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Ander Iraizoz

PARIS SCHOOL OF ECONOMICS
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Saving for retirement through the public pension system: Evidence from the self-employed in Spain

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Abstract

Using the fact that the Spanish self-employed voluntarily choose their contributions to Social Security, I study the effect of financial incentives on public pension savings for self-employed workers in Spain. For this, I implement a difference-in-differences approach exploiting the change in public pension saving incentives induced by the 1997 pension reform. I find that the Spanish self-employed significantly respond to the financial incentives for public pension savings. However, the estimated response could be considered modest relative to the magnitude of the return to contributions provided by pension formulas in Spain. I provide evidence suggesting that the lack of salience of the return to contributions could be one of the main drivers of such a modest response, highlighting the importance of information and salience on the responsiveness of self-employed workers to saving incentives.

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1 Introduction

In many countries, self-employed workers are required to make lower mandatory contributions into pension schemes compared to employees. Several examples of this include setting lower Social Security Contribution (SSC) rates for the self-employed in Italy, eligibility to wage base deductions for the self-employed in the US, or giving freedom to decide SSCs to the public pension system in Spain[1]. In addition to this, self-employed workers do not participate in complementary pension schemes such as occupational pensions in many countries like the UK, US or Netherlands. Larger freedom for old-age social protection for self-employed workers is mainly justified by two reasons. First, the self-employed need to accumulate their own business savings, which contribute to their old-age wealth at retirement. Second, the self-employed face irregular earning patterns[2]. However, the lower level of mandatory old-age social protection for self-employed workers raises concerns on the possibility of insufficient retirement savings. This concern has become particularly relevant following the emergence of new forms of self-employment with low social protection, also known as "gig" jobs (OECD, 2018). Furthermore, the decrease in the generosity of public pension systems because of rapid population ageing has accentuated the reliance on individual provision of retirement savings in developed countries. In this context, the design of optimal pension schemes for the self-employed requires to understand the determinants of retirement saving behaviour for the self-employed, including the effectiveness of saving incentives for stimulating retirement savings.

Despite the increasing relevance of this issue, evidence on the determinants of retirement savings for self-employed workers is very scarce. In this regard, recent studies provide evidence on the fact the larger discretion for old-age social protection for the self-employed leads to lower retirement savings. Benzarti et al. (2020) study the effect of a reform that relaxed the mandate for making SSCs for Finnish entrepreneurs, finding substantial reductions in their SSCs[3]. The authors interpret these findings as evidence supporting that the social insurance mandate is binding for entrepreneurs. In addition to this, Mastrogiacomo and Alessie (2015)

[1]For further examples, see Choi (2009) or Spasova et al. (2017).

[2]In addition to this, the group of self-employed workers is very heterogeneous, including entrepreneurs, freelance workers, individuals working in liberal professions, or individuals working in low-paid jobs. This requires flexibility for customizing social protection to individual needs.

[3]They also find that younger firms channel this money to increase their business activity, while more mature firms dedicate this to improve their net lending position.

provide evidence suggesting self-employed workers do not accumulate larger voluntary savings than employees to compensate for their ineligibility to the second pillar in the Netherlands. In the case of Spain, Sanchez-Martin (2019b) provides descriptive evidence on the fact that the vast majority of the Spanish self-employed contributed by the minimum mandatory level between 2008 and 2018, while Sanchez-Martin (2019c) calculates that the Spanish pension system gave sizeable returns. However, to the best of my knowledge, the effect of saving incentives for self-employed workers has not yet been causally evaluated.

The lack of causal evidence on the effect of financial incentives on retirement savings for self-employed workers is in contrast with the large interest of the economics literature on the determinants of retirement savings for employees. In this regard, the effect of financial incentives for increasing savings for employees has been found to be positive but relatively small (Engen et al., 1996; Chetty et al., 2014), particularly when considering the effect of financial incentives on total wealth[4]. A recent strand of literature has highlighted the effectiveness of interventions to overcome behavioural explanations for low savings, such as bounded rationality, inertia or present bias. In this regard, very large effects on savings have been found for low cost interventions such as changing default options (Madrian and Shea, 2001), the need to make active decisions (Carroll et al., 2009), offering commitment for delayed enrollment to avoid present bias (Thaler and Benartzi, 2004), simplifying the saving problem by offering a salient pre-selected plan (Beshears et al., 2013) or making particular saving choices salient through simple cues (Choi et al., 2017). In addition to this, framing and presentation of incentives have been found to affect the responsiveness to saving incentives[5] (Duflo et al., 2006; Saez, 2009), while peer effects (Duflo and Saez, 2002), as well as information and social interactions (Duflo and Saez, 2003) have been found to be significant determinants of savings decisions. However, neither the responsiveness to saving incentives nor the effect of other determinants for retirement savings have been causally evaluated for self-employed workers[6].

This paper aims to study the causal effect of financial incentives on retirement savings for

[4]Chetty et al. (2014) provide evidence on the fact that most employees are passive savers who are driven by inertia and default options, while a minority of people actively respond to financial incentives of particular financial instruments. The latter group strongly substitute savings from between alternative saving options, which results in small overall effects of total savings to financial incentives.

[5]For similar financial incentives, Duflo et al. (2006) find a very different savings response to financial incentives between the matching contributions of Individual Retirement Arrangements (IRA) and Saver's Credit, emphasizing the effect of information and salience of incentives.

[6]For health insurance coverage, Gruber and Poterba (1994) and Selden (2007) find a significant and sizeable effect of income tax deductions on private health insurance coverage of the self-employed in the US.

the self-employed, as well as the determinants of the responsiveness of retirement savings of the self-employed to financial incentives. This is, to the best of my knowledge, the first study providing causal evidence on the effect of financial incentives on retirement savings for the self-employed, which is a critical determinant of optimal pension schemes for self-employed workers. In order to tackle these questions, I exploit an unique case study provided by the Spanish Social Security system. The Spanish Special Scheme for Self-Employed Workers (*Régimen Especial para Trabajadores Autónomos, RETA*) allows the self-employed in Spain to voluntarily choose their SSCs, within maximum and minimum limits that are legislated annually. Therefore, this gives the opportunity to observe self-employed workers optimize the financial incentives for public pension savings provided by pension formulas in Spain. I use administrative microdata from the 2005 wave of the Spanish Continuous Sample of Employment Histories (*Muestra Continua de Vidas Laborales*, MCVL) provided by the Spanish Social Security. This dataset provides information on the contributions and employment histories for a random sample of 4% of Spanish taxpayers that had relationship with the Spanish Social Security in 2005.

In order to estimate the causal effect of the incentives to save through the public pension system, I exploit the 1997 pension reform approved in Spain, which increased the number of years of contribution taken into account for the calculation of pension benefits from the last 8 to the last 15 years of contributions. As a result, the reform changed contribution incentives for self-employed workers aged 50-52 years, while contribution incentives remained unchanged for those aged 40-46 years. Therefore, I implement a difference-in-differences approach comparing the contribution behaviour of self-employed workers aged 50-52 years with those aged 40-46 years. I estimate that the 1997 pension reform increased the probability of contributing above the minimum contribution level by 10.12 percentage points for male self-employed workers aged 50-52 years 5 years after the reform, while real contributions increased by 6.52%. When comparing contribution responses with the dimension of financial incentives, I estimate that 1 percentage point increase in financial incentives for public pension savings leads to an increase between 0.042 percentage points and 0.115 percentage points in the probability of making contributions above the minimum for male self-employed workers aged 50-52 years, while the increase in real contributions ranged between 0.027% and 0.074%. Therefore, the estimated response could be considered small relative to the magnitude of the return provided by the contributions made by self-employed workers in Spain[7].

[7]I calculate that the real rate of return provided by contributions for those aged 50-52 years increased from

I also exploit particular features of the freedom of the self-employed in Spain to choose their contributions to provide evidence on the mechanisms driving their responsiveness to saving incentives. Using the introduction of a reduced minimum contribution for various age subgroups of new self-employed workers in 2003, I provide evidence on the reluctance of self-employed workers to make SSCs other than the standard minimum contribution. This is because I find that a large share of new self-employed workers do not take advantage of the reduced contribution level even when the incentives to contribute are minimal. Importantly, this cannot be attributed to inertia since new self-employed workers make active decisions on their SSCs. I interpret this as evidence supporting that the lack of information on the return of contributions to Social Security could be one of the main drivers of the small saving response of self-employed workers to financial incentives. This is because the return provided by the pension system is implicit within complicated pension formulas, which may be difficult to calculate for the ordinary self-employed worker. This is also supported by survey evidence from the Spanish Association of Self-Employed Workers (*Asociación de Trabajadores Autónomos*, ATA) (2019), which showed that only 11,4% of the Spanish self-employed reported to understand the pension benefits covered by their contributions to Social Security.

In addition to this, I use a restriction on contributions from the age of 50 years to provide further evidence on mechanisms of saving responses. From the age of 50 years, the ability to make large contributions to Social Security is restricted by a lower maximum ceiling. However, if self-employed workers decide to contribute by an amount that is larger than the reduced maximum by the age of 50, they will be able to keep their contributions during the following year even when aged over 50 years. This "option value" at age 50, which is an irreversible decision, coincides with the first period when contributions matter for pensions and therefore there is a large change in public pension saving incentives. I find eligible cohorts to adjust their contributions to the "option value" at the age of 50 years respond more strongly than those not eligible. However, this does not increase the share of individuals contributing above the reduced maximum level, which is the region on which eligibility matters. Self-employed workers are therefore found to be more responsive to saving incentives when large changes in saving incentives coincide with irreversible decisions on savings, even for irreversible decisions that appear not to be appealing for self-employed workers. This may capture the fact that irreversible decisions induce self-employed workers to consider their retirement savings, in

-100% to 5.8% after the 1997 pension reform.

addition to capturing the effect of a "nudge" on the timing to increase public pension savings.

These results suggest that setting lower levels of mandatory old-age social protection for the self-employed may not support the goal of transferring resources over the lifetime when public pension saving incentives are not salient. This study therefore highlights the importance of information and salience on the responsiveness of self-employed workers to saving incentives. Future studies should aim to extend this evidence by studying the effect of financial incentives on total retirement savings for the self-employed. In addition to this, future studies should evaluate the effectiveness of further interventions, including default options or offering commitment for delayed enrollment, for stimulating retirement savings for self-employed workers.

The rest of this paper is structured as follows. Section 2 describes the Spanish Social Security Scheme for Self-Employed Workers and the 1997 pension reform. Section 3 describes the financial incentives for public pension savings in Spain. Section 4 describes the data and empirical strategy used in this study. Section 5 describes the estimation results on the 1997 pension reform. Section 6 provides further evidence on the determinants of public pension savings for self-employed workers. Section 7 concludes.

2 Institutional design

The Spanish public pension system is a contributory defined benefit Pay-As-You-Go (PAYG) system. It is comprised of the General Social Security Scheme (*Régimen General de la Seguridad Social*, RGSS) and a number of Special Social Security Schemes (*Régimenes Especiales de la Seguridad Social*, RESS), among which the most numerous scheme is the Special Scheme for Self-Employed Workers (*Régimen Especial de Trabajadores Autónomos*, RETA). In the following lines, I describe the most relevant features of the RETA scheme for the purpose of this study. For further details on the Spanish pension system and the reforms passed since 1985, see Boldrin et al. (2010) and Garcia-Gomez et al. (2018).

2.1 Special Scheme for Self-Employed Workers (RETA)

The RETA scheme regulates the Social Security system for self-employed workers in Spain. While all pension schemes in Spain have common pension formulas, RETA has several distinct

features in the determination of SSCs. In particular, self-employed workers can voluntarily choose their Contribution Bases to Social Security, within the maximum and minimum ceilings that are legislated annually[8]. The maximum and minimum ceilings for contributions, as well as the SSC rate paid on the Contribution Base are specifically legislated for RETA. Table A.1 in Appendix A describes the maximum and minimum ceilings for Contribution Bases, as well as the SSC rate applied during 1994-2002, which is the period of study.

Access to an old-age pension under RETA is conditional on several eligibility requirements. First, taxpayers should have contributed to Social Security for a minimum of 15 years, two of which should be in the last 15 years before claiming the benefit. Second, the minimum age for claiming an old-age pension is 60 years. Upon compliance with these requirements, pension benefits are calculated using the following pension formula:

$$P_t^s = \alpha_n^s \times \beta_{R,n}^s \times BB_t^s \tag{1}$$

where P_t^s refers to the pension benefits if retiring at time t under the formulas system of $s \in \{1985, 1997\}$, which represent pension system before and after the 1997 pension reform respectively. BB_t^s refers to the Benefit Base for retiring at time t in system s, α_n^s refers to the penalization for contribution years n in system s and $\beta_{R,n}^s$ refers to the penalization for early retirement for retirees with age R with n years contributed to Social Security under system s. Importantly, pension benefits are bounded by maximum and minimum pensions, which are described in Table A.1 in Appendix A for the period 1994-2002.

2.2 The 1997 pension reform

The 1997 pension reform[9] was a parametric reform that changed the three parameters of pension formulas: the determination of the Benefit Base, the penalization for lack of contribution years and the penalization for early retirement. Importantly, the change in pension formulas introduced by the 1997 reform was applied to all Social Security schemes. The precise formulation of the these elements before and after the 1997 reform is described in Appendix A.

[8]Self-employed workers have larger discretion for social protection compared to employees across OECD countries (Choi, 2009; OECD, 2018). However, full discretion for choosing SSCs is particular to the Spanish Social Security system (Sanchez-Martin, 2019a)

[9]Ley 24/1997, de 15 de julio, de Consolidación y Racionalización del sistema de la Seguridad Social.

Benefit Base. The modification of the Benefit Base is the most important element of the 1997 pension reform for this study. Before the 1997 reform, the Benefit Base was calculated as the weighted average[10] of the monthly Contribution Bases during the last 8 years before retirement. The 1997 reform gradually increased the number of years taken into account for the calculation of pension benefits from 8 years to 15 years between 1997 and 2002 according to the year of retirement[11].

Penalization for lack of contribution years. Regarding the penalization for lack of contribution years, there was a small change that affected those with contribution years between 15 and 25 at retirement. Before the 1997 reform, the pension benefits were reduced by 2% for each year falling short of 35 years of contributions, starting from a minimum of 15 years of contribution for eligibility of a retirement pension. The 1997 pension reform increased the penalization from 2% to 3% of the Benefit Base for those between 15 and 25 years at retirement.

Retirement age penalization. The 1997 pension reform also implied a small reduction in the penalization for early retirement for those with more than 40 years of contributions. Before the 1997 reform, the penalization for falling short of the statutory retirement age of 65 years amounted to 8%, while the 1997 reform changed this to 7% for individuals with at least 40 years contributed to Social Security. The pension formulas in the period of study did not provide any incentive for delaying retirement above statutory retirement age of 65 years[12].

3 Financial incentives for public pension savings

This section describes the financial incentives for saving through the Spanish public pension system. I first introduce the methodology measuring public pension savings incentives and I then calculate them for the period between 1994 and 2002 in Spain.

[10] Contribution Bases are indexed by the Consumer Price Index (CPI) corresponding to 25 months before retirement for contributions made before that date. Nominal values of Contribution Bases are used for the last two years of contributions.

[11] The number of years taken into account was 9, 10, 11, 12, 13 and 15, respectively for retirement in 1997, 1998, 1999, 2000 2001, and 2002 and beyond.

[12] The incentives to delay retirement beyond the age of 65 years were introduced by the 2002 pension reform, which is out from the period of study.

3.1 Marginal Social Security Benefits (MSSB)

The MSSB represents the net discounted benefits generated by the current payment of SSCs[13]. The MSSB takes the following form:

$$MSSB_{a,t}(r_t) = \frac{\partial SSW_{a,t}}{\partial SSC_{a,t}}(r_t) \tag{2}$$

where $SSC_{a,t}$ 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. Developing this expression, one obtains:

$$MSSB_{a,t}(r_t) = \frac{\partial P_t}{\partial SSC_{a,t}} \left[\frac{1}{(1+r_t)^{R-a}} \sum_{s=R+1}^{\overline{LE}} \frac{\pi_t(s|a)}{(1+r_t)^{s-a}} \right] \tag{3}$$

where P_t stands for the initial pension at time t, $\pi_t(s|a)$ is the survival probability for a person aged a to remain alive at age s at time t, 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 described in Equation 1. An increase in the Contribution Base only leads to an increase in the initial pension if the theoretical pension lies within the statutory maximum and minimum pensions in Spain.

$$\frac{\partial P_t}{\partial SSC_{a,t}} = \begin{cases} \alpha_n \times \beta_{R,n} \times \frac{\partial BB_t}{\partial SSC_{a,t}} & \text{if } P_t \in (\underline{P}_t, \overline{P}_t) \\ 0 & \text{otherwise} \end{cases} \tag{4}$$

where BB_t stands for the Benefit Base at time t, α_n stands for the penalization for the number of contributed years, $\beta_{R,n}$ stands for the penalization coefficient for retirement age, while $\underline{P}_t$ and $\overline{P}_t$ stand for the minimum and maximum statutory pensions respectively. The expression for $\frac{\partial BB_t}{\partial SSC_{a,t}}$ can be further developed[14]::

$$\frac{\partial BB_t}{\partial SSC_{a,t}} = \begin{cases} \frac{w_{a,t}}{T \times \tau} & \text{if } a \in (R-T, R) \\ 0 & \text{otherwise} \end{cases} \tag{5}$$

where $w_{a,t}$ stands for the weight of each Contribution Base of age a at time t, T stands for

[13]The MSSB has already been calculated by Liebman et al. (2009) for the US.

