Formal Labor Market and Pension Wealth: Evaluating the 2008 Chilean Pension Reform*

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Abstract

This study aims to estimate the impact of the 2008 Chilean pension reform on the Chilean labor market participation. During 2008 Chile reformed its Defined Contribution Pension System, widening the welfare tier and improving the contributory tier. The main goals of the reform were to guarantee a minimum level of consumption upon retirement, prevent old-age poverty and reduce gender inequalities. The reform ensures old-age income to individuals that have not saved enough to self-finance a minimum level of consumption and promotes labor market participation, in particular among groups whose attachment has been traditionally infrequent or irregular, such as women, the self-employed and young people. We use a difference in difference estimator to address the effect of the expected pension wealth on the formal labor market participation. We exploit the differential effects of the reform on individuals belonging to several year-of-birth cohorts and different groups to gain identification. The main results of the paper are two folds. Firstly, the reform has increased not only the self-financed pension wealth, due to the different mechanisms or subsidies received during the accumulation period, but also has importantly improved the final pension due to the first tier reform. For those workers retiring before 2015, the self-financed pension wealth and the final pension will increase in average 0.7% and 15%, respectively. Secondly, the changes in the final pension wealth at retirement and the accrual rate have reduced slightly the formal labor market participation. The probability to contribute to pension system has decreased as a result of the reform, reducing the participation in the formal labor market around 0.4% for those workers elder than 40 years old. The results are significantly higher for women and elder workers. The reform reduces the probability of being formal in 0.5% and 0.2% for women and men between 56 and 65 years old, respectively. Even though the final pension changes have been positive for both gender, the female pension improvement has been 78% higher than the rise for men reducing importantly the gender inequalities.

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1 Introduction

Before the early 1980s, public pensions in Chile were organized as a PAYG system characterized by a large degreee of heterogeneity in terms of benefit and contribution rates, depending on the sector and industry of occupation. After a few attemps to simplify it and homogenize it, the entire system was reformed in 1981. Chile instituted a mandatory defined contributions (DC hereafter) pension system, which later became a model for the reform in public pensions in many countries that, since 1990, implemented a capitalization system, as a DC system is sometimes called. Countries that followed the Chilean example include Argentina (1994), Bolivia (1997), Colombia (1993), Costa Rica (1995), Dominican Republic (2003), El Salvador (1998), Mexico (1997), Panama (2008), Peru (1993), Uruguay (1996), Slovakia (2005).The reasons and motivations of the early eighties reform were many. However, among the most important concerns were the high individual contribution rate, which varied between 16% and 23% depending on the sector of economic activity, and the low associated replacement rates. In the new system, every affiliate working with labor contract was obliged to contribute to the system, starting with her first job, creating automatically an individual account which would accumulate her resources until retirement. These accounts were (and are) privately managed by regulated Pension Fund Administrators (PFAs hereafter) and accumulate returns each period depending on the financial investment choices made by the PFA. The PFAs face some significant constraints on the type of investment they can undertake. The old PAYG system continued working for individuals who decided to stay on it, but any worker was allowed to change to the new system until 1986. The exodus to the new system was massive, as of 1982 around 1,500,000 workers were contributing in the new system and just 500,000 stayed in the PAYG.

The new system was highly advertised during its implementation, offering a common low rate of contribution and promising higher future pensions. However, in practice, pensions have been lower than their initial expected value, generating low replacement rates: 28% for women and 51% for men in 2005[1]. The main reason behind these ex-post low average replacement rates seems to be the fact that many

[1]Final report, 2006 Pension Reform Commission. See [1] in the References.

individuals do not contribute frequently enough to the system. After more than 25 years since its implementation, the low frequency of contributions appears as one of the main system problems, which is particularly serious for groups with low labor market attachment, such as women. The average frequency of contributions has been 42% for women and 61% for men. For women, 44% of the non contributed periods correspond to periods of inactivity (Final report, 2006 Pension Reform Commission), reflecting one of the features of the Chilean labor market, namely its low female labor participation.

The crucial structural parameters characterizing the original DC system, such as the contribution rate and the legal age of retirement, were chosen on the basis of the demographic structure and the labor market characteristics prevailing in the periods previous to the reform in 1981. However, Chile has experienced important demographic and socioeconomic changes in the last 3 decades that could suggest an explanation for the system's failure to achieve the expected results. Life expectancy at birth has increased from 71 in 1980 to 79 in 2005, requiring larger levels of accumulated pension wealth in order to cover a longer period of retirement satisfactorily. Female labor participation jumped from 29% in 1986 to 37% in 2005. This increase implies that a larger fractions of individuals contributing to the system are characterized by a lower attachment to the labour market and by important interruptions in employment and therefore contributions, partly induced by fertility deecisions. This situation lead to a decrease in the average number of contributions. The fraction of employees working under temporary labor contracts or fixed-term contracts has increased during last decades. These types of contractual-relationship would have reduced the average frequency of contributions due to the likely reduction in the continuity of labor histories.

In March 2006, a panel of experts was formed with the aim of addressing the main problems of the pension system and set up the guidelines for improving it, tackling mainly the problems relevant for those with low attachment to the formal labor market and, consequently, low frequency of contributions. The reform suggested by the expert panel was announced in 2006 and, by and large, implemented in 2008. Some of the reforms were designed explicitly to improve the female labor market

participation. The reform costs annually around 1.1% of GDP[2], being one the largest social Chilean reform in the last years.

The main goals of the reform were to guarantee a minimum and stable level of consumption upon retirement, preventing old-age poverty and reducing gender inequalities. Regarding the former, the reform ensures old-age income even to individuals that have not saved for retirement at all or have saved too little to self-finance a minimum level of consumption. At the same time, the reform aims to promote participation to the system, in particular among groups whose attachment has been traditionally infrequent and/or irregular, such as women, the self-employed and young people. Further, the reform has set up a more comprehensive system in which the redistributive and the mandatory tiers of the system have been integrated with each other.

This study will estimate the impact of the 2008 Chilean pension reform over the labor market, focusing mainly on female labor market participation, using the methodology that we describe below. In particular, we use a version of the "difference in differences" estimator to address the effect of the accumulated pension wealth and pension on the formal and informal labor market participation. In doing so, we will follow the approach used by Attanasio and Rodhwedder (2003) and Attanasio and Brugiavini (2003), who estimate the substitution effect on saving rate induced by the pension reforms implemented in UK and Italy, respectively. This approach uses changes in expected pension wealth and pensions across groups and time in order to estimate the relationship between pension wealth and saving rates. We will estimate the relationship between pension wealth/acrrual rate and participation rates to the formal and informal labor market.

The main results of the paper are two folds. Firstly, the reform has increased not only the self-financed pension wealth, due to the different mechanisms or subsidies received during the accumulation period, but also has importantly improved the final pension due to the first tier reform. For those workers retiring before 2015, the self-financed pension wealth and the final pension will increase in average 0.7% and 15%, respectively. Secondly, the changes in the final pension wealth at retirement

[2]According to forecasts by the Chilean Pension Regulator, "Superintendencia de Pensiones" (SPE), and the Budget Office, "Direccion de Presupuesto" (DIPRES). See [1] in the references.

and the accrual rate have reduced slightly the formal labor market participation. Therefore, the probability to contribute to pension system has decreased as a result of the reform, reducing the participation in the formal labor market around 0.4% for those workers elder than 40 years old. The results are significantly higher for women and elder workers??. The reform reduces the probability of being formal in 0.5% and 0.2% for women and men between 56 and 65 years old, respectively. Even though the final pension changes have been positive for both gender, the female pension improvement has been 78% higher than the rise for men reducing importantly the gender inequalities. On the other hand, there are several outcomes of interest that we have analyzed, such as the effect of the reform on the poverty levels or the effect of having an additional child on the labor market participation after the reform.

