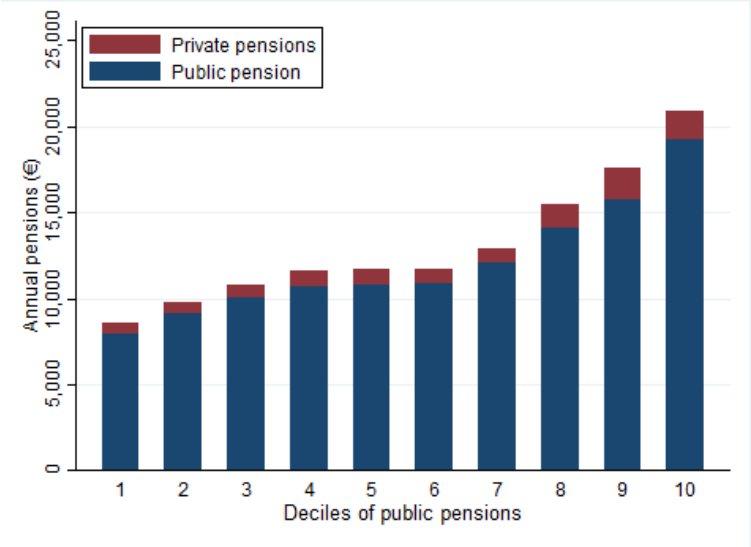


Notes: This figure displays the histogram of contributions for female new self-employed workers older than 50 years in 2004, expected contribution periods below 25 years (panel a) and above 30 years (panel b). Expected contributed years assume the self-employed work until retirement at 65 years. The red vertical line represents the reduced minimum contribution and the blue vertical line represents the ordinary minimum contribution.
Source: MCVL 2005.

I Private annuity pensions

This appendix provides evidence on the private pensions received by Spanish self-employed workers at retirement. I use that Social Security data is merged with data coming from tax withholding files since 2006, which allows observing both public and private pensions. I select a sample of self-employed retirees aged 65-70 of cohorts 1944-1948, which are closest to the treatment group of my analysis on the 1997 reform. Figure I.1 illustrates that average private pensions are generally low across all deciles of public pensions, suggesting minimal substitution between public and private pensions.

Figure I.1: Public and private pensions for self-employed retirees



Notes: This figure shows the average annual public and private pensions received by Spanish self-employed retirees of cohorts 1944-1948 when aged between 65 and 70, classified by deciles of annual public pension benefits. Public pensions represent the annual public pension, while private pensions represent the average private pensions received between age 65 and 70.
Source: MCVL 2006-2018.

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