[14]The Benefit Base in the Spanish pension system can be expressed as

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

the number of years of contributions entering the calculation of the Benefit Base and τ stands for the SSC rate. Notice that the Benefit Base is only increased if SSCs are made within the last T years before retirement.

Implicit net-of-tax rate of public pension savings

Using the rate of return of alternative saving options as the discount rate for the MSSB, I use the definition of the MSSB to calculate the implicit net-of-tax rate of public pension savings. The implicit net-of tax rate of public pension savings represents the current value of saving through the public pension system as opposed to saving through alternative saving option d providing return r_t^d:

$$1 - \tau_{a,t}^d = \frac{MSSB_{a,t}(r_t^d)}{NPV_t^d(r_t^d)} \tag{6}$$

where $\tau_{a,t}^d$ refers to the tax rate of saving through the public pension system as opposed to the alternative saving option d for an individual with age a at time t, $MSSB_{a,t}(r_t^d)$ refers to the MSSB of SSCs for an individual aged a at time t discounted at the rate of return r_t^d of asset d and $NPV_t^d(r_t^d)$ refers to the Net Present Value of saving through asset d, discounting cash flows at rate r_t^d.

3.2 Calculation of public pension incentives between 1994 and 2002

I now calculate the implicit net-of-tax rate for male self-employed workers in Spain between 1994 and 2002. For this, I first describe the assumptions for the parameters and I provide the baseline description of incentives based on these assumptions. I then assess the sensitivity of these calculations adjusting penalization parameter on the Benefit Base, as well as mortality and retirement age assumptions.

Along with the calculation of the implicit net-of-tax rate of public pension savings, I provide the calculation of the Marginal Internal Rate of Return (MIRR) for further illustrating the dimension for public pension saving incentives. The MIRR represents the rate of return provided by a marginal increase in SSCs at a given point in time. The methodology for calculating the MIRR is described in Appendix C.

3.2.1 Assumptions and parameters

I use a number of assumptions and parameters to calculate the public pension saving incentives for male self-employed workers in Spain between 1994 and 2002. First, survival probability data are drawn from mortality tables from the Spanish Office of National Statistics (*Instituto Nacional de Estadística, INE*) (2018a; 2018b). Second, I use a coefficient for contribution years for male self-employed workers of $\alpha_n = 91.3\%$, which corresponds with the average penalization of 8,7% for male self-employed workers retiring in 2005. Third, I assume self-employed workers plan to retire at the Statutory Retirement Age of 65 years old, which is the choice of the vast majority of self-employed workers in Spain, as shown in Table B.1 in Appendix B. Fourth, I rule out the possible disincentive of minimum legal pensions for male self-employed workers because the ratio between minimum pensions to minimum contributions stayed well below the coefficient for contribution years for male self-employed workers between 1994 and 2002. As shown in Figure B.2 in Appendix B, the minimum pensions to minimum contributions ratio for self-employed workers stayed below 65% for retirees without dependent spouse and below 75% for retirees with dependent spouse, which is below the average penalization for male self-employed workers. Fifth, I ignore the effect of progressive income taxes on financial incentives since pension benefits are liable for income taxes, but SSCs are also deduced from income tax payments. Sixth, my calculation does not consider the uncertainty involved in this decision, neither for prospects for changes in legislation nor for labour market conditions. Finally, my calculations only consider the financial incentive provided by old-age pensions, while SSCs also give rise to other contributory benefits such as disability pensions or survivor pensions.

In order to provide a plausible range for the implicit net-of-tax rate in Spain, I use risk-free and market rates of return to represent upper and lower bounds of the return on alternative investments. For providing the reference risk-free rate of return in Spain, I use the series of the nominal rate of return of the 10-year Central Government bonds negotiated in the secondary markets in Spain available at the European Central Bank (ECB)[15], which I deflate using CPI rates available at INE (2019), as shown in Figure B.3 in Appendix B[16]. I construct the series

[15]Link: https://www.ecb.europa.eu

[16]In order to construct real risk-free rates, I assume individuals' expected inflation over the following 10 years is determined by current inflation. This could be considered plausible since the nominal 10-year bond yield and CPI series closely follow each other in the period of this study, as shown in Figure B.3 in Appendix B.

for market rates of return applying a premium of 4.5% on the risk-free rate of return[17]. Figure 1a shows that the real risk-free rate of return stayed between 1% and 3% in the 5 years period after the 1997 pension reform, while the market rate of return stayed between 5.5% and 7.5% in this period.

3.2.2 Baseline calculation of incentives between 1994 and 2002

Under the methodology and assumptions presented, I calculate the financial incentives to contribute through the Spanish public pension system for self-employed workers aged 50-52 years between 1994 and 2002. Figure 1 shows the evolution of the implicit net-of-tax rate and the MIRR of public pension savings between 1994 and 2002. In the pre-reform period, the implicit net-of-tax rate of contributing through the public pension system is 0% for self-employed workers aged 50-52 years since their contributions were not linked to pension benefits. However, after the 1997 pension reform, the implicit net-of-tax rate using the market rate of return grew to a range between 65% and 90%, while for the risk-free return this increased to a range between 180% and 260%. This implies that the NPV of SSCs is nearly as large for the asset providing the market return, while this is over twice as large as the risk-free asset. The average MIRR for those aged 50-52 years increased from -100% to 5.8% because of the 1997 pension reform, while the MIRR remained unchanged at -100% for those aged below 49 years old[18].

3.2.3 Sensitivity to alternative assumptions

In order to check the sensitivity of my baseline calculation of the public pension saving incentives between 1994 and 2002, I use alternative assumptions on three of the main parameters entering the calculation: the replacement rate coefficient applied to the Benefit Base, the mortality rates at each age, as well as the possibility for early retirement. Regarding the sensitivity to replacement rates, I recalculate incentives for a replacement rate of 70% and 100%, while my baseline calculation uses a replacement rate of 91.3%[19]. This jointly accounts for adjustments on penalization coefficient for shorter contribution periods α_n and for the probability of

[17] I rule out private pension plans as an alternative assets since several authors have pointed to a negative average real return over the period of this study in Spain (Palacios and Alvarez, 2003; Fernandez et al., 2007).

[18] Table C.1 in Appendix C displays the MIRR by year of age for male self-employed workers between 1994 and 2002.

[19] This comes from the average penalization on contribution periods of 8.7% in 2005. This is in addition to the 4% penalization for not adjusting the inflation during the last 2 years, which is applied to all cases.

contributions at a given age eventually not counting for pension benefits. Second, I consider the sensitivity to adjusting survival probabilities for those aged 50-52 years by applying the mortality profile of those 5 years younger and older. Third, I consider the incentive when self-employed workers retire at the age of 62 years, which provide a penalization of 8% per year of early retirement.

Figure D.1 in Appendix D illustrates the sensitivity of the implicit net-of-tax rates and the MIRR for the proposed alterations of the baseline calculation of the incentive. The decrease of replacement rates to 70% imply the MIRR to decrease to about 4%, while a replacement rate at 100% increases the MIRR to about 6.2%. Alterations of the mortality probabilities to those aged 5 years older or younger makes the MIRR range between 4.4% and 6.4%. However, early retirement hardly changes the MIRR since the decrease in replacement rate on the Benefit Base is compensated by the receipt of additional pension benefits at an earlier period.

4 Data and empirical strategy

4.1 Dataset and sample selection

The empirical analysis of this study is based on administrative microdata from the 2005 wave of the Spanish Continuous Sample of Employment Histories (*Muestra Continua de Vidas Laborales*, MCVL). This dataset is provided for research purposes by the Spanish Ministry of Labour, Migrations and Social Security since 2004, when the first wave of the MCVL was generated. This dataset is updated every year and annual waves of the MCVL are available between 2004 and 2019.

The MCVL combines administrative records from the Spanish Social Security with records from the Spanish tax agency and the Continuous Municipal Register of Inhabitants. This provides a non-stratified random sample of 4% of all the individuals with relationship with the Spanish Social Security in a given year, either contributing to Social Security or in receipt of a contributory pension. The sample of the 2005 wave of the MCVL is comprised of 1,143,829 individuals.

The MCVL provides detailed information on the employment history for the individuals in the sample since 1967. This includes the precise periods of employment spells, type of contract or the type of Social Security regime. Importantly, this dataset provides records

of the Contribution Bases to Social Security, which represent labour income for employees, while they are at the discretion of the self-employed, since 1980. The MCVL also provides socioeconomic variables such as gender, age, nationality, region of residence or education. One limitation of this dataset is that this does not provide information on the income earned by self-employed workers. Further information about the MCVL can be found in MTAS (2006).

In this study, I use a sample a representative of the population with a relationship with Social Security in 2005[20] for a period of study between 1994 and 2002. Therefore, I carefully select the sample of study in order to address issues around representativeness of the sample for retrospective use of the MCVL data[21] (Perez-Salamero et al., 2016). Retrospective use of MCVL data could be problematic for studying labour transitions or focusing on subpopulations with long periods of inactivity such as females or those without Spanish nationality. Therefore, the sample of this study is comprised of males with Spanish nationality working as self-employed between 1994 and 2002, for whom representativeness is most likely to be preserved. In addition to this, the Spanish economy did not go through any particular economic shock that could have caused self-employed workers to withdraw from the labour market between 1994 and 2005. This results in a sample of 20,891 male self-employed workers aged 40-52 years between 1994 and 2002, for a total of 117,787 observations. Table 1 provides the summary statistics of the variables entering the empirical part of this study.

Table E.1 in Appendix E provides the number of observations per year and age for the 2005 wave of the MCVL. One can observe that the sample size per block of age and year is relatively stable for the age range 40-52 in the period 1994-2002. Comparing the sample of the 2005 wave of MCVL with the same sample selection criteria using the 2007 wave, which is provided in Table E.2. The tables show that the difference in the sample size per age and year blocks is minimal, which gives confidence that my selected sample stays stable over time.

4.2 Empirical strategy

The empirical analysis of this study is based on a dynamic Difference-in-Differences (DiD) approach exploiting the 1997 pension reform in Spain. As described in Section 3, the 1997 reform linked the SSCs with pension benefits for those aged 50-52 years, resulting in a sharp

[20] The 2005 wave is the closer dataset to the period of this study. Although the 2004 wave is also available, this has been reported to have errors and is therefore rarely used for research.

[21] Other studies using the MCVL retrospectively include Agrimon et al. (2013), Cairó-Blanco (2010), Izquierdo et al. (2009) and Rebollo (2012).

increase in the financial incentive to increase public pension savings. However, for those younger than 50 years, SSCs remained unlinked to pension benefits. Therefore, I undertake a dynamic DiD comparing the before and after 1997 reform contribution behaviour of self-employed workers aged 50-52 years (*Treatment group*), with those aged 40-46 years (*Control group*). The validity of the DiD empirical strategy rests on the parallel trends assumption, requiring the average contribution behaviour of self-employed workers aged 50-52 years and 40-46 years would have followed parallel trends absent the 1997 pension reform. The outcomes of interest to measure contribution behaviour are the probability of contributing above the minimum and the real contributions made by self-employed workers.

Dynamic DiD model. The baseline dynamic DiD regression takes the following form:

$$Y_{iat} = \alpha_a + D_t + \sum_{\tau=1}^{3} \gamma_{-\tau} T_a \times D_{1997-\tau} + \sum_{\tau=1}^{5} \gamma_{\tau} T_a \times D_{1997+\tau} + \mathbf{X_{iat}}\theta + \varepsilon_{iat} \tag{7}$$

where Y_{iat} refer to the 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, or the logarithm of the real contributions $Y_{iat} = \ln(C_{iat})$. α_a refers to age dummies and D_t refers to time dummies. T_a refers to the treatment group indicator, which takes value of 1 if $a \in [50, 52]$, while it takes the value of 0 if $a \in [40, 46]$[22]. $\mathbf{X_{it}}$ 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, contribution period (from age 26[23]) and province real GDP. Standard errors are clustered at the individual level.

The coefficient estimate γ_τ measures the average difference in the outcome variable between the treated and control groups τ years after the 1997 pension reform. Under the parallel trends assumption, the coefficient γ_τ identifies the Average Treatment effect on the Treated (ATT). The coefficient estimates for $\gamma_{-\tau}$ enable to test for pre-trends, which will provide evidence on the plausibility of the parallel trends assumption.

[22] I define age at the beginning of the year t, when self-employed workers decide their contributions for the entire year.

[23] Employment spell are only available from 1967. Therefore, the contribution period can only be constructed from the age of 26 years for all individuals entering this study.

2SLS estimation. The DiD framework also allows to identify the effect of the implicit net-of-tax rate of public pension savings relative to alternative saving options on the contribution behaviour response of self-employed workers aged 50-52 years[24]. For this, I estimate the following 2SLS regression specification:

$$Y_{iat} = \alpha_a + D_t + \sum_{\tau=1}^{5} \delta_\tau^d (1 - \tau_{a1997+\tau}^d) + \sum_{\tau=1}^{3} \gamma_{-\tau} T_a \times D_{1997-\tau} + \mathbf{X_{iat}}\theta + \varepsilon_{iat} \tag{8}$$

using $T_a \times D_t$ as an instrument for $1-\tau_{at}^d$ for each $t \in (1998, 2002)$[25]. δ_τ^d represent the 2SLS coefficient estimates on the effect of the implicit net-of-tax rate on contribution behaviour τ years after the 1997 reform using alternative saving option d. This can be expressed as the Wald ratio of two dynamic DiD estimates:

$$\widehat{\delta_\tau^d} = \frac{E\left[Y_{1\tau}\right] - E\left[Y_{10}\right] - \left[E\left[Y_{0\tau}\right] - E\left[Y_{00}\right]\right]}{E\left[1-\tau_{1\tau}^d\right] - E\left[1-\tau_{10}^d\right] - \left[E\left[1-\tau_{0\tau}^d\right] - E\left[1-\tau_{00}^d\right]\right]} \tag{9}$$

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

5 Estimation results

This section presents the empirical results on the effect of the 1997 pension reform on the contribution behaviour of self-employed workers in Spain. As mentioned before, I use a DiD approach to provide evidence on the behaviour of self-employed workers aged 50-52 years, who saw their contributions linked to their pensions after the 1997 reform, using the behaviour of those aged 40-46 years as a control group.

5.1 Graphical evidence

I first graphically describe the average contribution behaviour of treatment and control groups between 1994 and 2002. Figure 2 describes the average contribution behaviour for treatment and control groups each year between 1994 and 2002, while Figure 3 displays the average

[24] The tax literature usually measures the incentive in logarithms in order to obtain an elasticity. Given the pre-reform implicit net-of-tax rate is 0, the logarithm is not defined. Measuring τ_{at}^d as the incentive, the post-reform value would be negative, where the logarithm would not be defined.

[25] Notice that I measure the average yearly implicit net-of-tax rate for self-employed workers per each year. Therefore, the point estimates of my coefficient of interest δ_t^d will be correct, but the standard errors obtained using these approach will underestimate the true ones.

contribution behaviour before and after the 1997 pension reform for those aged between 40 and 59 years.

Figure 2 shows that the contribution behaviour in the pre-1997 reform period was small, stable and relatively parallel for both treatment and control groups. Only about 7% of self-employed workers aged 50-52 years made contributions above the minimum, while this amounted to only 2% for those aged 40-46 years. The fact that pre-trends are well aligned supports the plausibility of the parallel trends assumption that determines the validity the DiD empirical strategy. After the 1997 reform was introduced, the contribution behaviour of treatment and control groups substantially diverged. The fraction of self-employed workers aged 50-52 years making contributions above the minimum years gradually increased from 7% to 20% by 2002, while the counterpart for those aged 40-46 years sightly increased from 2% to 5%. Regarding the average real contributions, treatment and control average real contributions also followed a relatively parallel evolution before the 1997 reform, while they substantially diverged in the period after the reform[26]. Between 1997 and 2002, the average real contributions for the treatment group increased from 288 € (of 2016) to 317 € (of 2016), while for the control group the stayed at about 277 € (of 2016).

Figure 3 provides evidence for attributing the change in contribution behaviour to the financial incentives of the 1997 pension reform. For those younger than 46 years, for whom I described the 1997 pension reform to have no effect, the profile of contributions before and after the 1997 reform are very similar. The difference between the before and after contribution behaviour sharply increases at the age of 50 years, which is the age from which the 1997 reform has an effect on incentives. For older ages, the pre-1997 reform contribution behaviour is sharply increasing with age, following the larger incentive to contribute before the 1997 pension reform.

5.2 Regression results

I now present my baseline DiD estimations on the contribution response estimates the 1997 pension reform of male self-employed workers aged 50-52 years. Figure 4 illustrates the dynamic DiD estimates on the probability of contributing above the minimum and on real contributions.

[26]The general evolution of real contributions is affected by the evolution of the minimum contribution level due to the large fraction of self-employed workers contributing by the minimum.

DiD results. I estimate the 1997 pension reform increased the probability to make contributions above the minimum by 10.12 percentage points 5 years after the reform for male self-employed workers aged 50-52 years. Regarding the estimated effect on real contributions, I estimate that the 1997 pension reform increased the real contributions of male self-employed workers aged 50-52 years by 6.52%. The estimated ATTs are significant even at the 0.1% significance level in all cases. Table F.1 in Appendix F displays the ATTs for all leads and lags for my baseline specification.