This document is structured as follows: the next section describes the main elements of the Chilean pension system and explains the 2008 pension reform. Section 3 describes briefly the data used in our empirical strategy presented in section 4. The main results are shown in section 5, followed by the conclusion in section 6.

2 Chilean pension system

The Chilean pension system is referred to as a three tier system because its main Defined Contribution component comes on top of a basic pension and on bottom of a voluntary saving component. The second tier consists of a funded pension benefit to be drawn at retirement from the account accumulated during the working life of an individual up to retirement. Individual accounts are created automatically once the first workers' contributions are made. Formal workers make compulsorily monthly contributions[3] of 10%, which is saved into the individual accounts. These savings are managed by a private PFA, chosen by the worker, which invests the funds in the national and international financial market until the worker decides to retire[4]. FPAs

[3]Even though, the system contributions are monthly based we will use years as the time-period relevant variable. This assumption reduces enormously the computing time required by the estimations.

[4]Since October 2002 workers can choose among 5 funds with different combinations of risk and return. When workers do not choose any fund their savings are invested in a default fund defined by age. The FPAs' investments are regulated in terms of the possible set of financial instrument

charge an additional variable fee of 2%, which is used to cover the administration costs and finance a survivor and disability benefit pension through an insurance company. Workers can move, without additional cost in the practice, from one FPA to another one at any moment. Although the second tier is mandatory for employees, it is voluntary for the self-employed. As a result only a very small fraction, around 5%, of the self-employed contribute to the pension system every month[5]. At the legal age of retirement[6], 65 for men and 60 for women, individuals can withdraw from the labor force and start to receive a pension. Individuals can continue working and contributing in the system after the legal age of retirement. In this sense the legal age of retirement is defined as the minimum age under which welfare pensions could be received. Retirees can choose mainly between two pension modalities, either a scheduled withdrawal scheme, which is payed until funds are running out or an annuity scheme. Regarding the former, the accumulated resources are still managed by the PFAs and invested in the financial market during retirement. The annuities are provided by insurance companies on payment of the individuals capital[7].

The level of the pension, therefore, depends primarily on the amount saved during the life cycle and on the return to those savings. The former is mainly determined by the wage profile and the frequency of contributions observed during the life cycle. Thus, workers with low frequency of contributions do not accumulate enough pension wealth, leading to low pensions. On the other hand, as contributions accrue returns over the life cycle, contributions made during the initial periods of the cycle bear more weight than those made in the periods near retirement. Consequently, individuals that do not participate in the pension system in their early working-periods, such as women in their reproductive years, are more likely to end up with low pensions.

Besides the mandatory second tier, the pension system, before 2008, also had a

to be chosen and on the proportion of foreign investments done.

[5]This in turn results in low pension benefits. Final Report, 2006 Pension Reform Commission. See [1] on the References.

[6]Early retirement is allowed if the worker can finance a pension larger or equal to 150% of the Minimum Pension, described below, and 70% of the last 10 years average wages.

[7]More than 60% of retirees at year 2005 have chosen an annuity scheme. See Mitchell and Ruiz (2009).

dual-component redistributive first tier composed by:

- A contributory minimum pension, "Pension Minima Garantizada" (PMG hereafter).To be eligible for the PMG, the individual should have contributed to the pension system's second tier for at least 240 months and not be able to self-finance the PMG with her accumulated pension contributions. In 2008 the PMG was Ch$ 96,390 (US$ 184). Therefore, individuals with less attachment to the formal labor market, such as women and the less skilled, would be less likely to contribute to the pension system and would, consequently, be less able to fulfill the contribution requirement and obtain the PMG. Less than 37% of women and 67% of men will have pensions above PMG for the period 2020-2025; moreover 61% of women who will not accumulate enough to self-finance a pension higher than PMG will also not satisfy the 240 months requirement needed for receiving it (Berstein 2005).

- A means-tested welfare pension, "Pension Asistencial" (PASIS henceforth). To be eligible for the PASIS the individual had to comply with the means testing embodied in the system and had to have no other pension entitlements. The PASIS is allocated according a poverty indicator and it has been usually given to retirees belonging to the poorest quantile. In 2008 the PASIS was Ch$ 54,091 (US$103) a month, being financed by the government out of general taxation revenues. Since 2006 the used poverty indicator for allocating most of the Chilean welfare subsidies has been the FPS (Ficha de Proteccion Social). This indicator, used for allocating the PASIS and the new welfare pensions implemented by the reform, is determined taking into account a complete set of socioeconomic household's characteristics such as the permanent incomes, household size and its composition, health and years of education among others. This new indicator has allowed to have a better measure of the long term household vulnerabilities.

Finally, the third system's tier comes on top of the compulsory DC component as a voluntary saving complement. Workers can save additional resources into their individual accounts in order to increase their self-financed pensions. Voluntary sav-

ings are excluded from taxable income[8] (ETT), being all taxes paid at retirement, and from the self-financed pension wealth used to determine the eligibility for the welfare first tier pensions.

2.1 General description of the 2008 reform.

The 2008 reform modified and replaced completely the redistributive (first) tier by introducing two new components. First, a flat welfare pension (PBS hereafter) intended to alleviate poverty for those not entitled to a second pillar benefit. Second, a welfare pension complement (APS hereafter), intended to sustain consumption by topping-up the funded second tier pension.

There are several elements of the reform aimed at fostering not only participation in the contributory and voluntary pillar, but also at encouraging continuity of contributions. These elements are targeted to groups with historically low attachment to the labor market, so as to encourage them to participate in the pension system. Women, young workers and the self employed were the explicit target of these incentives. For women, contributions to the pension system are subsidized for each child they have; there is now a pension saving compensation upon divorce in favour of the worst off member of the couple and women will have to provide pension funds to leave a survivor pension benefit to her husband. As for young workers, they get a subsidy both to their wage, through the employer, and to their contributions. The reform allows the self-employed to be eligible for the benefits in the first tier and obliges them to participate in the pension system[9]. Lastly, new voluntary occupational saving plans and new tax exemption schemes are introduced in the third tier.

[8] For monthly amounts below to $Ch 1050000 (US$ 2000).

[9] From 2012 to 2014 self-employed participate voluntarily in the system, but they have to explicitly opt out to avoid participation. From 2015 participation is compulsory and contributions will be done over 80% of gross earnings. Table A2 in the Appendix summarizes the main features of reform to the contributory pillar.

2.2 Components of the reform to be evaluated.

2.2.1 The first tier redistributive pensions.

Probably the largest change introduced by the 2008 reform is the reform to the first tier system, trough the new PBS and the APS.