2SLS results. In order to understand the magnitude of the contribution response relative to the incentive of the 1997 pension reform, I use the 2SLS approach described in Section 4.2. I estimate a 1 pp increase in the implicit net-of-tax rate leads to an increase in the probability of making contributions above the minimum between 0.042 pp and 0.115 pp for male self-employed workers aged 50-52 years. I estimate that a 1 pp increase in the implicit net-of-tax rate leads to an increase in real contributions between 0.027% and 0.074% for male self-employed workers aged 50-52 years. The public pension saving response to the 1997 reform could be considered modest relative to the change in saving incentives induced by the reform. Table G.1 in Appendix G displays the full 2SLS estimates for my baseline specification.

Relative to maximum response. I also compare the estimated responses to the maximum ceiling for their response to understand the magnitude of the response. Figure 5 illustrates estimated observed outcomes, the counterfactual and the maximum response to the 1997 pension reform for male self-employed workers aged 50-52 years. While the 1997 pension reform significantly increased the probability to contribute above the minimum by 10.12 pp 5 years after the reform, this only represents 11.23% of the maximum response. Regarding the effect of the 1997 pension reform on real contributions, the 1997 reform increased the monthly real contributions by 19.14 € (of 2016) 5 years after the reform. However, this only represents 2.85% of the maximum monthly response of 671.60 € (of 2016) that self-employed workers aged 50-52 years could have responded by 2002.

5.3 Robustness checks

In order to assess the robustness of my main results, I perform several robustness checks. Table 2 provides the DiD estimates 5 years after the reform under a number of adjustments

to my baseline specification. Table F.1 in Appendix F displays the ATTs for all leads and lags for these specifications.

Robustness to control variables. One condition behind the DiD empirical strategy is that the composition of treatment and control groups observed over time is similar. In order to assess the importance of the composition of treatment and control groups according to observable characteristics, I estimate my baseline specification without controls. Column (2) in Table 2 shows that the estimated ATTs very similar either including control variables or not.

Definition of the treatment and control groups. I verify the sensitivity of my results to the use of different age ranges for defining treatment and control groups. For this, I first consider extending the treatment group up to the range 50-54 years, who could also be considered affected by the 1997 pension reform but could be less comparable to the control group. Columns (3) and (4) in Table 2 indicate that the results are robust to the extension of the treatment group to include those aged 53 and 54 years. I also consider restricting the control group to those aged 40-44 years, ruling out any effect of early retirement, as well as to those with 42-46 years who could be consider to be more comparable to the treatment group. Columns (5) and (6) in Table 2 indicate that the results are robust to alterations of the age range entering the control group[27].

Sample selection criteria. The baseline results use a sample of Spanish males who worked as self-employed between 1994 and 2002. This enables to deal with the retrospective use of data from MCVL 2005 for analysis between 1994 and 2002. I relax the criteria for selecting the long-term self-employed as those with employment as self-employed of at least 3 years. As observed in column (7) in Table 2, my results are robust to relaxing the criteria for selecting the long-term self-employed.

Sensitivity to assumptions on financial incentives. My baseline calculation of financial incentives for public pension savings in Spain depends on the assumptions described in Section 3. I check the sensitivity of my results to alternative assumptions on financial incentives

[27]The pre-trends are better aligned when using closer age ranges to define treatment and control groups, as observed in the p-value for the F-test on pre-trends.

for public pension savings. For this, I calculate the implicit net-of-tax rate of contributing through the Spanish public pension system for a replacement rate of 70% and 100%, while my baseline calculation uses a replacement rate of 91.3%[28]. This jointly accounts for adjustments on penalization coefficient for shorter contribution periods α_n and for the probability of contributions at a given age eventually not counting for pension benefits. Second, I consider the sensitivity to adjusting survival probabilities for those aged 50-52 years by providing the profile of those 5 years younger and older. Third, I consider the incentive when self-employed workers retire at the age of 62 years, which provide a penalization of 8% per year of early retirement. Table 3 provides the 2SLS results using different assumptions from the baseline calculation of the incentive. The 2SLS results in all cases point to a modest response from Spanish self-employed workers to financial incentives.

5.4 Heterogeneity analysis

I now study the heterogeneity of the contribution responses to the 1997 pension reform according to demographic and labour market characteristics. Table H.1 in Appendix H reports the dynamic DiD results for various subsamples of self-employed workers according to their gender, education, regional income, municipality size, economic activity and contribution history.

First, the heterogeneity analysis indicates the contribution response of females to the 1997 reform is about half compared to the response males[29]. This could be expected since females tend to have shorter contribution periods and therefore a lower return on contributions, as well as having lower income. In addition to this, significant heterogeneity is found according to regional income, with self-employed workers in lower income regions responding about half as compared to those in higher income regions. As one could expect, those the higher education attainment level and city population, the larger the contribution response. However, the group heterogeneity is hardly significant at the 5% significance level. By economic activity, self-employed working in transport services tend to give larger responses although the heterogeneity by economic activity is hardly significant at the 5% significance level. Finally, the heterogeneity of contribution responses according to the length of the contribution period is

[28]This comes from the average penalization on contribution periods of 8.7% in 2005. This is in addition to the 4% penalization for not adjusting the inflation during the last 2 years, which is applied to all cases.

[29]Notice that the baseline results only consider male self-employed workers in order to address the fact that data from 2005 is used retrospectively for the period between 1994-2002, as well as for ruling out the "minimum pension trap" that could be relevant for females, who have shorter contribution periods.

modest. Overall, the variables associated to individual income appear to explain the largest heterogeneity in responses, suggesting that income could play a role to explain the response to financial incentives.

6 Evidence on determinants of saving responses

I exploit two particular policies in order to provide evidence on mechanisms driving contribution responses to financial incentives. For this, I first study the effect of the "option value" at the age of 50 years faced by the Spanish self-employed. In addition to this, I study the effect of the decrease of the minimum contribution for certain groups of new self-employed workers introduced by the 35th Transitory Provision of the Social Security Law introduced on the 27th April 2003.

6.1 "Option value" at the age of 50 years

I first study the determinants of the public pension savings of Spanish self-employed workers using the "option value" at the age of 50 years. The maximum ceiling for contributions under RETA is reduced above the age of 50 years. However, self-employed workers older than 50 years can keep their previous year's contributions if their previous year's contributions were above the reduced maximum level. Therefore, self-employed workers should decide by the age of 50 years whether they want to make contributions above the reduced maximum, which would enable them to keep their contributions above the reduced maximum in the following period and beyond.

Importantly, the 1997 pension reform made the first period of contributions counting for pensions to coincide with the "option value" at the age of 50 years. In order to provide evidence on the role of the "option value" on the contribution response to the 1997 pension reform, I exploit the heterogeneity between cohorts regarding the eligibility to adjust the "option value" decisions after the 1997 pension reform. Those who were already 50 years old when the reform was implemented in 1997, i.e. cohorts born before 1947, were not eligible to adjust their decisions about the "option value" for the change in financial incentives. However, those aged 49 years and younger in 1997 pension reform were eligible to fully adjust their "option value" decisions after the reform was approved.

Figure 6 illustrates the dynamic DiD estimates by individual year of age in order to illustrate heterogeneity in response by different cohorts. Figures 6a, 6c and 6e provide the dynamic DiD estimates of probability of above the minimum for those aged 50, 51 and 52 years respectively. Figures 6b, 6d and 6f, illustrate the dynamic DiD estimates for making contributions above the reduced maximum for those aged 50, 51 and 52 years respectively.

Regarding the probability of making contributions above the minimum, the treatment effect sharply increases for the cohort born in 1948, which is the first eligible to the "option value" after the 1997 pension reform, while the treatment effect seems to stabilize after this. For those aged 50 years, the substantial increase in ATTs comes in year 1999, for those aged 51 years in year 2000, while for those aged 52 year the main increase in ATTs comes in 2001. However, the eligibility to the option value does not translate in an increase in the probability of making contributions above the reduced maximum.

The eligibility to the "option value" therefore seems to increase the effect of financial incentives on public pension savings for self-employed workers. This could be attributed to the fact that the first period when contributions matter for pensions coincides with the irreversible decision of the "option value" at 50 years. This coincidence could have made the timing when contributions matter for pensions more salient, inducing larger responses. In addition to this, this irreversible decision about whether they would like to contribute above the reduced maximum contributions could have encouraged individuals to plan their contribution behaviour, which could have made self-employed workers more responsive to financial incentives.

6.2 Reduced minimum contribution for new self-employed workers

I provide further evidence on the public pension saving behaviour of Spanish self-employed workers using the 35th Transitory Provision of the Social Security Law put in place between 27th April 2003 and 17th January 2005[30]. This law reduced the minimum ceiling for contributions by 25% during 3 years after becoming self-employed for new self-employed workers aged below 30 years old and females older than 45 years old.

According to the analysis provided before, the incentive to contribute for new self-employed workers aged below 30 years could be considered negligible and they should choose the min-

[30]This was put in place through the Royal Decree-Law 2/2003, 25 of April, of policies for economic reform.

imum contribution level available to them. For females older than 45 years, the size of the financial incentive depends on the previous contribution history. However, the previously described contribution behaviour of self-employed workers suggests that most self-employed workers would desire to contribute by the minimum available to them. The reduction of the minimum contribution amounted to 675€ over the year 2004 (833.67€ of 2016), which could be considered sizable.

Figure 7 illustrates the contribution behaviour of new self-employed workers eligible to the reduced minimum contribution, both before and after the regulation was put in place on the 26th April 2003. Before the availability of the reduced contribution, almost all new self-employed workers aged below 30 years chose the minimum contribution available to them. However, when they are offered a reduced minimum contribution level, only 40.85% of males and 48.01% of females choose the reduced minimum contribution, while 58.51% and 51.71% choose the ordinary minimum contribution respectively. For females older than 45 years, 95% of the new self-employed choose the minimum contribution before the introduction of the reduced minimum contribution. However, only 15.18% of the new self-employed choose the reduced minimum contribution when this is offered, while about 79% choose the ordinary minimum contribution[31]. Figure I.1 in Appendix I shows that there is only a modest increase in the fraction of individuals choosing the reduced minimum contribution over the time frame.

These findings seem to be in contradiction with financial incentives, as well as with the expectation that most self-employed workers would like to choose the minimum contribution available to them. Even when there is virtually no incentive to have larger contributions the reduced minimum contribution, a substantial share of the new self-employed choose the ordinary minimum contribution, which is not the minimum available to them. Given that most new self-employed workers did not take advantage of this reduction in contributions, this voluntary policy was replaced on the 17th January 2005 with a direct discount of 25% of SSCs chosen by new self-employed workers of particular demographic groups, without affecting Social Security benefits.

The limited take-up on the reduced minimum contribution suggests that self-employed

[31]If the possibility for lower contributions would effectively induce individuals to self-employment, the contributions observed after 26th April 2003 would include a selection of individuals that would like to take advantage of the possibility of lower contributions. In this regard, Borella and Belloni (2019) find that differentials between the SSC rate paid by employees and self-employed workers encourage transition to self-employment in Italy.

workers are reluctant to choose SSCs other than the ordinary minimum contribution. New self-employed workers are required to actively decide their contribution choices and communicate them to the Spanish Social Security when registering as self-employed. Therefore, explanations other than inertia are necessary to reconcile the large share of new self-employed workers contributing by the ordinary minimum level when a reduced contribution is available. In addition to this, the behaviour of self-employed workers could not be explained by the fact that a large fraction of individuals are liquidity constrained.

An explanation for reconciling these facts could be the lack of information on the Social Security benefits that SSCs give rise to. Given that the trade-off involved in this decision is negligible, the behaviour of the self-employed require a misunderstanding of the incentives to contribute to Social Security. Indeed, the return from public pension formulas is implicit within relatively complicated pension formulas. Therefore, the self-employed would first require a good knowledge of the pension formulas, as well as being able to calculate the dimension of the financial incentives implicit in them. This explanation is supported by a recent survey conducted by the Spanish Association of Self-Employed Workers (*Asociación de Trabajadores Autónomos*, ATA) (2019), which showed that only 11,4% of self-employed workers reported to understand the pension benefits covered by their contributions to Social Security.

Another complementary explanation for this is that contributing by the minimum could be considered the reference level of contributions and social protection for the self-employed. In this case, endowment effects and loss aversion could lead to value social protection reductions disproportionately (Kahneman et al., 1990; Tversky and Kahneman, 1991).

7 Conclusion

This investigation has studied the contribution response from Spanish self-employed workers to the financial incentives provided by the Spanish pension system for self-employed workers, which allows them to voluntarily choose their SSCs in order to secure their desired pensions. Using a difference-in-differences approach, I study the effect of the 1997 pension reform on the contribution behaviour of male self-employed workers with Spanish nationality. I estimate that the 1997 pension reform increased the real contributions of male self-employed workers aged 50-52 years by 6.52%, which implies a 1 pp in the implicit net-of-tax rate led to an increase between 0.027% and 0.074% in real contributions. This suggests that self-employed

workers in Spain provide modest responses relative to the incentives offered by their pension scheme. This investigation therefore suggests that financial incentives on their own may not be enough to ensure adequate retirement savings for self-employed workers, which is consistent with the recent evidence on employees.

There are several possible explanations for the modest public pension saving responses of the Spanish self-employed to the financial incentives provided by pension formulas, all of which may be complementary. In this regard, I provide evidence on the fact that Spanish self-employed workers are adverse to making contributions other than the ordinary minimum contribution. This is because when offered a reduced minimum contribution, a large fraction of the new self-employed keep contributing by the ordinary minimum, even when the incentives to do so are minimal. Along with loss aversion from the reference social protection level, I interpret this suggests that the lack of information and salience on the return of SSCs may be one of the main factors for the low contribution responses of self-employed workers, which is supported by survey evidence.

I further provide evidence on the fact eligibility to the "option value" at the age of 50 years increases the responsiveness to public pension saving incentives for self-employed workers, which after the 1997 reform coincides with the first period of contributions counting for pensions. This could capture the fact that irreversible decisions induces self-employed workers to consider their retirement savings, or this could capture the effect of the increased salience on the timing when there is a large change in financial incentives to increase contributions.

This study has some limitations that future research should aim to further develop. First, data limitations do not allow to consider the substitution between alternative saving options in order to evaluate the effect on total savings. Another data limitation is that the MCVL does not provide information on the income of self-employed workers. In addition to this, I perform my study on a subpopulation of males with Spanish nationality working as self-employed between 1994 and 2002[32]. I show that results are robust to less restrictive definitions of long-term self-employed workers, as well as providing evidence for females. Furthermore, focusing on male long-term self-employed workers could provide an upper bound for the responsiveness of the self-employed because they could be considered to have larger contribution capacity

[32]This is to deal with the use of data from 2005 retrospectively for a period between 1994-2002. Focusing on males, who have longer contribution periods at retirement compared to females, also enables us to rule out the effect of minimum pensions as an alternative explanations for low contributions.

than the ordinary self-employed worker.

Therefore, future work should look at the effect of saving incentives for self-employed workers on total savings, accounting for possible substitution among different saving sources. In addition to this, further studies should be undertaken in order to evaluate the effectiveness of different interventions for stimulating retirement savings for self-employed workers.

References

Argimón, I., Botella, M., González, C.I., and Vegas-Sánchez, R. (2013). "Old Age Pensions and Retirement in Spain." *SERIEs-Journal of the Spanish Economic Association*, 4(3): 273–307.

Asociación de Trabajadores Autónomos (2019). "El Trabajador Autónomo ante la Previsión Social." Executive summary, Fundación MAPFRE.

Benzarti, Y., Harju, J., and Matikka, T. (2020). "Does Mandating Social Insurance Affect Entrepreneurial Activity?" *American Economic Review: Insights*, 2(2): 255-268.

Beshears, J., Choi, J.J., Laibson, D., Madrian, B.C., (2013). "Simplification and Saving." *Journal of Economic Behaviour and Organization*, 95: 130–145.

Boldrin, M., García-Gómez, P., and Jimenez-Martín, S. (2010). "Social Security Incentives, Exit from the Workforce and Entry of the Young." In: *Social Security Programs and Retirement around the World: The Relationship to Youth Employment.* University of Chicago Press, pp. 261-294.

Borella, M., and Belloni, M. (2019). "Self-Employment in Italy: The Role of Social Security Wealth." *Journal of Pension Economics and Finance*, 18(1): 31-65.

Cairó-Blanco, I. (2010). "An Empirical Analysis of Retirement Behaviour in Spain: Partial versus Full Retirement." *SERIEs-Journal of the Spanish Economic Association*, 1(3): 325-356.

Choi, J. (2009). "Pension Schemes for the Self-Employed in OECD Countries." OECD Social, Employment and Migration Working Papers, No. 84, OECD Publishing, Paris.

Choi, J.J., Haisley, E., Kurkoski, J., and Massey, C. (2017). "Small Cues Change Savings Choices." *Journal of Economic Behavior and Organization*, 142: 378–395.

Carroll, G., Choi, J., Laibson, D., Madrian, B. and Metrick, A. (2009). "Optimal Defaults and Active Decisions." *Quarterly Journal of Economics*, 124(4): 1639-1674.