- The PBS welfare pension was started on 1^{st} July 2008 and intends to alleviate poverty among those not entitled to the second tier of the system. It is means tested using a poverty indicator FPS targeted to the 40% poorest of the population older than 65 years old. The coverage will be gradually increased each year until 2012 when it will have reached the poorest 60% of the elderly population. The PBS is a flat non-contributory pension set at Ch$60000 for 2008 and increasing to Ch$75000 from 2009. This new welfare pension could be understand as the minimum floor income that any older than 65 years old retiree, who belong to 60% poorest population, will receive. The reform eliminates the number of contributions as one of the eligibility conditions for getting a minimum pension.

- The APS welfare pension complement, also starting on 1^{st} July 2008, intends to sustain consumption by topping-up the funded second tier pensions between the PBS and a maximum funded pension, PMAS, which will be increased gradually[10] until it reaches the value of Ch$255000 in 2012. The APS is decreasing in the funded pension and will not have, in the same way than the PBS, a minimum contribution-periods condition. It is defined as APS=(PBS-$\frac{PBS}{PMAS}$*PB), where PB is the sum of the funded second tier pension plus any received survivor pension and any pension received from the past PAYG system.

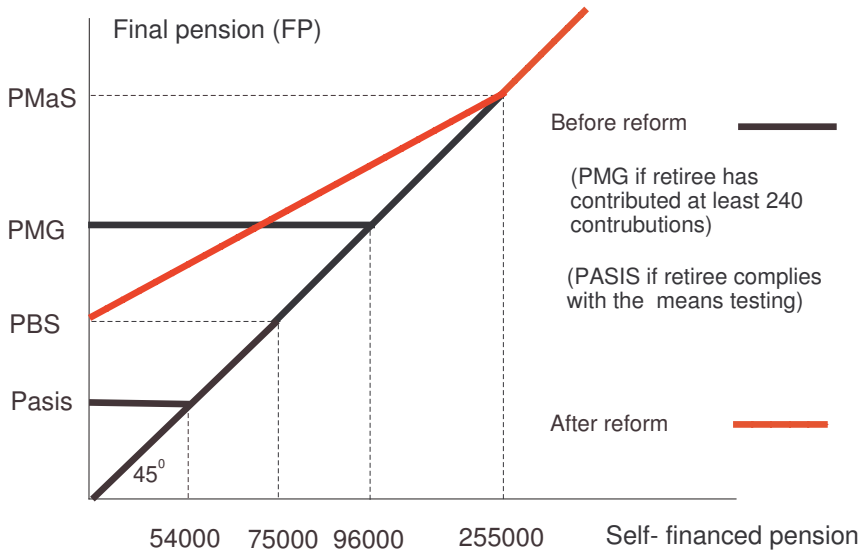
These two new welfare pensions come to replace the PMG and PASIS pensions described before, therefore changing completely the first tier of the system. The changes introduced by the reform are illustrated in Figure 1. Before the reform, retirees at the bottom of the distribution (of second tier pension benefits) could be divided into three groups: (i) those who received their funded pension (the 45

[10]The main features of the two new components of the redistributive tier are summarized in the tables at the end of section C in the Appendix.

degree line in Figure 1); (ii) those who received the PMG, (which was the case if the funded second tier pension was lower than the PMG and the 240 months of contributions requirement was satisfied); (iii) those who received the PASIS pension (if the funded second tier pension is lower than PASIS and the retiree satisfies the means testing). After the reform, the third group of retirees, receiving a PASIS before the reform, now get a PBS, because of the weaker means testing criteria. The first group mentioned above (those receiving a pension lower than the PMG because they did not satisfy the contributory requirement) are receiving a higher level of pension, as indicated by the red line in Figure 1. Of those receiving the PMG before the reform, however, some will receive a higher and some a lower pension[11]. The latter group is constituted by those who satisfied the 240 months contribution requirement and had not enough entitlements in the second tier to self-finance a final pension of CH$75,000: under the new system, the PBS, while higher than their self-financed pension is below the PMG.

Figure 1

Pre and Post Reform First Tier



[11] Workers older then 50 years old in 2008 will receive the higher pension, either the PMG or the post reform pension.

2.2.2 Additional components of the reform.

In addition to the first tier, the 2008 reform also introduced a number of other elements that will be evaluated. The main items are the following.

- A subsidy for every child ever born to the mother (implemented since 1^{st} July 2009). Every woman older than 65 years old who is affiliated to the system receives a subsidy of 1.8 times the minimum wage existing at the time of birth of every child[12]. Subsidies earn returns since the date of birth of the child until the date of retirement or from July 2009 until retirement in cases when children were born before this date. This specific element of the reform is designed to compensate women for their lower frequency of contributions due to their childbearing periods, reducing gender inequality in pensions.

- Around 2% percent of the individual mandatory monthly contribution is used for financing a survivor and disability insurance for each affiliate. Even though the risks of death and illness have been historically lower for women than men, the system has not recognized this fact charging a common premium rate. Since 1^{st} July 2009 the reform introduced a mechanism which intends to recognize gender differences in longevity and disability risk. The premium rate for the survivor and disability insurance is determined by an auction mechanism where all FPAs bid for managing the insurance. FPAs could offer different rates for men and women recognizing the difference on their risks. Both groups will be charged with the higher offered rate but the difference will be incorporated in the women individual accounts as part of their contribution.

- Before 1^{st} October 2008 survivor pensions were received just by wives, this has been changed by the reform incorporating a survivor pension benefit to the husband as well. On the other hand, the reform introduced a possible compensation upon divorce in favour of the worst off member of the couple. Compensation is determined by family courts as a fraction (up to the half) of the accumulated resources of the best off member.

[12] In 2009, it was equivalent to Ch$ 286200.

2.3 Other components introduced by the reform.

There are several other elements incorporated in the 2008 reform which we are not evaluating. These components target different groups, such as young employees and the self-employed, start on different dates (some of them are not even active yet) and include some general modification to the whole system, such as the elimination of the fixed fee charged by the PFAs and a new auction mechanism under which PFAs compete for administrating the funds of the new affiliates. A partial list is the following

- Self-employed contributions. From the 1^{st} of January 2012, the self-employed are incorporated gradually into the mandatory system. They will be eligible for the first tier benefits, but they must contribute annually according to 80% of their gross earnings[13].

- Subsidy for young people contributions. From the $1^{st}$of July 2011, employees between 18 and 35 years old who earn a salary below 1.5 times the minimum wage receive a subsidy for all their first 24 contributions. The subsidy will be equal to 5% of the minimum wage at the period in which the contribution is done. This subsidy is deposited into their individual accounts as part of their pension wealth. Considering that this new element and the previous one will start to be effective since 2011 and 2012 respectively, we do not expect a current effect on the labor market due to them.

- Subsidy for hiring young people. From the 1^{st} of October 2008, employers receive a monthly subsidy. As in the previous case, the subsidy is equal to 5% of the minimum wage, when they hire young workers between 18 and 35 years old who are doing any of their first 24 contributions and earning a salary lower than 1.5 times the minimum wage at that point in time[14].

[13]From 2012 to 2014 a default-voluntary participation is introduced, where workers have to explicitly decide not to participate in the system. For the years 2012 and 2013 contributions will be done considering the 32% and 56% of annual salary, respectively. After 2015 the participation is compulsory and contributions are done over the 80% of annual salary from 2014 onwards.

[14]Two additional programs, Subsidio al Empleo Juvenil and Jovenes Bicentenario, focused on the young workers (18-24 years old) were implemented around the same time of the reform imple-

- Subsidy for voluntary contributions. From the $1^{st}$of October 2008, the third tier of the system is subsided for workers who choose the new tax form (TTE) introduced for voluntary savings. In this case, employees pay taxes for the amount saved at the moment of doing them and pay taxes for the earned returns at retirement. Before the reform, voluntary savings were excluded from taxable income (ETT) and all taxes were paid at retirement. Those workers choosing the first tax scheme option will receive a subsidy equal to the 15% of all saved amount[15]. On September 2010 the number of voluntary contributions operating with this new tax regime was 7% of the total voluntary number of contributions[16].

- Occupational voluntary saving plans. From the 1^{st} of October 2008, employers are allowed to set up collective voluntary saving plans for their employees in which they can define joint contributions. Employers have tax incentives for contributing in their employees accounts, as those contributions are considered as company's expenditures and then do not pay taxes. Employees will not only get the subsidy given by the employer but also can get all the available benefits for voluntary savings described above. Even though this element has been operating since two years ago, the number of collective voluntary saving plans has been minor according the regulator information. Therefore, we do not expect any important effect on the labor market due to this element.

- Fixed fee elimination. From the 1^{st} of October 2008, the FPA fixed fees, charged before the reform for managing the individual accounts, are abolished.

- New affiliates auction. From the 1^{st} of October 2008, new affiliates to the system are allocated to the winner FPA of an auction for the new affiliates portfolio. Affiliates can choose another FPA after 24 months of the original auction. This new mechanism aims to generate more competition in the system

mentation. Even though there are not currently official data about the benefits and beneficiaries of these programs, we know that the benefits have been larger than those proposed by the reform.

[15]With a maximum of Ch$ 221178 at 2009. This value will be updated each year according the inflation.

[16]Superintendencia de Pensiones de Chile.

reducing the charged fees.

3 Data

In evaluating the pension reform, we will use two sources of data that will complement each other: the Social Protection Survey (Encuesta de Protección Social, EPS) and the Pension System Administrative Records. The EPS is a nation-wide survey containing a rich set of information about Chilean households and their participation in the labor market and the social security system[17]. It was initiated on 2002 and followed-up in years 2004, 2006 and 2009, which allows to us to have data before and after the reform. In particular, we will use the information on job and contribution histories and the usual range of socio-demographic individual characteristics. In addition, the EPS survey can be linked with a wide range of administrative files covering contribution and benefits patterns. These Pension System Administrative Records provide us with monthly earnings, contributions, fees paid and accumulated pension savings for all years previous to 2005[18].

As we aim to see the effects of the reform on the labor market participation before retirement[19], we only use information about non retired AFPs affiliates who are younger than 65 and older than 20 in all the EPS waves.

As we explained before, the two new elements of the first tier are means tested and will be targeted to the 60% poorest 65+ years old population. This target group will be defined by the poverty indicator FPS (Ficha de Protection Social, FPS) defined previously. To evaluate the redistributive elements of the pension

[17] See Arenas et al. (2006) for a complete description about the aims and the relevance of the EPS.

[18] As we just observe administrative records until 2005 we need to forecast the accumulated resources onwards. In doing that we not only predict a set of variables such as the future wages and the contribution profile but also assume certain parameters suchas returns earned. Having the Administrative Records information for all years until 2009 allow us to reduce the amount of assumptions, increasing the efficiency of our estimations. For example, observing the complete pension wealth history give us information about the heterogenus returns obtained by each affiliate.

[19] As we mentioned earlier, it is possible to continue working after the legal age of retirement. However, we are not considering those individuals who continued working after 65 and, for simplicity, in some of the computations we perform we will assume that all employees retire at the age of 65 in the post-reform scenario.

reform we will need to identify the individuals in the EPS that belong to the eligible group at retirement. As we do not have yet information about the FPS for the EPS interviews, we will use in the meanwhile the percapita household income computed using the all self-reported incomes in the survey. Even though, the EPS contains detailed information about different household income sources, which allows us to compute a precise measure for the percapita household income, the welfare pension alllocation according this indicator will likely differ from the one using the FPS[20].

4 Methodology

In this section, we describe the methodology we will be using in our study to estimate the impact of the 2008 reform on a variety of outcomes. We start this section listing, in the next subsection, the outcomes in which we are interested.

4.1 Outcomes of interest.

As the reform affects differently individuals in different periods across the life cycle, the short and long run effects of the reform will differ. This happens mainly because the reform targets groups in different periods of their life cycle, such as women in their fertility periods and young employees, and because younger cohorts have more time to react optimally to the incentives introduced by the reform. We will compute the effects of the reform over the different outcomes listed below, showing their change before and after the reform for different cohorts. In order to asses the long run effects of the reform and the effects for the younger cohorts, we need to forecast a set of variables, such as the future wages and contributions, which allow us to compute these outcomes of interest. We describe these forecasts in the what follows. Before doing that, we list here the outcomes that we will be studying. We will estimate the following impacts of the pension reform:

1. Changes in the distribution of pensions resulting from the reform.

2. Changes in the distribution of the pension difference between men and women.

[20]See Appendix D for a detailed discussion.

3. Changes in the accumulated pension wealth before and after the reform.

4. Changes in poverty levels before and after the reform for elderly people, in particular, for elderly women.

5. Changes in the probability to contribute and changes in the frequency of contributions.

6. Changes in the coverage of the system measured as the number of women that contribute to the system over the employees and over the economically active people.

7. Changes in male and female formal labor market participation.

8. Effects of having a child on the labor market participation before and after the reform.

4.2 Empirical Strategy.

The nature of the pension system available to an individual is likely to affect his or her labor market participation decisions. In its simplest form, the life-cycle model predicts that the expected future income affects the incentives to participate in the labor market and thus to contribute to the pension system. Indeed, it seems that some of the changes introduced by the 2008 reform were motivated by the perceived need to change the incentives to participate into the formal labor market. For example, while before the reform poor informal workers had little incentives to contribute (as were not likely to meet the 240 contributions and then not likely to be eligible for a PMG), they would now be actually encouraged to participate if they are likely to self-finance a pension above the PBS, so they would get the APS. On the other hand, if the self-financed pension is likely to be below the PBS, the individual could be deterred from contributing as he would be entitled to the PBS in any case.