Chetty, R., Friedman, J.N., Leth-Petersen, S., Nielsen, T.H., and Olsen, T. (2014). "Active vs Passive Decisions and Crowd-out in Retirement Savings Accounts: Evidence from Denmark." *Quarterly Journal of Economics*, 129(3): 1141-1219.

Conde-Ruiz, J.I. and Gonzalez, C.I. (2016). "From Bismarck to Beveridge: The Other Pension Reform in Spain." *SERIEs-Journal of the Spanish Economic Association*, 7(4): 461-490.

Duflo, E., Gale, W., Liebman, J., Orszag, P., and Saez, E. (2006). "Saving Incentives for Low- and Middle-Income Families: Evidence from a Field Experiment with H&R Block." *Quarterly Journal of Economics*, 121(4): 1311-1346.

Duflo E., and Saez, E. (2002). "Participation and Investment Decisions in a Retirement Plan: The Influence of Colleagues' Choices." *Journal of Public Economics*, 85(1): 121–148.

Duflo E., and Saez, E. (2003). "The Role of Information and Social Interactions in Retirement Plan Decisions: Evidence from a Randomized Experiment." *Quarterly Journal of Economics*, 118(3): 815–842.

Engen, E.M., Gale, W.G., Scholz, J.K., (1996). "The Illusory Effect of Saving Incentives on Saving". *Journal of Economic Perspective*, 10(4): 113–138.

Garcia-Gomez, P., Garcia-Mandico, S., Jiménez-Martín, S., and Vall-Castelló, J. (2018). "Trends in Employment and Social Security Incentives in the Spanish Pension System: 1980–2016." NBER Chapters in: *Social Security Programs and Retirement around the World: Reforms and Retirement Incentives.*

Gruber, J. and Poterba, J. (1994). "Tax Incentives and the Decision to Purchase Health Insurance: Evidence from the Self-Employed." *Quarterly Journal of Economics*, 109(3): 701-734.

Instituto Nacional de Estadística (2019). "Hipótesis de Mortalidad en España: Tablas de Mortalidad Proyectadas 2018-2067: Esperanza de Vida por Edad y Sexo."

Instituto Nacional de Estadística (2019). "Tablas de Mortalidad por Año, Sexo, Edad y Funciones. Series desde 1991."

Izquierdo, M., Lacuesta, A., and Vegas, R. (2009). "Assimilation of Immigrants in Spain: A Longitudinal Analysis." *Labour Economics*, 16(6): 669-678.

Kahneman, D., Knetsch, J.L., and Thaler, R.H. (1990). "Experimental Tests of the Endowment Effect and the Coase Theorem." *Journal of Political Economy*, 98(6): 1325–1348.

Kitces, M. (2018). "When it Pays to Pay Social Security Taxes." Blog article.

Liebman, J.B., Luttmer, E. F.P., and Seif, D.G. (2009). "Labor Supply Responses to Marginal Social Security Benefits: Evidence from Discontinuities." *Journal of Public Economics*, 93(12): 1208-1223.

Madrian, B.C., and Shea, D.F. (2001). "The Power of Suggestion: Inertia in 401(k) Participation and Savings Behavior." *Quarterly Journal of Economics*, 116(4): 1149-87.

Mastrogiacomo, M, and Alessie, R. (2015). "Where are the Retirement Savings of Self-Employed? An Analysis of Unconventional Retirement Accounts." DNB Working Papers 454.

Ministerio de Trabajo y Asuntos Sociales (2006). "La Muestra Continua de Vidas Laborales." Colección, Informes y Estudios. Serie Seguridad Social, 26. Madrid: Ministerio de Trabajo y Asuntos Sociales.

OECD (2018). "The Future of Social Protection: What Works for Non-Standard Workers?" OECD Publishing, Paris, https://doi.org/10.1787/9789264306943-en

Palacios, J., and Alvarez, L. (2003). "Resultados de los Fondos de Inversión Españoles: 1992-2001." IESE Research Papers D/486, IESE Business School.

Perez-Salamero, J.M., Regulez-Castillo, M., and Vidal-Meliá, C. (2016). "Análisis de la Representatividad de la MCVL: el Caso de las Prestaciones del Sistema Público de Pensiones." *Hacienda Pública Española/Review of Public Economics*, 217(2): 67-130.

Rebollo, Y. (2012). "Unemployment Insurance and Job Turnover in Spain." *Labour Economics*, 19(3): 403-426.

Saez, E. (2009). "Details Matter: The Impact of Presentation and Information in the Take-up of Financial Incentives for Retirement Savings." *American Economic Journal: Economic Policy*, 1(1): 204–228.

Sanchez-Martin, A.R. (2019a). "Normativa de Cotización y Pensiones de Trabajadores Autónomos en España: ¿Se Incentiva al Ahorro de Ciclo Vital?" Studies on the Spanish Economy eee2019-18, FEDEA.

Sánchez-Martín, A.R. (2019b). "Capacidad Económica y Pautas de Cotización y Formación de Pensiones de los Trabajadores Autónomos en España: Evidencia Empírica en el Intervalo 2008/2017." Studies on the Spanish Economy eee2019-27, FEDEA.

Sánchez-Martín, A.R. (2019c). "Elección de Base de Cotización de Trabajadores Autónomos: Cálculo de Incentivos." Studies on the Spanish Economy eee2019-29, FEDEA.

Selden, T.M. (2007). "The Impact of Increased Tax Subsidies on the Insurance Coverage of Self-Employed Families: Evidence from the 1996-2004 Medical Expenditure Panel Survey." *Journal of Human Resources*, 44(1): 115-139.

Spasova S., Bouget D., Ghailani D. and Vanhercke B. (2017). "Access to Social Protection for People Working on Non-Standard Contracts and as Self-Employed in Europe. A

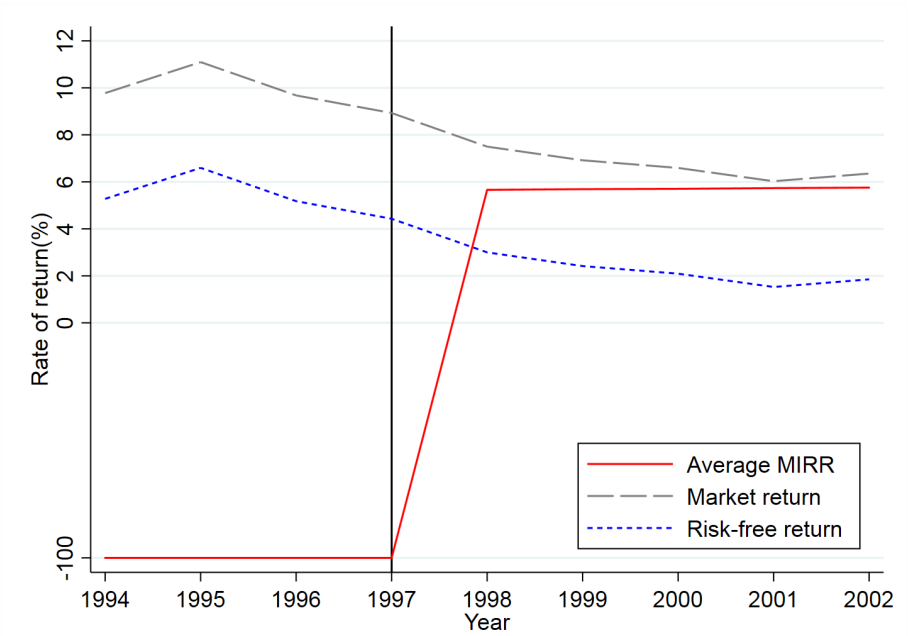
Study of National Policies." European Social Policy Network (ESPN), Brussels: European Commission.

Thaler, R., and Benartzi, S. (2004). "Save More Tomorrow: Using Behavioral Economics to Increase Employee Saving." *Journal of Political Economy*, 112(1): 164–187.

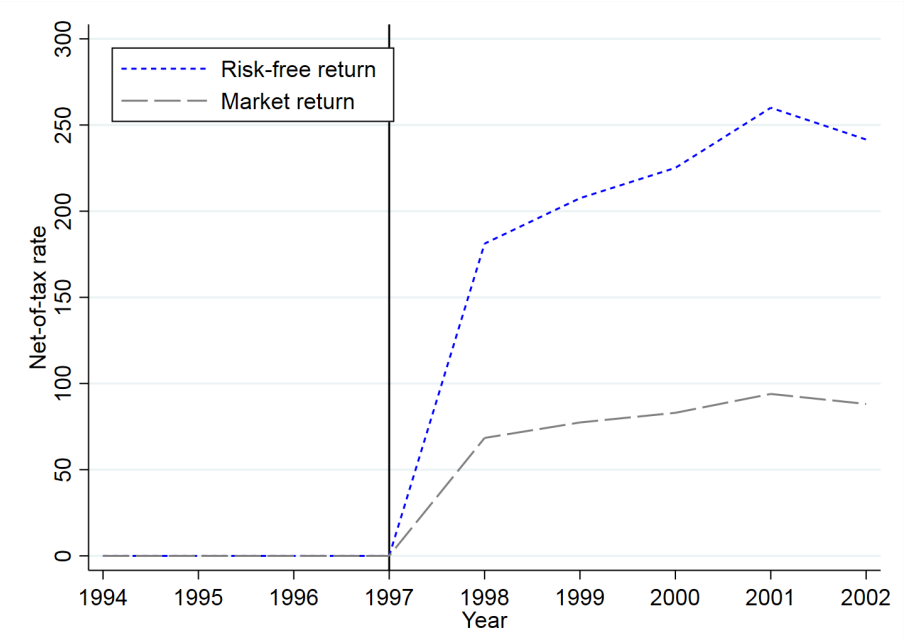
Tversky, A. and Kahneman, D. (1991). "Loss Aversion in Riskless Choice: A Reference Dependent Model." *Quarterly Journal of Economics*, 106(4): 1039-1061.

Figure 1: Public pension saving incentives for male self-employed workers aged 50-52 years

(a) Real rates of return



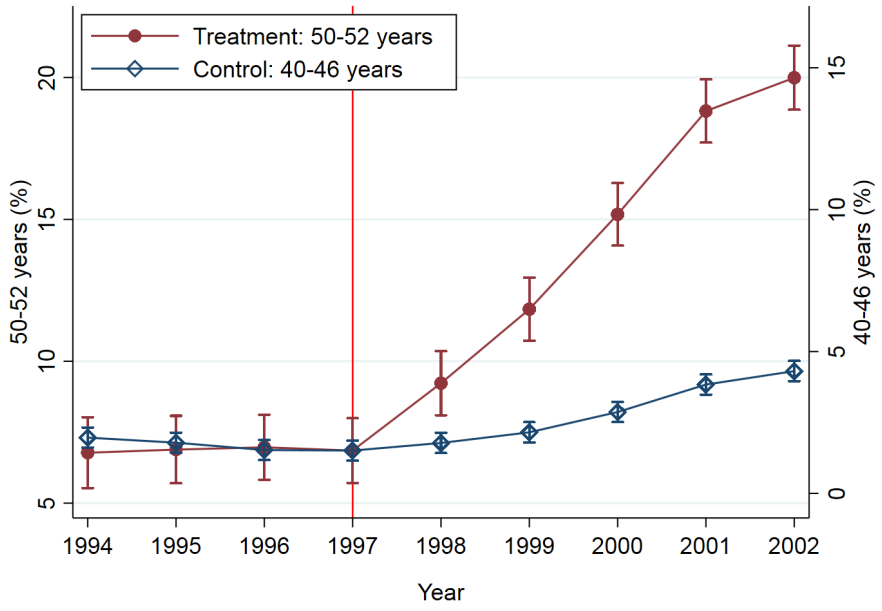
(b) Implicit net-of-tax rate



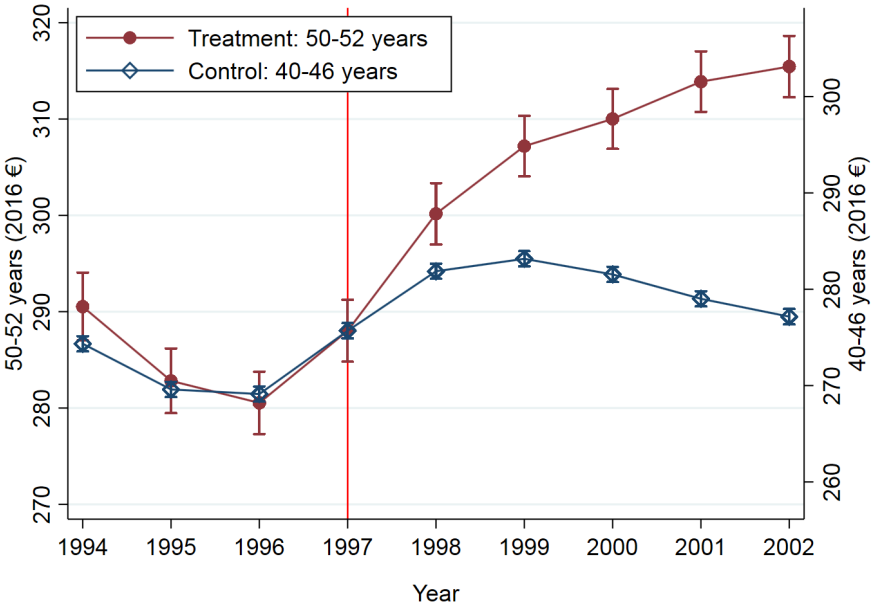
Notes: The figure shows the rates of return of alternative assets (panel a) implicit net-of-tax rate of self-employed workers aged 50-52 years (panel b) between 1994 and 2002. The red line represents the average MIRR for self-employed workers aged 50-52 years, with negative values of MIRR being normalized to 0%. The blue short-dashed line represents the risk-free rate of return, which is the real 10-year bond yield in Spain. The gray long-dashed line represents the reference market rate of return. The vertical black line in 1997 denotes the reform year.
Source: MCVL 2005.

Figure 2: Contribution behaviour of treatment and control groups between 1994-2002

(a) Fraction above the minimum



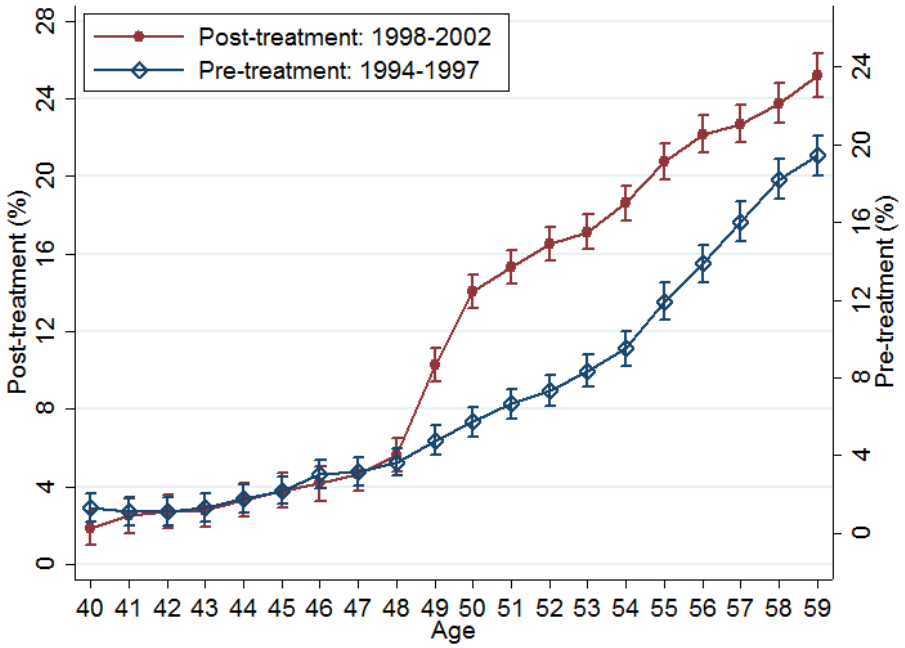
(b) Average real contributions



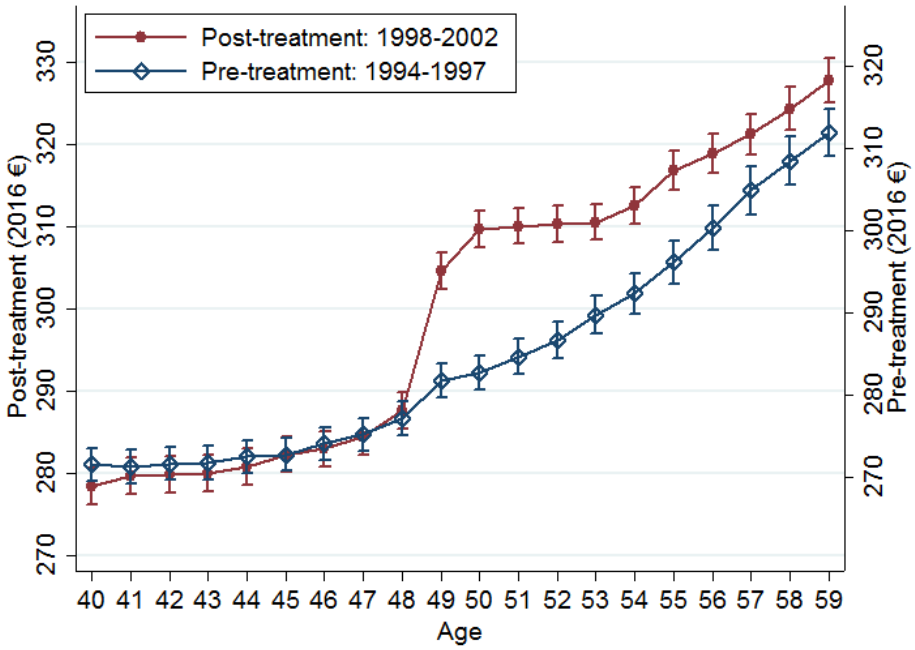
Notes: The figure shows the fraction of self-employed workers contributing above the minimum (panel a) and of average real contributions (panel b) between 1994 and 2002. The vertical red line in 1997 denote the reform year. The red lines refer to the treatment group (50-52 years), while blue lines represent average values of the control group (40-46 years). The left y-axis refers to the treatment group, while the right y-axis refers to the control group. The right y-axis is shifted so that average values coincide in year 1997.
Source: MCVL 2005.

Figure 3: Contribution behaviour before and after the 1997 reform by age.

(a) Proportion above the minimum



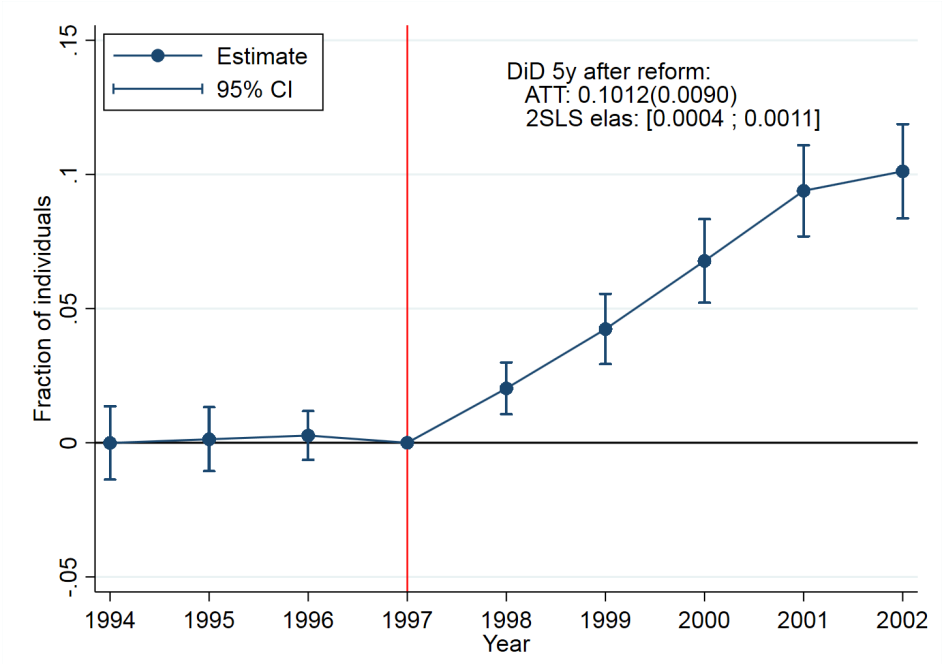
(b) Average real contributions



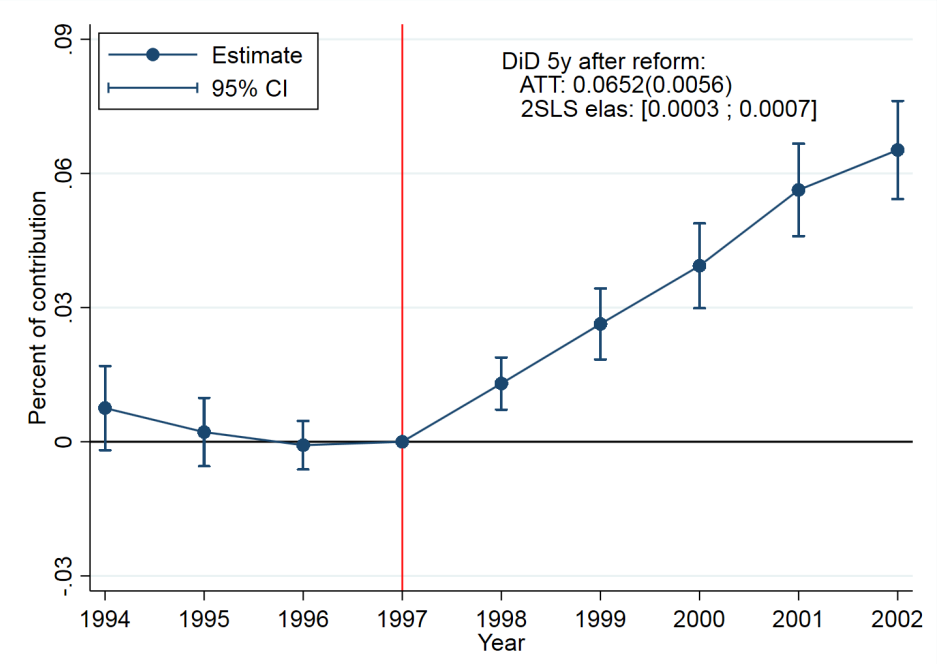
Notes: The figure shows the fraction of self-employed workers contributing above the minimum (panel a) and of average real contributions by individual year of age between 40 and 52 years. The red lines refer to the period between 1998 and 2002, while blue lines represent average values in between 1994-1997. The left y-axis refers to the period between 1998 and 2002, while the right y-axis refers to the period between 1994 and 1997. The right y-axis is shifted so that the values coincide at the age of 47.
Source: MCVL 2005.

Figure 4: Dynamic DiD results for male self-employed workers aged 50-52 years

(a) Probability above the minimum



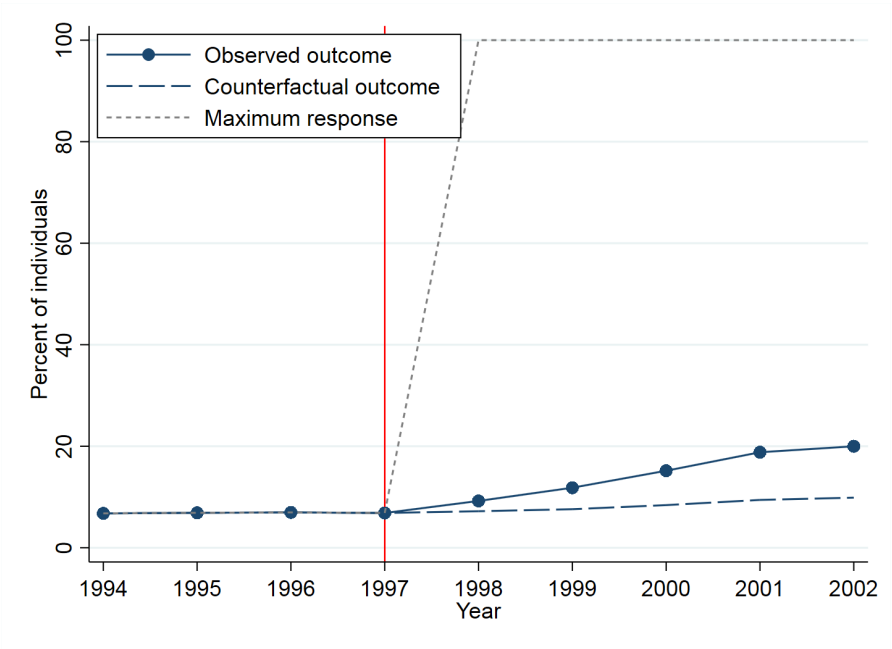
(b) Log of real contributions



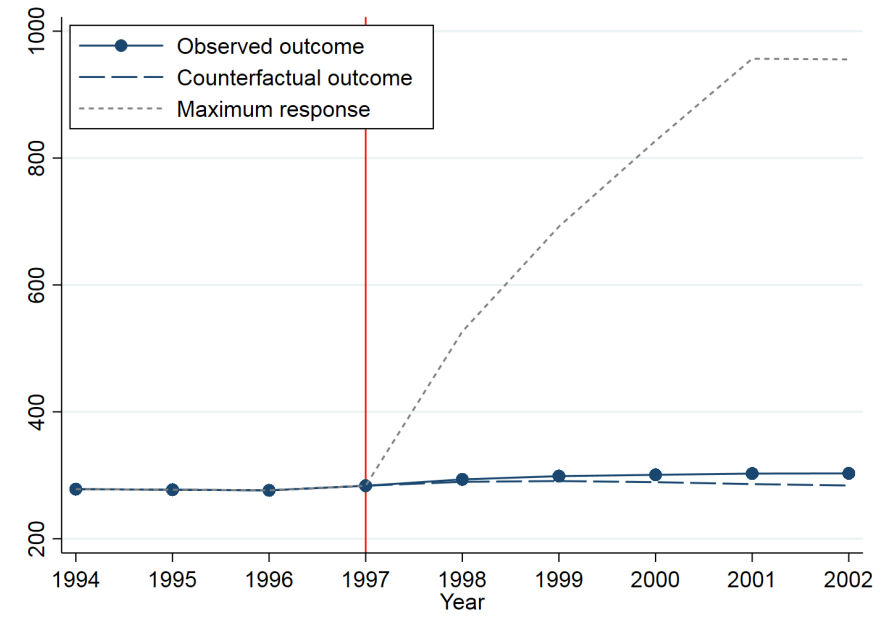
Notes: The figure shows the dynamic DiD estimates of the probability of contributing above the minimum (panel a) and of average real contributions (panel b) between 1994 and 2002. The treatment group is represented by self-employed workers aged 50-52 years and the control group by those aged 40-46 years. The vertical red line in 1997 denotes the reform year.
Source: MCVL 2005.

Figure 5: Contribution response relative to the maximum contribution response

(a) Probability of contributing above minimum



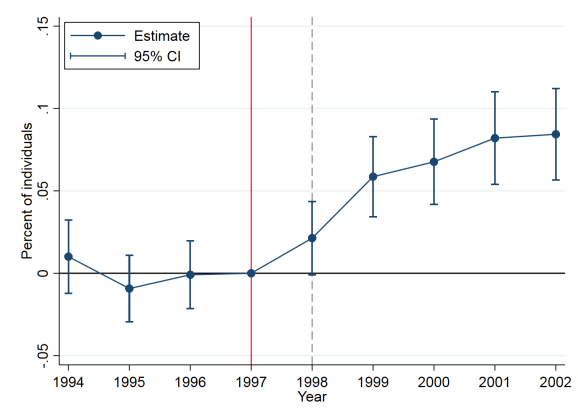
(b) Real contributions (2016€)



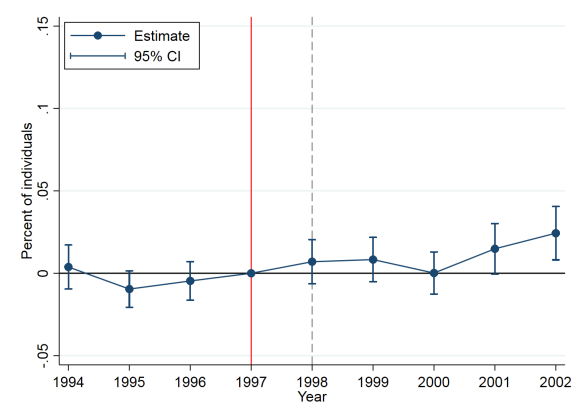
Notes: The figures display the contribution response for the probability or contributing above the minimum (panel a) and real contributions measured in 2016€ (panel b) of self-employed workers aged 50-52 years relative to the maximum contribution response. The blue lines represent observed outcomes, 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 6: Dynamic DiD on the probability of contributing above the minimum and reduced maximum for those aged 50, 51 and 52 years

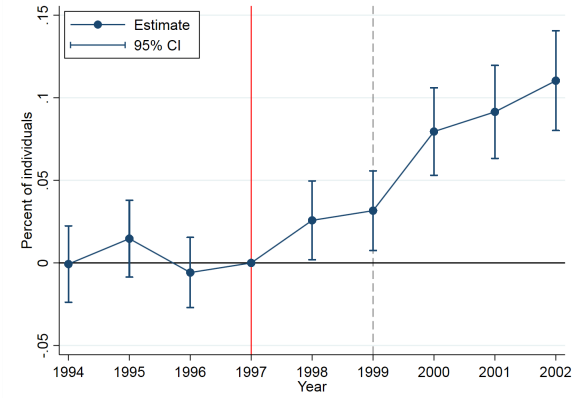
(a) Above the minimum contr. (50 years)



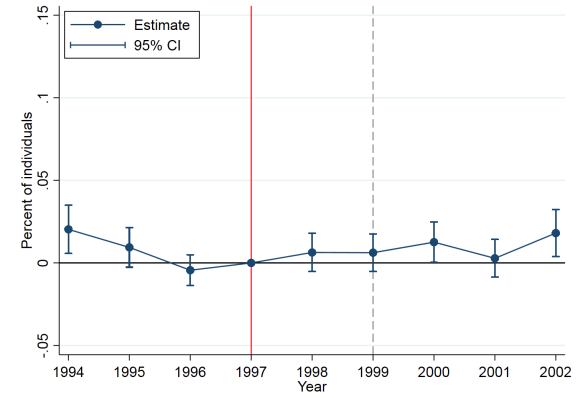
(b) Above the reduced max. contr. (50 years)



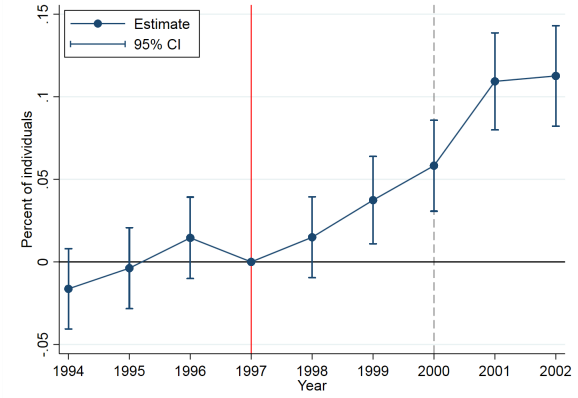
(c) Above the minimum contr. (51 years)



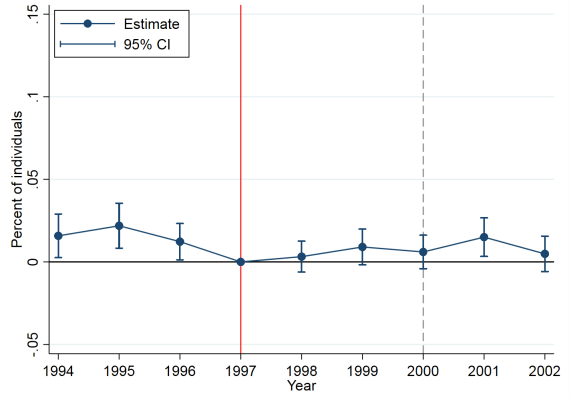
(d) Above the reduced max. contr. (51 years)



(e) Above the minimum contr. (52 years)

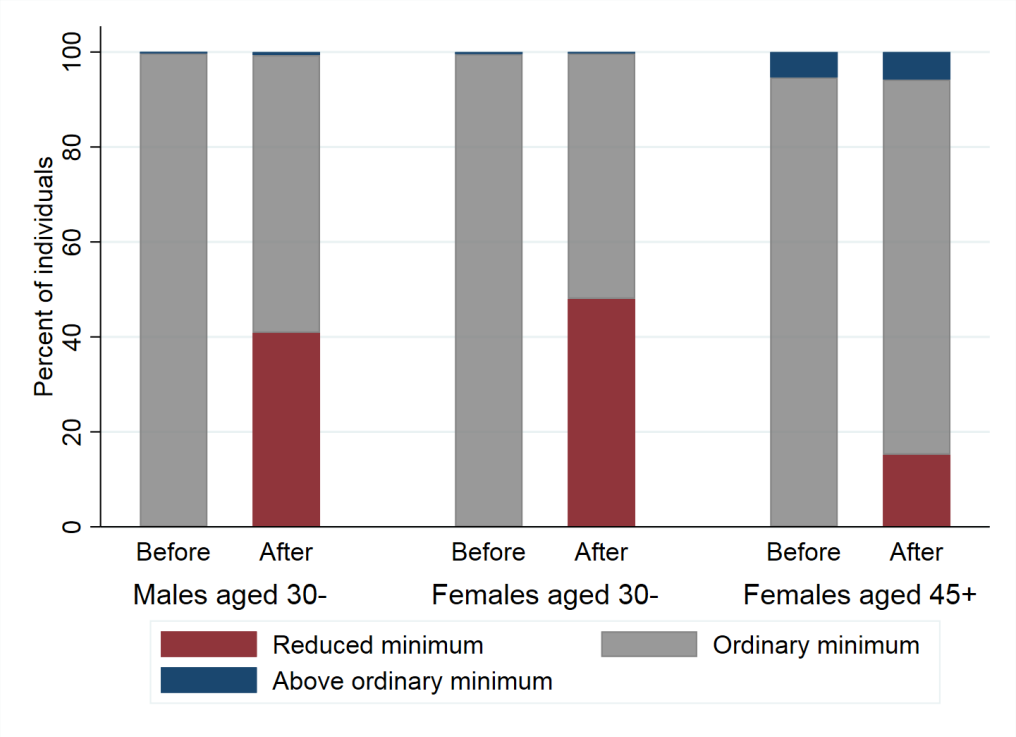


(f) Above the reduced max. contr. (52 years)



Notes: The figure display the dynamic DiD estimates on the probability of making contributions above the minimum for male self-employed workers aged 50 (panel a), 51 (panel c) and 52 years (panel e) compared to those aged 40-46 years. This also shows the dynamic DiD estimates of the probability of contributing above the reduced maximum level for those aged 50 (panel b), 51 (panel d) and 52 years (panel f) compared to those aged 40-46 years. The vertical red line in 1997 indicates the reform year. The vertical dashed gray lines represent the 1947 cohort, which was the last ineligible to the "option value" after the 1997 reform.
Source: MCVL 2005.