In estimating the effect of the pension reform, we will need to compute expected pension wealth at time t for each individual upon retirement. In doing so, we will need to estimate the future patterns of contributions to the pension systems and

wage profiles. With this in hand we will then use our detailed knowledge of the pension benefits formulas to compute expected pension wealth. The model can be written as

$$Y_{it} = 1[Y_{it}^* > 0] \tag{1}$$

$$Y_{it}^* = X_{it}\gamma + \beta E_t PW_{iR} + \delta E_t AR_{iR} + \tau_t + \alpha_i + \epsilon_{it} \tag{2}$$

where Y_{it} is the discrete labor supply taking the value of 1 if individual i is working in the formal sector[21] at year t and 0 otherwise, X_{it} is a vector of controls including usual socioeconomic and demographic variables, $\mathrm{E}_t\mathrm{PW}_{iR}$ is the expected (at time t) pension wealth at retirement (R), $E_t AR_{iR}$ is the expected accrual rate at retirement of working the current year t, i.e. the pension benefits accruing due to work in this period; while pension wealth can have a negative effect on current work, the accrual rate is expected to act positively as it reflects the incentive structure of pensions. The accrual rate as well as pension wealth were affected by the 2008 reform. Finally, τ and α represents time and group effects, respectively. Thus, the parameters of interest are β and δ which represent the effect of the change in pension wealth and the accrual rate due to the reform on the labor market participation. The methodological problems are reflected into the fact that pension wealth PW ant the accrual rate AR[22] will be correlated with the residual term $\alpha_i + \epsilon_{it}$. If this endogeneity is not taken care of, the estimates of β, δ and all the other parameters in equation (2) will be inconsistent. To overcome this problem, we will instrument with time dummies interacted with group dummies, which will be defined to capture systematic differences in pension wealth and accrual rate. In other words, we will use a version of the "difference in differences" approach, whose key assumption is

[21] We define formality according participation in the pension system. We consider an employee as working in the formal sector at period t if she is contributing in the pension system at year t. All workers having a contract must contribute compulsory in the system. Then our definition of formality is wider than that one based in having a contract. As self-employed contribute voluntary in the pension system, we have an important fraction of them considered as informal workers.

[22] The accrual rate depends on the expected pension wealth at retirement as it will determine the final retiree's pension and then any change of an extra year working.

that the overall trends in the outcome variables of the different groups are the same, once the outcomes have been scaled appropriately.

As mentioned earlier, the reform's eligibility conditions, such as being poor, young or female, will allow us to define groups for whom the change in the expected self-financed pension wealth at retirement, E_tPW_{iR} , or the expected pension, $\mathrm{E}_t\mathrm{P}_{iR}$, due to the reform differs. The reform changes the expected accumulated wealth, through the different subsidies attempting to increase the contributions to the system, and also changes final pensions, through the new first tier. The final pension wealth differs of the self-financed pension wealth because the former considers the implicitly accumulated resources that are needed to finance a pension taking into account the welfare pension that eventually a retiree will receive. Before the reform, workers who did not have enough pension wealth to self-finance a pension above the PMG, but satisfy the contributory requirements such as they qualify for a PMG, have implicitly a final pension wealth equivalent to the one to self-finance a PMG. In this sense, as the reform changed the system's first tier, the expected pension wealth at retirement not only changed as a result of the new subsidies operating during the accumulation periods but also as a result of the changes in the welfare pensions. Therefore, both measures, the expected pension wealth, E_tPW_{iR}, and expected pension, $\mathrm{E}_t\mathrm{P}_{iR}$, could be used as relevant pension system's outcomes. However, working with the former one allow us to avoid to deal with the pension modality choice that workers must do at retirement. We will use the interaction of group dummies with time dummies as instruments for PW variation in equation (2). In this manner we will take care of unobserved heterogeneity and thus will be able to identify the causal effect of the pension reform on labor market participation (and other outcomes).

Thus, one crucial aspect of our methodology is the computation of E_tPW_{iR} and E_tAR_{iR} at each period t. As we have said before, pension wealth depends mainly on the life-cycle wage profile, labor market participation and the various components of the pension system in place. The entire analysis is based on the assumption that individuals expect the system to be permanent.

4.2.1 Estimation.

We propose the following estimation strategy. First we will construct expected pension wealth and accrual rates, based on the observable history of the individual and on forecasts of their future labor market paths. However, these measures are endogenous because they are based on past, current and future history, which is correlated with the unobserved individual characteristics. Hence we propose to regress these measures on interactions of cohort, gender and time dummies and use the predicted residuals as an new regressor in equation (2)[23]. The instruments capture the differential way that individuals will be affected by the reform for the exogenous reason of when they were born and because of their gender. One important difficulty in calculating pension wealth is that future labor supply will change as well as current one, as a result of the reform. In order to capture this relationship completely a fully specified dynamic model should be used. Here we will have to experiment with alternative scenarios about the probabilities to contribute for the unobserved future periods.

To capture permanent differences across cohorts and gender as well as secular trends we also include in the equation cohort dummies, gender dummy and time dummies. Thus the effect of pension wealth and accrual rates is captured purely by the differential impact that the reform has had on accrual rates and pension wealth. The model is discrete and hence we must either use semi-parametric methods or estimate the model using a logit/probit; this assumes that the pension wealth, the accrual rate and participation are jointly logistic/normal conditional on the remaining observables.

4.2.2 Forecasting pension wealth: wages and labor supply.

Using the EPS, we will estimate equations for labor market participation, sector choice (formal/informal) and wages. These allow us to forecast for each individual the earnings in future periods in which we do not observe data. At each period t individual i decides to work $H_{it} = 1$ or not to work $H_{it} = 0$. Workers could choose

[23] We report the results obtained using the standar IV approachas well, i.e using forecasted values for the endogenous variables in the main equation.

between the formal $F_{it} = 1$ and the informal labor market sector $F_{it} = 0$, receiving after tax wages $w_{it}^{F=1}$ and $w_{it}^{F=0}$, respectively. We estimate the following 4 equation system by maximum likelihood

$$H_{it} = 1[H_{it}^* = \gamma_1 X_{it} + \gamma_2 Z_{it} + \gamma_3 Q_{it} + \eta_i + \xi_{it} > 0] \tag{3}$$

$$F_{it} = 1[F_{it}^* = \gamma_4 Z_{it} + \gamma_4 Q_{it} + \alpha_1 \eta_i + \epsilon_{it} > 0] \tag{4}$$

$$ln(w_{it}^{F=1}) = \gamma_5 Q_{it} + \alpha_2 \eta_i + \nu_{it} \tag{5}$$

$$ln(w_{it}^{F=0}) = \gamma_6 Q_{it} + \alpha_3 \eta_i + \upsilon_{it} \tag{6}$$

Where ξ_{it} and ϵ_{it} are distributed $N(0,1)$, ν_{it} and υ_{it} are iid shocks distributed according $N(\mu, \Sigma)$ and η_i is a common unobservable heterogeneity distributed according $N(\mu_\eta, \sigma_\eta^2)$. Including η as an outcome of the estimation process allow us to control for different preferences across the population. Employees choose to work in the formal sector according the relative wages, benefits and preferences for each sector. Employees with high risk aversion could prefer to work in the formal sector as they will get the social security net. However, working in the informal sector could be associated with more flexibility, which could be valued for certain type of workers. We estimate the system by maximum likelihood[24] using just two points on the domain of η, which are estimated jointly with their associated probabilities (Laird (1978); Lindsay (1983); Heckman and Singer (1984)). Results are used

[24]The log likelihood function could be written as

$$L(\gamma; X, Z, Q, R) = \sum_i ln \int_\eta \prod_t [\{[\phi(\frac{\log w_{it}^F - \gamma_3 Q_{it} - \alpha_2 \eta_i}{\sigma_\nu}) \Phi(\gamma_2 Z_{it} + \alpha_1 \eta_i)]^F \times$$

$$\times [\phi(\frac{\log w_{it}^I - \gamma_4 R_{it} - \alpha_3 \eta_i}{\sigma_\upsilon}) \Phi(-\gamma_2 Z_{it} - \alpha_1 \eta_i)]^{1-F} \Phi(\gamma_4 R_{it} + \eta_i)^{P)} \times \}$$

$$\times [\Phi(-\gamma_4 R_{it} - \eta_i)]^{1-P}] dF(\eta)$$

for forecasting individual wages on the future periods, allowing us to compute the expected accumulated resources at retirement.