Figure 7: Range of contributions of new self-employed workers eligible to the reduced minimum contribution



Notes: The figure shows the range of contributions by eligible groups to the reduced minimum contributions before and after the introduction of the policy. The before period goes from 01/01/2002 to 26/04/2003, while the after period considers the period between 27/04/2003 and 31/12/2004.
Source: MCVL 2005.

Table 1: Summary statistics for the main variables between 1994 and 2002

	Control: 40-46 years		Treatment: 50-52 years		Full sample	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Outcome variables						
$1\{Contr_{it} > \underline{Contr}\}$	0.024	(0.153)	0.116	(0.320)	0.051	(0.220)
Real Contr. (2016€)	276.816	(34.401)	299.307	(90.118)	283.393	(57.592)
Control variables						
Education level						
Primary	0.333	(0.471)	0.442	(0.497)	0.365	(0.481)
Secondary	0.330	(0.470)	0.278	(0.448)	0.315	(0.464)
Superior	0.239	(0.426)	0.164	(0.370)	0.217	(0.412)
N.A.	0.099	(0.298)	0.115	(0.318)	0.103	(0.305)
Economic activity						
Agriculture	0.024	(0.152)	0.025	(0.156)	0.024	(0.153)
Manufacturing	0.129	(0.335)	0.131	(0.337)	0.130	(0.336)
Construction	0.159	(0.365)	0.139	(0.346)	0.153	(0.360)
Retail service	0.298	(0.458)	0.296	(0.456)	0.298	(0.457)
Hotel	0.092	(0.289)	0.080	(0.271)	0.088	(0.284)
Transport	0.123	(0.329)	0.141	(0.348)	0.128	(0.334)
Estate & Finance	0.064	(0.245)	0.053	(0.225)	0.061	(0.239)
Social service	0.058	(0.234)	0.055	(0.228)	0.057	(0.232)
N.A.	0.052	(0.223)	0.081	(0.272)	0.061	(0.239)
Prov. GDPpc (2016€)	18,386.98	(3,714.71)	18,391.71	(3,727.91)	18,388.36	(3,718.56)
Small municipality	0.555	(0.497)	0.516	(0.500)	0.544	(0.498)
Contributed years	15.897	(3.958)	21.719	(4.930)	17.600	(5.021)
N (obs)	63,945		26,428		90,373	

Notes: This table shows the descriptive statistics of the variables entering this study. The sample is divided between the control group and treatment groups, as well as providing descriptives for the full sample. I provide the two outcome variables and controls, which includes categorical variables on education (default no education) and economic activity and the rest of the covariates. Contributed years considers the years contributed above age 26. Fractions of categorical variables may not add up due to rounding.
Source: MCVL 2005.

Table 2: Dynamic DiD results using alternative specifications

	Baseline	No controls	Treatment group		Control group		Sample sel.
			50-53y	50-54y	40-44y	42-46y	Dur. > 3y
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Prob above min.							
$T_a \times D_{2002}$	0.101***	0.104***	0.106***	0.103***	0.108***	0.095***	0.092***
	(0.009)	(0.009)	(0.008)	(0.007)	(0.009)	(0.009)	(0.008)
Pre-trends	0.917	0.839	0.576	0.201	0.806	0.773	0.051
Log of real contr.							
$T_a \times D_{2002}$	0.065***	0.067***	0.067***	0.063***	0.069***	0.062***	0.062***
	(0.006)	(0.006)	(0.005)	(0.005)	(0.006)	(0.006)	(0.005)
Pre-trends	0.183	0.270	0.304	0.134	0.078	0.333	0.818
N (obs)	90,373	90,373	98,729	106,498	71,891	72,244	155,219

Notes: This table provides the dynamic DiD estimates of contribution behaviour 5 years after the reform using alternative specifications. This includes the Baseline specification (column 1), the Baseline specification without covariates (column 2), extensions of the Treatment group to include those aged 50-53 years (column 3) and 50-54 years (column 4), alterations of the control group to those aged 40-44 years (column 5) and 42-46 years (column 6), as well as an alteration of the sample selection criteria for male self-employed workers in employment spells with longer duration than 3 years. 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 3: 2SLS results 5 years after the 1997 reform on the self-employed aged 50-52 years

	Baseline	Replacement rate		Mortality		Early retirement
		$\alpha = 100\%$	$\alpha = 70\%$	45-47y	55-57y	R = 62y
	(1)	(2)	(3)	(4)	(5)	(6)
Prob above min.						
Market return	0.042	0.038	0.055	0.035	0.053	0.046
Risk-free return	0.115	0.105	0.150	0.095	0.129	0.115
Log of real contr.						
Market return	0.027	0.025	0.035	0.023	0.034	0.030
Risk-free rate	0.074	0.068	0.096	0.061	0.083	0.074

Notes: This table provides the 2SLS results 5 years after the 1997 pension reform on self-employed workers aged 50-52 years using alternative measurements for the incentive. This includes the Baseline results (column 1), which uses a replacement rate of 91.3%, adjustments of the measurement of the incentive to contribute for a replacement rate of 100% (column 2) and 70% (column 3); using the survival probabilities of those aged 45-47 years (column 4) and 55-57 years (column 5) for the target population of those aged 50-52 years; assuming self-employed workers retire at the age of 62 years (column 6).
Source: MCVL 2005

Saving for retirement through the public pension system: Evidence from the self-employed in Spain

Appendix

Ander Iraizoz

A Appendix: Institutional details

This Appendix provides institutional 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 Special Scheme for Self-Employed Workers (RETA)

The RETA scheme in Spain regulates the Social Security for self-employed workers in Spain. One of the most important particularities of the RETA scheme is that this allows self-employed workers to voluntarily choose their Contribution Bases to Social Security within maximum and minimum limits legislated annually. Table A.1 describes the maximum and minimum Contribution Bases under RETA, as well as the SSC rate between 1994 and 2002.

"Option value" at age 50 years. Above the age of 50 years, the maximum ceiling for contributions was substantially smaller compared to the regular maximum ceiling for Contribution Bases, as shown in Table A.1. However, if self-employed workers chose a Contribution Base above this reduced threshold right before the age of 50 years, they would be able to choose a Contribution Base as large as their previous Contribution Base, which could 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 50 years of age, they should have decided to increase their contributions before reaching the age of 50 years. This provides an "option value" on contributions above the reduced maximum level by the age of 50 years. The rationale for this restriction in the freedom of contributions for self-employed workers was to limit the possibility of "purchasing pensions". Given that

Table A.1: Social Security parameters under RETA (1994-2002)

	SSC rate (%)	Monthly Contribution Bases (€)			Annual retirement pensions 65+ (€)		
		Minimum	Maximum		Minimum		Maximum
			age < 50	age ≥ 50	Dep. spouse	No dep. spouse	
1994	28.8	563.81	2,103.24	1,099.85	4,895.36	4,160.39	21,569.72
1995	28.3	591.94	2,176.81	1,135.91	5,110.77	4,343.81	22,518.76
1996	28.3	612.67	2,253.07	1,171.97	5,289.99	4,496.11	23,306.91
1997	28.3	639.72	2,311.67	1,208.03	5,427.56	4,613.07	23,912.90
1998	28.3	664.60	2,360.17	1,244.10	5,541.57	4,710.25	24,415.06
1999	28.3	681.19	2,402.73	1,280.16	5,691.34	4,837.73	25,074.22
2000	28.3	698.14	2,450.87	1,316.22	6,067.04	5,152.00	26,102.27
2001	28.3	712.04	2,499.91	1,334.25	6,230.98	5,291.16	26,807.20
2002	28.3	726.30	2,574.90	1,360.80	6,474.02	5,497.52	27,852.72

Notes: This table describes the SSC rates and Contribution Base ceilings in RETA and the minimum and maximum retirement pension benefit ceilings for those aged 65+ years. The minimum Contribution Base is unique for the self-employed, but the maximum contribution from the age of 50 years. Minimum retirement pensions depend on whether individuals have a dependent spouse or not. Contribution Bases are expressed in monthly terms, while pension benefits are expressed in annual terms.
Source: Presupuestos Generales del Estado 1994-2002.

pension benefits in Spain only depended on the contributions made during the years close to retirement, there was a strong incentive for self-employed workers to make low contributions initially and then increase contributions in the last years before retirement to secure their desired pension.

A.2 Pension formulas before and after 1997 pension reform

I now describe the pension formulas before and after the 1997 reform for the three elements of pension formulas, namely the Benefit Base, the penalization for lack of contribution years and the penalization for early retirement.

Benefit Base. The 1997 pension reform increased the number of years entering the Benefit Base from the last 8 years to the last 15 years. Therefore, the Benefit Base in the before and after 1997 pension system were computed in the following manner:

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

where BB_t^{1985} stands for the Benefit Base for individuals retiring at time t in the system between 1985 and 1997, CB_{t-i} stands for the Contribution Base made i periods before retire-

ment date t, CPI_{t-i} stands for the CPI i months before the retirement date t[33] and BB_t^{1997} represents the benefit base in the post-1997 pension system.

Penalization for lack of contribution years. The 1997 pension reform increased the penalization for lack of contribution years from 2% to 3% for those retiring with contribution years between 15 and 25 years. The penalization for lack of contribution years before and after the 1997 reform was the following:

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

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

Penalization for early retirement. The 1997 pension reform decreased the penalization for early retirement from 8% to 7% for those retiring with contribution years above 40 years. The penalization for early retirement before and after the 1997 pension reform took the following form:

$$\beta_R^{1985} = \begin{cases} 0 & \text{if } R < 60 \\ 0.6 + 0.08(a-60) & \text{if } 60 \leq R < 65 \\ 1 & \text{if } R \geq 65 \end{cases} \qquad \beta_{R,n}^{1997} = \begin{cases} 0 & \text{if } R < 60 \\ 0.6 + 0.08(a-60) & \text{if } 60 \leq R < 65 \text{ and } n < 40 \\ 0.65 + 0.07(a-60) & \text{if } 60 \leq R < 65 \text{ and } n \geq 40 \\ 1 & \text{if } R \geq 65 \end{cases}$$

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

[33] The reason why 96 months of contributions are divided by 112 is because taxpayers make 12 annual contributions while working, but they receive 14 annual pension payments at retirement.

B Appendix: Methodology of public pension incentives

This Appendix provides details on the parameters for calculating the public pension saving incentives concerning the penalization for lack of contribution years, retirement age assumptions, the possible disincentive of minimum pensions and alternative real rates of return.

B.1 Penalization for lack of contribution years

An important element behind pension incentives is the coefficient for lack of contribution years. For this, I take the contribution years information of self-employed retirees in 2005, which are summarized in Table B.1. One can observe a very large gender difference in the contribution years for self-employed workers retiring in 2005, with an average contribution period of 34,1 years for males compared to a contribution period of 23,5 years for females. Indeed, up to 52.7% of the male self-employed retire with a contribution period of over 35 years, while the majority of females have contribution periods between 15 and 25 years. The average penalization for contribution years in 2005 for males was 8.7%. Therefore, I use parameter $\alpha_n = 91.3\%$ for the calculation of public pension saving incentives.

Table B.1: Contribution history 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
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%

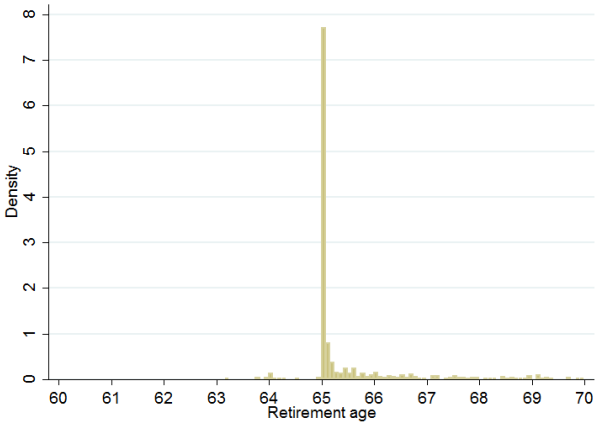
Notes: This table shows the contribution period characteristics of the self-employed retired in 2005. I provide this for female, male and all self-employed. The table includes information on average years contributed at retirement, as well as the fraction of self-employed retirees in ranges of contribution years between 15 and 25 years, 25 and 35 years and more than 35 years of contributions at retirement.
Source: MCVL 2005.

B.2 Retirement age for Spanish self-employed workers

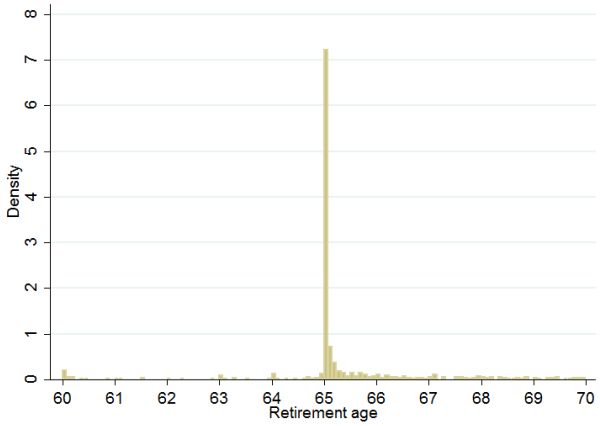
I assume that self-employed workers expect to retire with 65 years. This is the statutory age of retirement in Spain and this is chosen by the vast majority of self-employed workers between 1997 and 2002, as shown in Figure B.1.

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

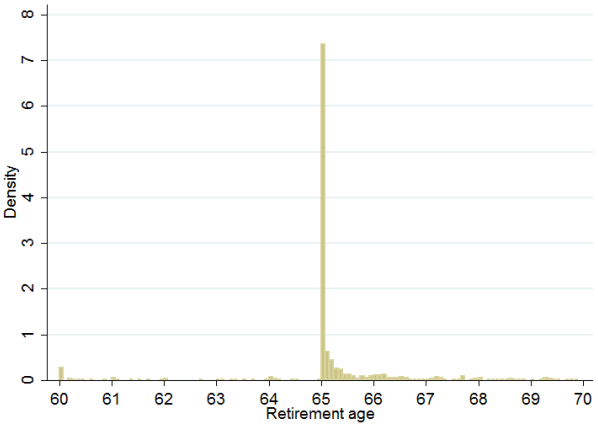
(a) 1997



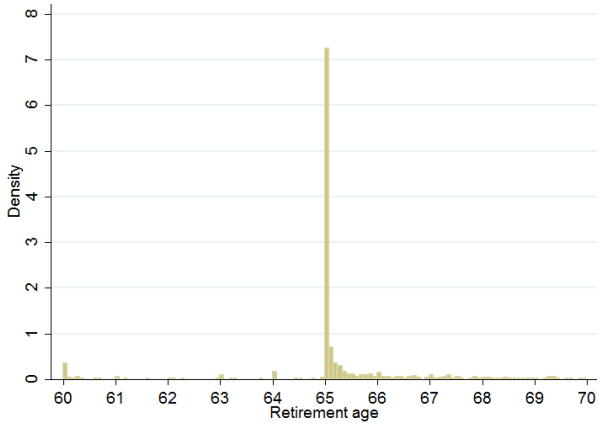
(b) 1998



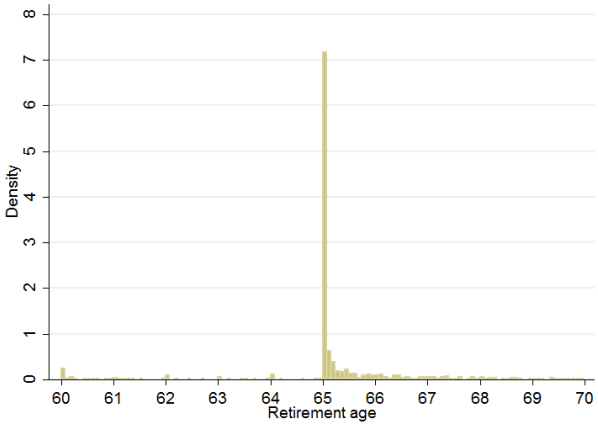
(c) 1999



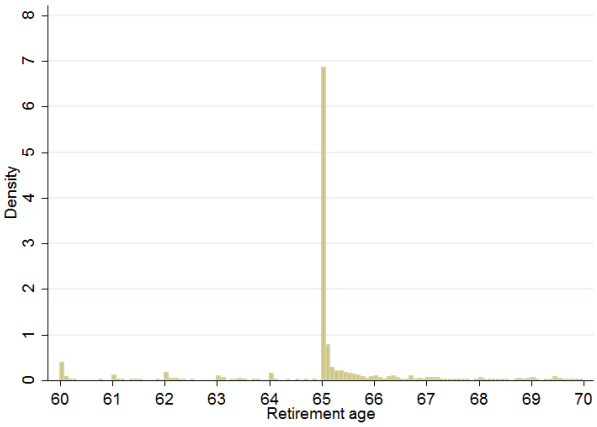
(d) 2000



(e) 2001



(f) 2002

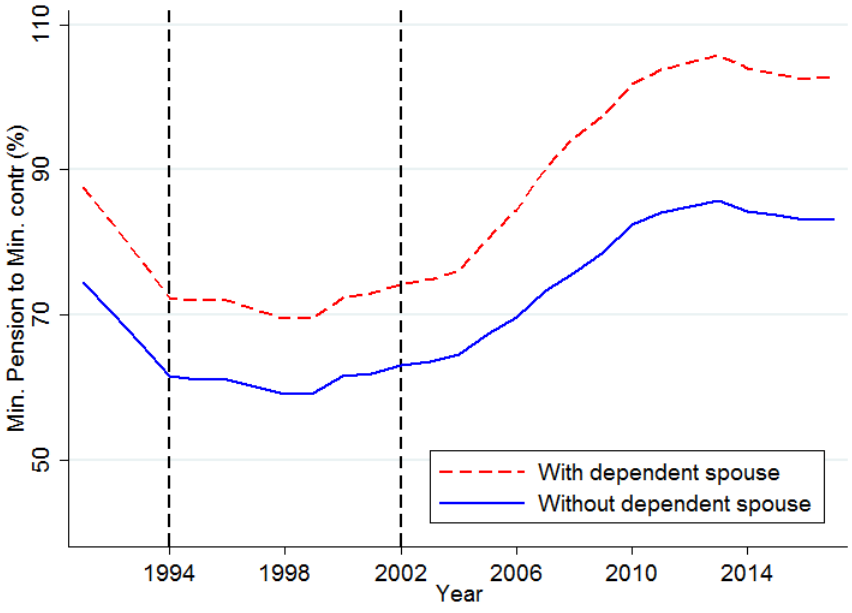


Notes: The figure displays the histogram of retirement ages for self-employed workers retiring in 1997 (panel a), 1998 (panel b), 1999 (panel c), 2000 (panel d), 2001 (panel e) and 2002 (panel f).
Source: MCVL 2005.

B.3 Disincentive of minimum pensions

The existence of minimum legal pensions could discourage contributions to Social Security for self-employed workers. If pensions generated by self-employed workers were below the minimum pension, self-employed workers would earn the minimum pension even after increasing their contributions to Social Security. The possibility of this disincentive is particularly important for self-employed workers with a large penalization coefficient for short contribution careers, which could lead to a "minimum pension trap"[34] (Sanchez-Martin, 2019a). Figure B.2 illustrates the ratio between the minimum pension to minimum contribution under RETA between 1991 and 2017. During 1994-2002, which is the period of study, the ratio between minimum pensions and contributions stayed very low and stable at 60-65% for those without a dependent spouse and at 70-75% for those with a dependent spouse. Given that I restrict the study to the male self-employed, who tend to have long contribution careers, the disincentive provided by minimum pensions in the period this study could be considered negligible[35].

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

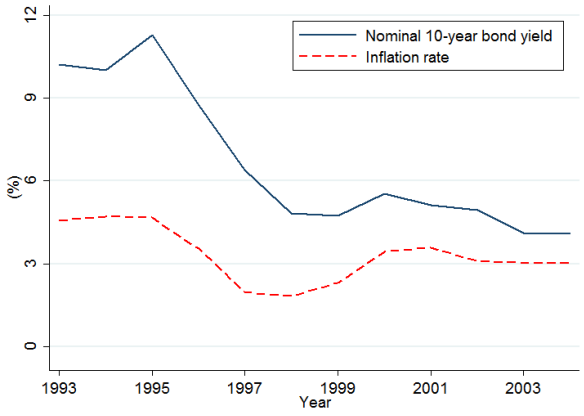
[34] See Sanchez-Martin (2019c) for detailed information of this disincentive for Spain between 2008 and 2016.
[35] The minimum pension-to-minimum contribution ratio greatly increased since the mid-2000s, which Conde-Ruiz and Gonzalez (2016) quoted as the "silent reform" in the Spanish pension system.

B.4 Alternative rates of return

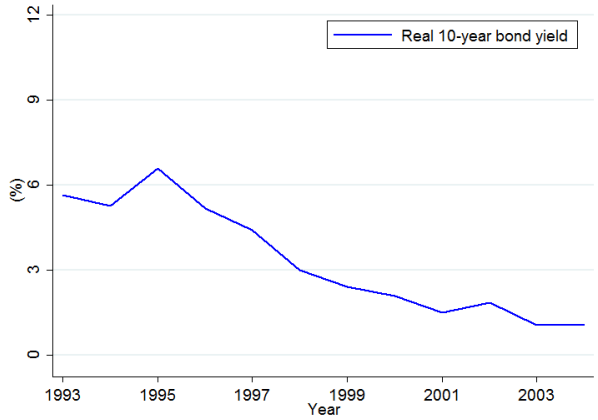
In order to provide a plausible range for the implicit net-of-tax rate in Spain, I use risk-free and market rates of return to represent upper and lower bounds of the return on alternative investments. I use the 10-year Central Government bonds in Spain negotiated in the secondary markets as the reference risk-free rate of return in Spain. I use the nominal rate of return for this series from the European Central Bank (ECB)[36], which I deflate using CPI data available at INE (2019). Figure B.3a shows the 10-year bond nominal interest rate taken from the in Spain between 1993 and 2004 ECB, along with the inflation rate over the same period taken from INE (2019). One can observe that the series closely follow each other in the period of study. Therefore, I assume individuals' expected inflation over the following 10 years is determined by current inflation in order to provide the real rates of return. I provide pre-tax rates of return, since I am interested on the risk-free rate of return at which self-employed workers could both invest and borrow. One can observe in Figure B.3b that the real risk-free rate of return was high in the range 4.5-6.5% in the pre-1997 reform period. In the period after the 1997 pension reform, the rates of return stayed between 1% and 3%.

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).

[36] https://www.ecb.europa.eu

C Appendix: Marginal Internal Rate of Return (MIRR)

I now introduce the methodology for measuring the Marginal Internal Rate of Return (MIRR) and I calculate this for the Spanish public pension system between 1994 and 2002. This is

C.1 Methodology

The MIRR[37] 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[38]:

$$\frac{\partial SSC_t}{\partial CB_{a,t}} = \frac{\partial SSW_{a,t}}{\partial CB_{a,t}}(\rho) \tag{10}$$

where 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 $\frac{\partial SSC_t}{\partial CB_{a,t}} = \tau_t$:

$$\tau_t = \frac{\partial P_t}{\partial CB_{a,t}} \left[\frac{1}{(1+\rho)^{R-a}} \sum_{s=R+1}^{\overline{LE}} \frac{\pi_t(s|a)}{(1+\rho)^{s-a}} \right] \tag{11}$$

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.

C.2 MIRR between 1994 and 2002

Table C.1 describes the MIRR for males aged between 40 and 64 years by individual year of age for males between 1994 and 2002. This applies the methodology presented above and the assumptions presented in Section 3. The sensitivity of my baseline calculation of the MIRR to alternative assumptions is provided in Appendix D.

[37] The MIRR should not be confused with the Internal Rate of Return (IRR) of a pension system. The IRR represents the rate of return that balances the lifetime contributions and pension benefits, while the MIRR balances the cost and benefit a marginal contribution at a given age at a given point in time.

[38] The MIRR for pension systems has already been calculated by Kitces (2018) for the US, or by Sanchez-Martin (2019c) for Spain.

Table C.1: Average MIRR by age for males between 1994 and 2002 (%)

	49 and below	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
1994	-100.0	-100.0	-100.0	-100.0	-100.0	-100.0	-100.0	-100.0	12.6	13.7	15.1	16.8	19.1	22.2	27.2	35.6
1995	-100.0	-100.0	-100.0	-100.0	-100.0	-100.0	-100.0	-100.0	12.6	13.7	15.1	16.8	19.1	22.3	27.2	35.8
1996	-100.0	-100.0	-100.0	-100.0	-100.0	-100.0	-100.0	-100.0	12.6	13.8	15.1	16.9	19.2	22.4	27.2	35.9
1997	-100.0	-100.0	-100.0	-100.0	-100.0	-100.0	-100.0	-100.0	12.7	13.8	15.2	16.9	19.2	22.4	27.3	35.9
1998	-100.0	5.4	5.7	5.9	6.3	6.6	7.0	7.5	8.0	8.5	9.3	10.1	12.9	15.8	20.3	28.3
1999	-100.0	5.4	5.7	6.0	6.2	6.6	7.0	7.4	8.1	8.6	9.3	10.2	11.3	14.7	18.7	25.5
2000	-100.0	5.5	5.7	6.0	6.3	6.6	7.1	7.5	8.0	8.7	9.4	10.2	11.4	12.8	17.3	23.2
2001	-100.0	5.5	5.7	6.0	6.3	6.7	7.0	7.5	8.0	8.7	9.5	10.4	11.4	12.9	14.9	21.2
2002	-100.0	5.5	5.7	6.0	6.3	6.7	7.1	7.5	8.1	8.7	9.4	10.4	11.5	12.9	15.0	18.0

Notes: This table shows the average MIRR for male self-employed workers by age between 1994 and 2002. For this, I use a penalization for the contribution period of 8.7%, which is based on the average penalization for self-employed workers observed in MCVL 2005. The 1997 pension reform was approved in August 1997, so I provide the MIRR for the contributions at the beginning of the year, when contributions are decided.

Sources: MCVL 2005.

D Appendix: Sensitivity of public pension incentives

This Appendix describes the sensitivity of the baseline calculation of public pension saving incentives. For this, I use alternative assumptions on three of the main parameters: the replacement rate on the Benefit Base, the mortality rates at each age and for early retirement.

Sensitivity to the replacement rate. The sensitivity to the replacement rate jointly accounts for adjustments on penalization coefficient for shorter contribution periods α_n and for the probability of contributions at a given age eventually not counting for pension benefits. In order to check the sensitivity of financial incentives to the replacement rate on the Benefit Base, I recalculate incentives for a replacement rate of 70% and 100%, while my baseline calculation uses a replacement rate of 91.3%. This comes from the average penalization on contribution periods of 8.7% in 2005. This penalization is in addition to the 4% penalization for not adjusting the inflation during the last 2 years. Figures D.1a and D.1b illustrate the sensitivity of the MIRR and the implicit net-of-tax rates to replacement rates of 70% and 100%. The decrease of replacement rates to 70% imply the MIRR to decrease to about 4%, while a replacement rate at 100% increases the MIRR to about 6.2%.

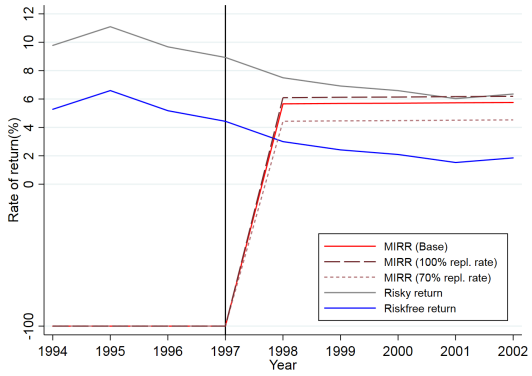
Sensitivity to mortality rates. The mortality rates determine the expected length of receipt of pension benefits, which greatly determines the public pension saving incentives. In order to check the sensitivity of mortality rates, I consider applying the mortality profile of those 5 years younger and older than those aged 50-52 years, which is the group of interest. Figures D.1c and D.1d illustrate the sensitivity of the MIRR and the implicit net-of-tax rates for the proposed alterations of the mortality rates. Applying mortality rates of those 5 years older decreases the MIRR to about 4.4%, while applying mortality rates of those 5 years younger increases the MIRR to about 6.4%.

Sensitivity to early retirement. I consider the incentive when self-employed workers retire at the age of 62 years instead of retiring at the statutory age of 65 years. Early retirement implies a penalization of 8% per year of early retirement, but this allows to earn pension benefits for further periods. Figures D.1e and D.1f illustrate the sensitivity of the MIRR and the implicit net-of-tax rates for the possibility of early retirement at the age of 62 years. Early retirement hardly changes the MIRR since the decrease in pension benefits is compensated by the addition pension benefits at an earlier period. In terms of the implicit net-of-tax rate, early retirement only decreases the implicit net-of-tax rate when pension benefits are

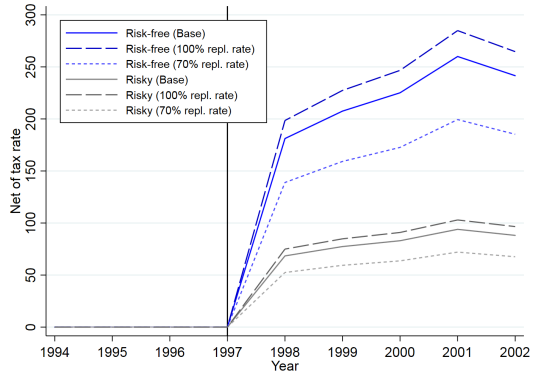
discounted using the risk-free rate of return.

Figure D.1: Sensitivity of incentives for those aged 50-52 years

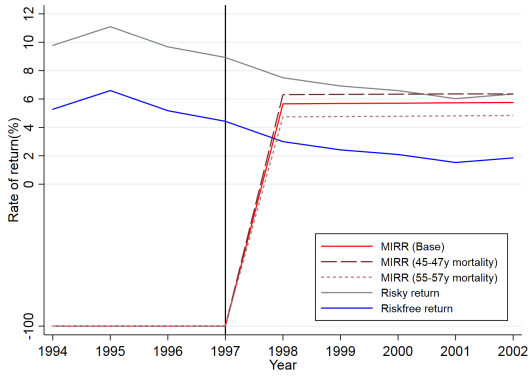
(a) MIRR: Replacement rate



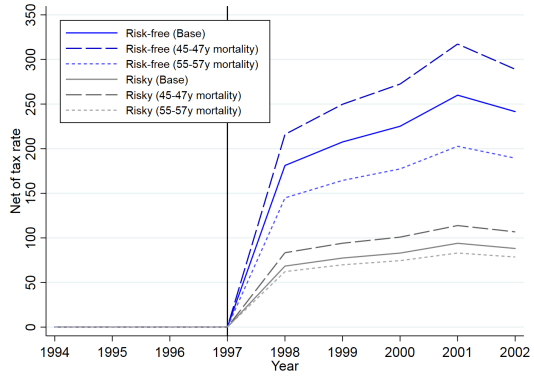
(b) MSSB: Replacement rate



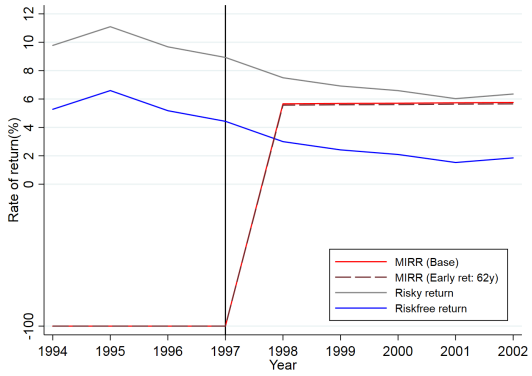
(c) MIRR: Mortality



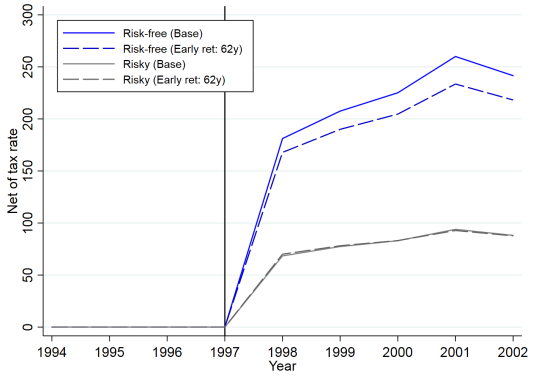
(d) MSSB: Mortality



(e) MIRR: Early retirement



(f) MSSB: Early retirement



Notes: The figure displays the sensitivity of the MIRR and MSSB of public pension savings for males aged 50-52 years for alternative assumptions about replacement rates (panel (a) and panel (b)), mortality probabilities (panel (c) and panel (d)) and for early retirement (panel (e) and panel (f)). This considers the sensitivity to using replacement rates of 70% and 50%, while baseline estimations consider 91.3%. This considers applying the mortality of those 5 years younger and older than the age range of interest. The sensitivity to early retirement is checked for an age of retirement of 62 years.
Source: MCVL 2005.

E Appendix: Sample selection

This study uses data from the 2005 wave of the MCVL, which is representative of the population of individuals with a relationship with the Spanish Social Security in 2005, retrospectively between 1994 and 2002. In order to ensure representativeness of my sample between 1994 and 2002, I select a sample of males with Spanish nationality working as self-employed between 1994 and 2002. This population is most likely to keep having a relationship with the Spanish Social Security over time and therefore be representative of the population of study. Table E.1 illustrates that the sample size per block of age and year is relatively stable for the age range 40-52 in the period 1994-2002. In order to provide evidence on the plausibility of the representativeness of my sample, I use the same sample selection criteria with the 2007 wave of the MCVL. Table E.2 illustrates that the number of observations using the 2007 wave of the MCVL is very similar to the number of observations of the 2005 wave of the MCVL. This supports that males with Spanish nationality working as self-employed between 1994 and 2002 keep having a relationship with Spanish Social Security over time.