The equation system estimations are reported in Table 1 and 2. The results for the formal and informal wages profiles, showed in the first and second column respectively, follow the same tendency typically found in the literature. The wages increase throughout the life cycle with a decreasing rate, male workers earn higher wages than women and the more educated is the employee the higher is the wage. Column 3 shows the estimated parameters for the participation in the formal labor market. The probability to participate in the formal sector is highly explained by the educational level, having a degree is one of the main variables explaining formality. The results for the participation in labor market are displayed in the last column. As we mentioned before, women participate less in the labor market than men. Moreover, the gender difference is even bigger when we consider married women and women with children [25].

[25] We included interactive variables between the number of children and sex.

TABLE 1 **Maximum Likelihood System Estimation**

VARIABLES	(1) Wage Formal	(2) Wage Informal	(3) Formal=1	(4) Participation=1
Sex (1=Men)	0.316***	0.429***	-0.193***	0.253***
	(0.00676)	(0.0277)	(0.0319)	(0.0224)
Age	0.0305***	0.0415**	-0.000344	0.130***
	(0.00436)	(0.0184)	(0.0109)	(0.00727)
Age 2	-0.000317***	-0.000555***	0.000111	-0.00147***
	(5.21e-05)	(0.000210)	(0.000132)	(8.55e-05)
Primary (1=Yes)	0.312***	0.430***	0.244***	0.229***
	(0.0110)	(0.0340)	(0.0243)	(0.0159)
Secondary (1=Yes)	0.509***	0.641***	0.384***	0.373***
	(0.0119)	(0.0419)	(0.0270)	(0.0186)
Degree(1=Yes)	1.019***	1.016***	0.615***	0.361***
	(0.0116)	(0.0482)	(0.0280)	(0.0189)
Married (1=Yes)			0.00553	-0.349***
			(0.0305)	(0.0195)
Sex*Married			0.125***	0.765***
			(0.0377)	(0.0286)
Num. Children 0-3 years			0.0965***	-0.174***
			(0.0215)	(0.0194)
Num. Children 4-5 years			0.0101	-0.0766***
			(0.0257)	(0.0239)
Num. Children 6-13 years			-0.0236**	-0.0997***
			(0.0118)	(0.0103)
Num. Children 14-18 years			-0.0409***	-0.0305**
			(0.0142)	(0.0122)
Constant	24.28***	12.51***	6.659***	
	(0.891)	(0.421)	(0.536)	
Observations	78036	78036	78036	78036

Standard errors in parenthe Dummies year and cohort are included in the estimations.

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

The next table shows the estimations for the common unobservable heterogeneity η, for two points of domain η_1 and η_2 with probability ϕ and 1-ϕ, respectively[26]. The higher the value for the individual unobservable heterogeneity, the higher the probability to participate in the formal labor market sector. The results could be interpreted as the existence of two groups within the population. The first group, around 30% of the population ($\phi = 0.315$), has lower preferences for the formal labor market ($\eta_1 = -3.309$) and the second group, around 70% of the population, has higher preferences for working formally (η_2= -2.062). The variances for the time varying shocks, ν_{it} and υ_{it}, are estimated jointly, $\sigma^{F=1}$ and $\sigma^{F=0}$, with the system[27]. Both shocks have similar volatility as the results indicate.

TABLE 2 **Modelling Heterogeneity**

Variables	Coefficients	Standard Dev.
Σ		
$\sigma^{F=1}$	-0.435^{***}	0.00353
$\sigma^{F=0}$	0.423^{***}	0.00617
ρ	Assumed 0	
Heterogeneity		
η_1	-3.309^{***}	0.16400
η_2	-2.062^{***}	0.16400
ϕ	0.315^{***}	0.00447
Coefficients equation		
α_1	2.903^{***}	0.0492
α_2	5.303^{***}	0.0858
α_3	0.129^{***}	0.0230
*** p<0.001	** p<0.005	* p<0.1

[26]This is similar to assume that η is distributed discretely.

[27]We are assuming that both shocks are independently between them. i.e. $\rho = 0$.

4.2.3 Child Subsidy.

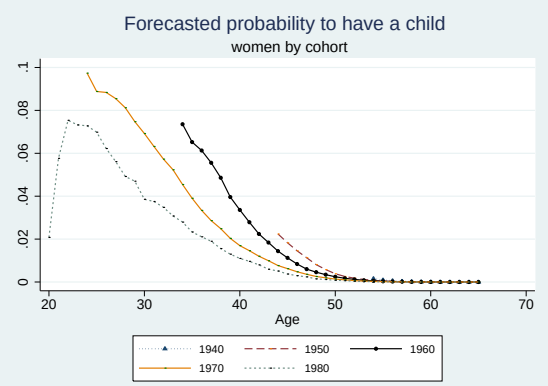
As the reformed system includes a subsidy for every mother, we need to model how many children a woman will have during her life. We do this by estimating a simple discrete choice model for the probability of having a child in period t, conditional on having C children in $t-1$, age, education E and marital status M[28].

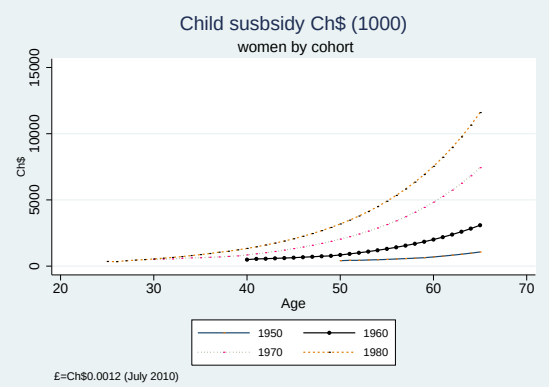
$$P(\Delta C_{it} = 1 | C_{it-1}, age_{it}, M_{it}, E_i) = \Phi(X_{it}\beta) \tag{7}$$

We estimate the equation 7 by maximum likelihood assuming random effects. The results are shown in the Appendix (Table A1, section A.1). As it is expected, individuals who are married have a higher probability of having a child than those who are single and individuals who have more years of education have a lower probability of having a child. Using these estimations we forecasted for each individual the probability to have a child conditional on the set of used regressors. The next left-hand side figure below shows for each cohort the average forecasted probability of having a child at each age.

With these results on hand we then impute to each individual-period a child if a randomly generated number falls within the prediction of the above equation. As we have now the complete fertility profile for each worker, we are able to compute the subsidy that every women will receive at retirement for each born child. The right-side figure shows the average subsidy for each cohort. The subsidy for each child is equal to 1.8 times the minimum wage existing at the time of birth of the child.[29] Subsidies earn returns since the date of birth of the child until the date of retirement or from July 2009 until retirement in cases when children were born before this date. Therefore, younger cohorts get higher amounts as subsidy because, instead of probably having fewer children than the older cohorts, they will earn returns during more periods. The average child subsidy at retirement for the cohort born in the 60's will be Ch$ 3076090, which represents around 9% of the total expected (at year 2010) accumulated resources at retirement [30].

[28] We assume that individuals expect the same number of children following the reform.
[29] In 2009, it was equivalent to Ch$ 286200. We assumed an annual rate of growth of 3%.
[30] Including all the elements introduced by the reform detailed in section 2.2.1 and 2.2.2.





4.2.4 Compensation upon divorce.

Expected benefits received as compensation upon divorce should be included in the expected pension wealth computations. To achieve this we need to compute the probability of divorce and the expected compensation amounts decided upon by family courts. We will then impute to each individual-period a forecasted expected compensation amount.

We observe the individual's marriage date and the marital status in the three last waves of EPS. With this information we estimate the probability of divorce using a proportional hazard model. The probability of divorce for individual i in period $j = \{[2004-2006], [2006-2009]\}$ is modeled as a function of a set of socio-economic and demographic variables, which includes the age, sex, education E, number of children C, years of marriage YM and dummy variables controlling for cohort effects Dc. The hazard rate function, denoted by h(j), or the instantaneous failure rate at time t could be written as:

$$h(j) = h_o(j)exp(\alpha_1 age_j + \alpha_2 sex + \alpha_3 E_j + \alpha_4 C_j + \alpha_5 YM_j + \alpha_6 Dc) \qquad (8)$$

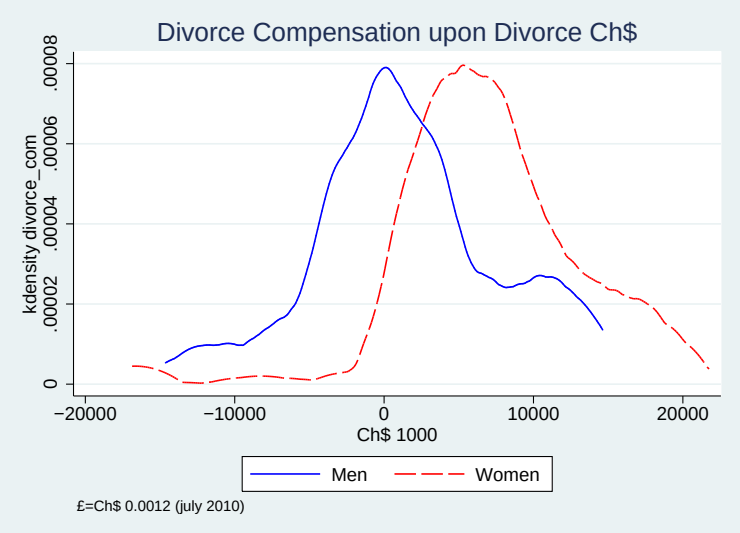
Table A3 in the Appendix, section A.2, has the results for the hazard ratios from a proportional Cox model estimation. The probability of divorce conditional on being married decreases with the age but increases with the number of years of marriage. The proportion of divorced individuals varies positively with the educational level. For example, for those who have finished a degree the probability of divorce is 36%

higher than for those who have not finished the primary school.

We need to estimate the probability to get married in order to be able to forecast the unconditional probability of divorce that a single individual will face in each future period. The probability to get married is estimated using a proportional hazard model in the same way that the probability of divorce[31].

The last two waves of the EPS contain information on the partners' contribution patterns. Specifically, the surveys include two questions which allow us to figure out which individual within the couple could be considered as the worse off member upon divorce (See Appendix section A.2 for a detailed explanation.). Combining this information with the unconditionally forecasted probability of divorce, the affiliates' accumulated pension wealth at each period and assuming a compensation fraction equal to 30% of the partner pension wealth, we then imputed for each affiliate an expected compensation in case of divorce[32].

The figure below displays the simulated compensation upon divorce by sex.



[31] The results are shown in the Appendix (Table A2, section A.2).

[32] In the same way that we did it with the child subsidy, we are assuming here that the reform does not change the expected probability of divorce. Individuals compute their expectations about the probability of being married without talking into account the incentives introduced by the reform. This simplifies enormously our computations and avoids us dealing, through an additional model, with the potential effects of the reform on the marital status.

4.2.5 Survivor pension.

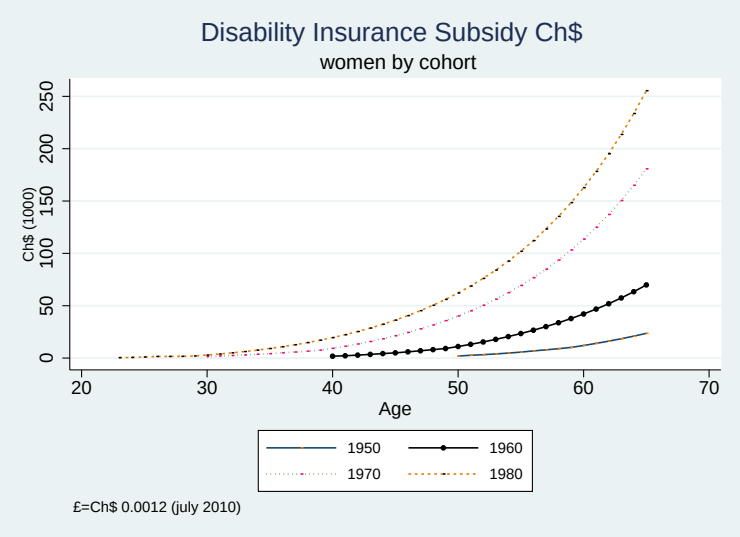
Before 2008 only the wives had the right to receive a survivor pension. However, the reform introduced a survivor pension for the husband in case his wife passes away. When workers chose the annuity modality as a pension they exchange with an insurance company their accumulated resources for a fixed pension upon retirement. In this bargaining process the insurance companies take into account the risk of death of the pensioner's partner. Thus, it is plausible to expect a decrease in the female annuity values as the expected cost for the insurance companies has risen, because they should eventually pay a survivor pension. To asses the extent of this new element and its impact on the final pensions we simulated annuities for women considering both scenarios, financing eventually a survivor pension and not [33]. The figures below show how the female self-financed pension moved slightly to the left if we consider this new element.

4.2.6 Disability Insurance.

Men and women pay the same premium rate for a compulsory disability insurance before the reform. Around 2 % of the monthly contributions was used to finance the

[33] Given we are forecasting the marital status at retirement, as we previously explained in section 4.2.4, we do not observe the partner's age. We are assuming that men are two years older than women. For a detailed description of the pension computations see the Appendix, section C.

insurance. An auction mechanism was incorporated with the reform, in which all the FPAs must bid a gender dependent premium rate. The difference between the male and female premium rate is transferred each period into the women' individual accounts earning returns upon retirement. We are assuming that observed average premium rate difference will be equal to 0.002 in any future period (Reyes, 2009). The next figure shows the simulated average disability insurance subsidy by cohorts. Younger cohorts will get a higher subsidy because they will receive the monthly subsidy during more periods earning at the same time the associated returns until retirement.



Finally, after assessing the value of all subsidies and incorporating all mechanisms introduced by the reform and listed in section 2.2.2, we computed both the expected accumulated pension wealth and accrual rate at retirement for periods $t = \{2002, .., 2009\}$[34]. We use the administrative records, which contain disaggregated information about the accumulated pension wealth for all years previous to 2005, and the EPS, which has information about contributions between 2005 and 2009. Future contributions were simulated using the predicted wages and frequency of contributions trough our estimated system explained in section 4.2.2. We finish incorporating the simulated child subsidy, compensation upon divorce, survivor

[34]A detailed description of the formulas used to compute the accumulated pension wealth and pension is in the Appendix, section C.