Table E.1: Number of observations by age and year in the selected sample. MCVL wave 2005

	40	41	42	43	44	45	46	47	48	49	50	51	52	Total
1994	1011	978	1045	974	1057	1116	1042	987	1022	978	947	809	708	12674
1995	993	1008	981	1042	972	1048	1117	1036	984	1016	973	937	805	12912
1996	1087	995	1012	976	1043	968	1046	1113	1032	979	1012	968	933	13164
1997	1011	1085	992	1005	982	1039	971	1046	1112	1030	977	1015	970	13235
1998	991	1011	1082	991	1003	974	1032	967	1044	1116	1027	975	1011	13224
1999	1007	991	1007	1083	988	1006	976	1035	962	1037	1106	1024	971	13193
2000	1032	1006	990	1008	1085	987	1004	971	1034	963	1033	1102	1021	13236
2001	983	1030	1006	989	1007	1082	992	1003	970	1032	960	1037	1101	13192
2002	931	979	1029	1000	985	1002	1080	985	996	964	1021	956	1029	12957
Total	9046	9083	9144	9068	9122	9222	9260	9143	9156	9115	9056	8823	8549	117787

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 males with Spanish nationality who continuously work as self-employed between 1994 and 2002. This also includes the self-employed who left self-employment to claim a retirement pension.
Source: MCVL 2005.

Table E.2: Number of observations by age and year in the selected sample. MCVL wave 2007

	40	41	42	43	44	45	46	47	48	49	50	51	52	Total
1994	1002	970	1029	961	1049	1107	1032	978	1007	961	931	797	695	12519
1995	987	999	973	1026	959	1040	1108	1025	976	1002	956	921	793	12765
1996	1083	989	1003	968	1027	956	1038	1105	1021	970	999	952	917	13028
1997	1004	1081	987	996	974	1021	959	1038	1103	1019	968	1001	953	13104
1998	981	1004	1078	984	994	966	1016	955	1036	1108	1016	966	998	13102
1999	999	981	1000	1079	982	997	968	1018	950	1029	1098	1013	963	13077
2000	1019	998	980	1001	1082	981	995	963	1019	951	1025	1095	1010	13119
2001	978	1017	998	979	1000	1079	986	994	962	1015	948	1029	1093	13078
2002	930	974	1016	992	975	995	1077	979	987	956	1005	944	1021	12851
Total	8983	9013	9064	8986	9042	9142	9179	9055	9061	9011	8946	8718	8443	116643

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 round of MCVL instead of the 2005 round. This consists of males with Spanish nationality who continuously work as self-employed between 1994 and 2002. This also includes the self-employed who left self-employment to claim a retirement pension.
Source: MCVL 2007.

F Appendix: DiD results for alternative specifications

Table F.1: Dynamic DiD results using alternative specifications: Complete results

	Baseline	No controls	Treatment group		Control group		Sample sel.
			50-53y	50-54y	40-44y	42-46y	Dur. > 3y
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Prob above min.							
$T_a \times D_{1994}$	−0.000	−0.004	−0.006	−0.008	0.005	−0.004	−0.017**
	(0.007)	(0.007)	(0.006)	(0.005)	(0.007)	(0.007)	(0.007)
$T_a \times D_{1995}$	0.001	−0.002	−0.005	−0.008	0.005	0.000	−0.009
	(0.006)	(0.006)	(0.005)	(0.004)	(0.006)	(0.006)	(0.006)
$T_a \times D_{1996}$	0.003	−0.001	−0.000	−0.002	0.004	0.002	0.003
	(0.005)	(0.005)	(0.004)	(0.003)	(0.005)	(0.005)	(0.004)
$T_a \times D_{1998}$	0.020***	0.021***	0.015***	0.015***	0.020***	0.020***	0.020***
	(0.005)	(0.005)	(0.004)	(0.004)	(0.005)	(0.005)	(0.005)
$T_a \times D_{1999}$	0.042***	0.044***	0.035***	0.035***	0.042***	0.040***	0.042***
	(0.007)	(0.007)	(0.006)	(0.005)	(0.007)	(0.007)	(0.006)
$T_a \times D_{2000}$	0.068***	0.070***	0.060***	0.053***	0.067***	0.065***	0.066***
	(0.008)	(0.008)	(0.007)	(0.006)	(0.008)	(0.008)	(0.007)
$T_a \times D_{2001}$	0.094***	0.096***	0.086***	0.084***	0.099***	0.089***	0.085***
	(0.009)	(0.009)	(0.008)	(0.007)	(0.009)	(0.009)	(0.008)
$T_a \times D_{2002}$	0.101***	0.104***	0.106***	0.103***	0.108***	0.095***	0.092***
	(0.009)	(0.009)	(0.008)	(0.007)	(0.009)	(0.009)	(0.008)
Pre-trends	0.917	0.839	0.576	0.201	0.806	0.773	0.051
Log of real contr.							
$T_a \times D_{1994}$	0.008	0.006	0.005	0.002	0.009	0.006	−0.003
	(0.005)	(0.005)	(0.004)	(0.003)	(0.005)	(0.005)	(0.000)
$T_a \times D_{1995}$	0.002	0.001	0.000	−0.002	0.003	0.002	−0.003
	(0.004)	(0.004)	(0.003)	(0.003)	(0.004)	(0.004)	(0.005)
$T_a \times D_{1996}$	−0.001	−0.002	0.000	−0.001	−0.001	−0.001	−0.003
	(0.003)	(0.003)	(0.002)	(0.002)	(0.003)	(0.003)	(0.004)
$T_a \times D_{1998}$	0.013***	0.013***	0.009***	0.007**	0.013***	0.013***	0.014***
	(0.003)	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)
$T_a \times D_{1999}$	0.026***	0.027***	0.020***	0.018***	0.026***	0.025***	0.030***
	(0.004)	(0.004)	(0.003)	(0.003)	(0.004)	(0.004)	(0.003)
$T_a \times D_{2000}$	0.039***	0.040***	0.036***	0.030***	0.039***	0.037***	0.043***
	(0.005)	(0.005)	(0.004)	(0.004)	(0.005)	(0.005)	(0.004)
$T_a \times D_{2001}$	0.056***	0.058***	0.051***	0.049***	0.059***	0.054***	0.056***
	(0.005)	(0.005)	(0.005)	(0.004)	(0.005)	(0.006)	(0.005)
$T_a \times D_{2002}$	0.065***	0.067***	0.067***	0.063***	0.069***	0.062***	0.062***
	(0.006)	(0.006)	(0.005)	(0.005)	(0.006)	(0.006)	(0.005)
Pre-trends	0.183	0.270	0.304	0.134	0.078	0.333	0.818
N (obs)	90,373	90,373	98,729	106,498	71,891	72,244	155,219

Notes: This table provides the dynamic DiD estimates of contribution behaviour using alternative specifications. This includes the Baseline specification (column 1), the Baseline specification without covariates (column 2), extensions of the Treatment group to include those aged 50-53 years (column 3) and 50-54 years (column 4), alterations of the control group to those aged 40-44 years (column 5) and 42-46 years (column 6), as well as an alteration of the sample selection criteria for male self-employed workers in employment spells with longer duration than 3 years. 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

G Appendix: 2SLS results

Table G.1: 2SLS results on the effect of public pension saving incentives on contribution behaviour: Complete results

	Probability above minimum		Log. of real contributions	
	Market return	Risk-free return	Market return	Risk-free return
	(1)	(2)	(3)	(4)
$1-\tau^{d}_{a,1998}$	0.011	0.030	0.007	0.019
$1-\tau^{d}_{a,1999}$	0.020	0.055	0.013	0.034
$1-\tau^{d}_{a,2000}$	0.030	0.082	0.017	0.047
$1-\tau^{d}_{a,2001}$	0.036	0.100	0.022	0.060
$1-\tau^{d}_{a,2002}$	0.042	0.115	0.027	0.074
N	90,373	90,373	90,373	90,373

Notes: This table provides the 2SLS estimates on the effect of the implicit net-of-tax rate on our outcome variables of interest. For probability above the minimum, the table provides the estimates where the implicit net-of-tax rate discounts expected pension benefits using the market return (column 1) and the risk-free return (column 2). For the log of real contributions, the table provides the estimates where the implicit net-of-tax rate discounts expected pension benefits using the market return (column 3) and the risk-free return (column 4). Standard errors are not reported since I use an average measure of the implicit net-of-tax rate, which would lead to an underestimation of standard errors.
Source: MCVL 2005.

H Appendix: Heterogeneity analysis

This Appendix investigates the heterogeneity of the contribution responses to the 1997 pension reform according to demographic and labour market characteristics. For this, the sample of study is split according to gender, education, regional income, municipality size, economic activity and contribution history of self-employed workers. Table H.1 reports the DiD results 5 years after the 1997 reform for self-employed workers aged 50-52 years according to the values of various demographic and labour market variables.

Gender. The public pension saving response of females to the 1997 reform is about half compared to my baseline results for males. This could be attributed to the fact that females tend to have shorter contribution periods and therefore a lower return on contributions, as well as having lower income.

Education level. The public pension saving response 5 years after the 1997 reform is slightly increasing in education attainment. However, the heterogeneity of responses by education levels is hardly significant at the 5% significance level.

Regional income. Self-employed workers living in provinces with lower average income in Spain provide significantly lower public pension saving responses to the 1997 pension reform compared to the response of those living in provinces with middle and higher average income. However, self-employed workers living in provinces with middle and higher average income provide similar responses.

Municipality size. The public pension saving response 5 years after the 1997 reform is slightly increasing in municipality size. However, the heterogeneity of responses by municipality size is hardly significant at the 5% significance level.

Economic activity. Self-employed workers working in services generally give larger responses although the heterogeneity by economic activity is hardly significant at the 5% significance level. Self-employed working in agriculture give significantly smaller responses.

Contributed years. There is modest heterogeneity according to the length of the contribution period, with the lower public pension saving responses coming from self-employed workers with the lowest contribution career (above the age of 26 years).

Table H.1: Heterogeneity analysis of the DiD estimate 5 years after the 1997 pension reform

	Prob. above min.		Log of real contr.)		N (obs.)
	Coefficient	[95% C.I.]	Coefficient	[95% C.I.]	
	(1)	(2)	(3)	(4)	(5)
Baseline	0.101	[0.084 ; 0.119]	0.065	[0.054 ; 0.076]	90,373
Gender					
Females	0.053	[0.032 ; 0.075]	0.034	[0.020 ; 0.048]	31,260
Education level					
Primary or less	0.086	[0.060 , 0.112]	0.056	[0.040 , 0.071]	32,996
Secondary	0.106	[0.073 , 0.138]	0.068	[0.047 , 0.088]	28,436
Sup. educ.	0.111	[0.064 , 0.158]	0.078	[0.046 , 0.110]	19,589
Regional income					
Lower	0.062	[0.034 , 0.090]	0.035	[0.019 , 0.051]	26,230
Middle	0.110	[0.078 , 0.141]	0.070	[0.051 , 0.089]	27,041
Higher	0.121	[0.092 , 0.151]	0.081	[0.062 , 0.101]	37,001
Municipality size					
$\leq$ 40,000	0.089	[0.066 , 0.113]	0.059	[0.044 , 0.074]	49,139
Middle	0.113	[0.082 , 0.143]	0.069	[0.050 , 0.088]	32,870
$\geq$ 600,000	0.123	[0.067 , 0.179]	0.081	[0.045 , 0.117]	8,364
Economic activity					
Agriculture	0.057	[0.004 , 0.111]	0.030	[0.001 , 0.060]	2,171
Industry and construction	0.096	[0.060 , 0.133]	0.065	[0.041 , 0.088]	25,553
Retail and hospitality	0.094	[0.068 , 0.119]	0.059	[0.044 , 0.074]	34,892
Transport	0.154	[0.108 , 0.200]	0.098	[0.072 , 0.125]	11,597
Estate and Financial	0.111	[0.027 , 0.195]	0.072	[0.012 , 0.131]	5,505
Social service	0.144	[0.055 , 0.232]	0.100	[0.043 , 0.157]	5,177
Contributed years (> 26y)					
Shorter (0-33.3 perc.)	0.087	[0.060 , 0.114]	0.056	[0.040 , 0.072]	30,050
Middle (33.3-66.7 perc.)	0.115	[0.085 , 0.146]	0.071	[0.052 , 0.090]	30,138
Longer (66.7-100 perc.)	0.099	[0.066 , 0.133]	0.066	[0.044 , 0.088]	30,185

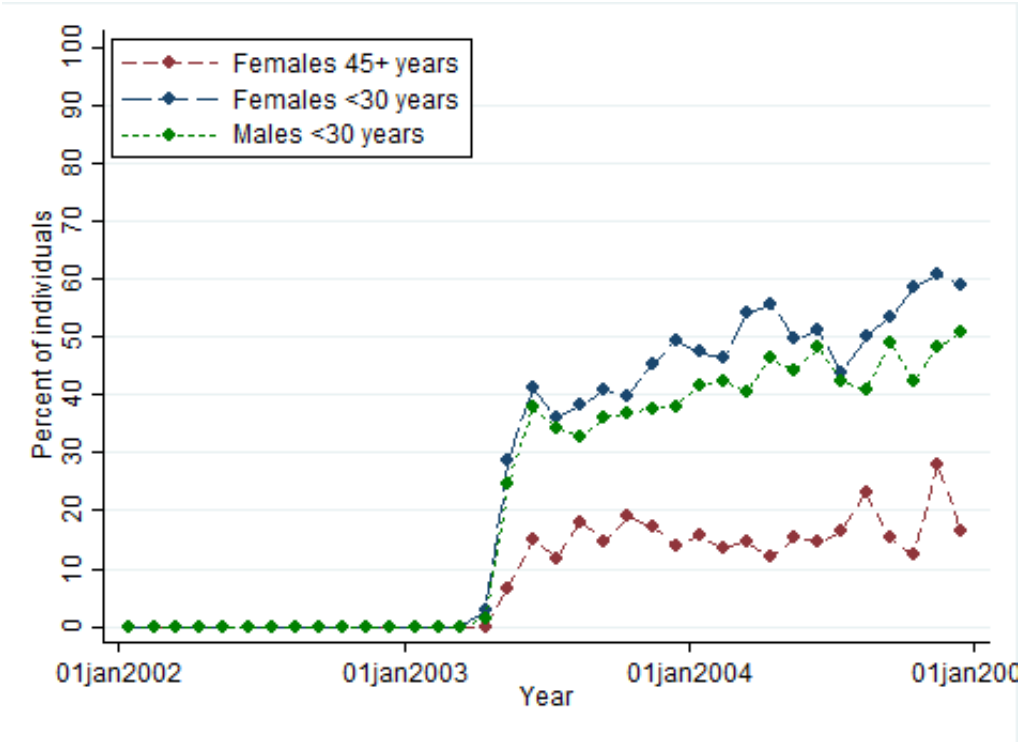
Notes: The table provides the heterogeneity of the DiD estimates 5 years after the 1997 pension reform, for which I split the sample in subgroups of my variables of interest. The Baseline estimate considers males as described above, while I also provide the estimate for female self-employed workers. For education, the sample is split between those with primary education or less, secondary education and superior education. On regional income, the sample is split by GDP pc in 1997 in regions with higher income (Balearic Islands, Basque Country, Catalonia, Community of Madrid and Navarre), Middle income (Aragon, Canary Islands, Cantabria, Castile and Leon, Ceuta, La Rioja, Melilla, Principality of Asturias and Valencian Community) and Lower income (Andalusia, Castile La Mancha, Extremadura, Galicia and Region of Murcia). On municipality population size, the sample is split between municipalities with less than 40,000 inhabitants, those between 40,000 and 600,000 inhabitants and those with more than 600,000 inhabitants. On the sector of activity of self-employed workers, the sample is split between those working in Agriculture; Industry and Construction; Retail, Reparations and Hospitality; Transport; Estate and Financial services and Social services (Education and Health). On contribution period, the sample is split in thirds according to the years contributed to SS above the age of 26 years (the percentiles are generated at each year of age). 95% CI in brackets.
Source: MCVL 2005

I Appendix: Response to the reduced minimum contribution over time

The 35th Transitory Provision of the Social Security Law reduced the minimum ceiling for contributions by 25% during 3 years after becoming self-employed for new self-employed workers aged below 30 years old and females older than 45 years old. This law was in place between 27th April 2003 and 17th January 2005.

Figure I.1 illustrates the monthly fraction of new self-employed workers contributing by the reduced minimum contribution. The figure shows that the fraction of female new self-employed workers aged 45 years and over contributing by the reduced minimum is between 10% and 20% and this is relatively stable between April 2003 and 2005. Among new self-employed workers aged below 30 year, the fraction of new self-employed workers grows from about 40% to about 50% for males, while this increases from 40% to 60% for females.

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



Notes: The figure shows the monthly fraction of new self-employed workers contributing below the reduced minimum by eligible groups. The fraction of new self-employed who are females aged over 45 years is represented by the red dashed line; females aged under 30 years by the blue long dashed line; and males aged under 30 years by the green short dashed line.
Source: MCVL 2005.