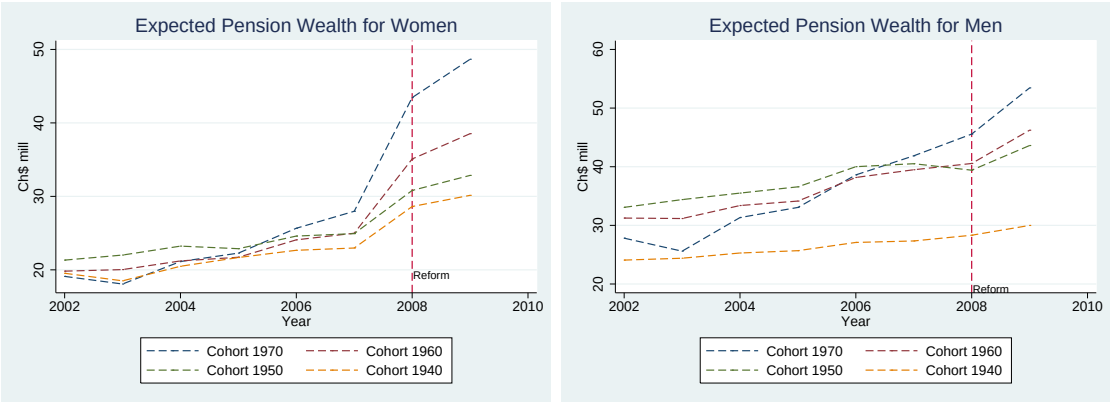
pension reform and the disability insurance compensation. The next section shows the results for the expected pension wealth at retirement, the accrual rate and the main equation results.

5 Results

5.1 Pension wealth and accrual rate.

The main goals of the reform were to guarantee a minimum and stable level of consumption upon retirement, preventing old-age poverty and reducing gender inequalities. In order to comply these goals two types of mechanisms were mainly introduced by the reform: Firstly, a set of different subsidies throughout the labor life cycle, such as the child subsidy, the divorce compensation and the disability insurance compensation. They change the individual pension wealth during the working life allowing to self-finance a higher pension at retirement. Secondly, the changes introduced to the welfare pensions, such as the PBS and the APS. They change implicitly the expected pension wealth that workers perceive to have. Before the reform, workers who did not have enough pension wealth to self-finance a pension above the PMG, but satisfy the contributory requirements such as they obtain a PMG, have implicitly a pension wealth equivalent to the one to self-finance a PMG. In this sense, as the reform changed the system's first tier, the expected pension wealth at retirement not only has changed as a result of the new subsidies operating during the accumulation periods but also as a result of the changes in the welfare pensions.

The next two figures show, considering all the elements of the reform listed in section 2.2.1 and 2.2.2, the expected (at year t) pension wealth at retirement by gender and cohort. There are differences not only in the level of the cohorts' pension wealth but also in its rate of growth. Particularly, the change of the $E_t PW_{iR}$ in 2008, the year of the reform, differs importantly by cohort and sex. Younger cohorts have more time to react optimally to the reform and several mechanisms were introduced having themselves and the women as specific targets.



There are mainly two things that could be explaining the PW change in 2008. First, the pension reform itself, and second, the financial crisis that happened around the same time[35]. As we explained before, workers can invest their accumulated resources in funds with different combinations of risk and return. Nevertheless, in case they do not show explicitly any preference for a particular fund, the accumulated resources are invested automatically in a default fund. The default funds have a particular combination of risk and return which varies according the age. Since 2004 onwards only a 40% of the workers have chosen explicitly their funds (Superintendencia de Pensiones), we can expect that the observed decline of the pension funds' value[36] during the crisis had been differently across cohorts, compensating the increment due to the reform.

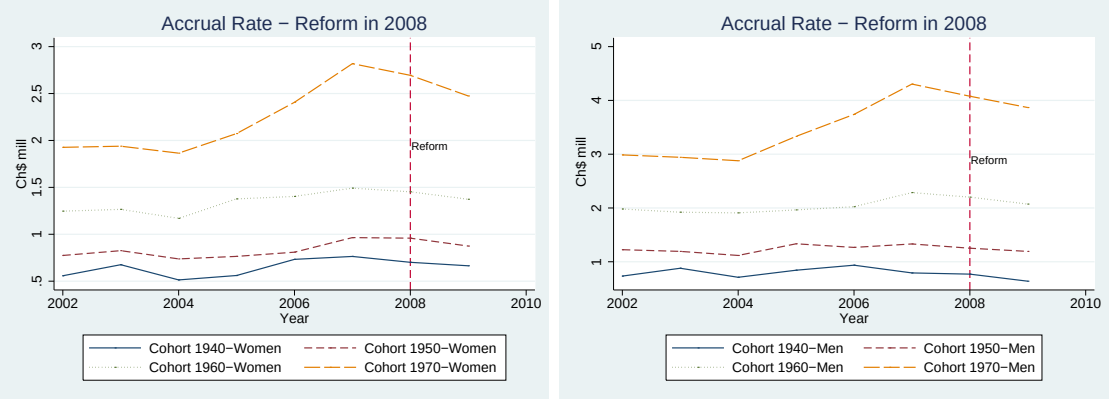
The accrual rate, defined as the extra expected pension wealth that a worker obtains if she works an additional year, will be different before and after the reform depending of the final self-financed pension. From Figure 1 in section 2.2.1, we can identify different groups, pre and post reform, with different accrual rates. For example, for those individuals receiving either the PMG or the PASIS, the implicitly extra pension wealth that they will accumulate for working an extra year will be zero [37]. After the reform, these workers started to receive the PBS plus the APS. Then,

[35] See Hurd and Rohwedder (2010).

[36] The pension system's funds lost in average around 15% of their value (Superintendencia de Pensiones).

[37] There are some workers in the margin that will not receive the PMG (PASIS) at retirement once they have worked an extra year. The extra accumulated pension wealth for working one more year allows them self-finance a pension above the PMG (PASIS) and then the accrual rate will be positive. There are several other cases of workers in different margins, such as those receiving a

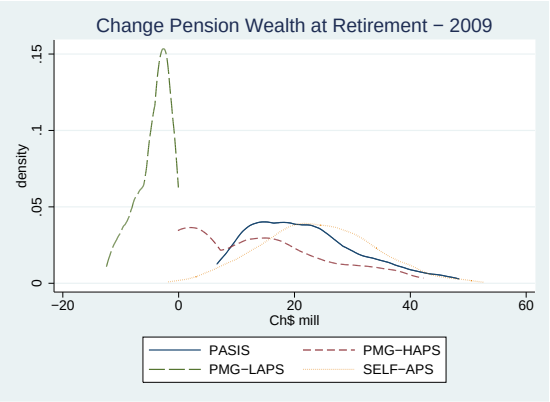
for any additional worked year, and consequently for any extra pound accumulated as pension wealth, the worker will receive at retirement a higher pension which means a positive accrual rate. The next figures show the expected (at year t) accrual rate at retirement of working the current year t. Considering that contributions earn returns since they were made until retirement, an extra worked year at early ages will increase the final pension wealth in a higher proportion than those made near to retirement. This explains why the younger cohorts have higher accrual rates for each year. The accrual rate differs by gender not only due to the observed differences in the wages profiles but also due to their different participation in the welfare system's tier.

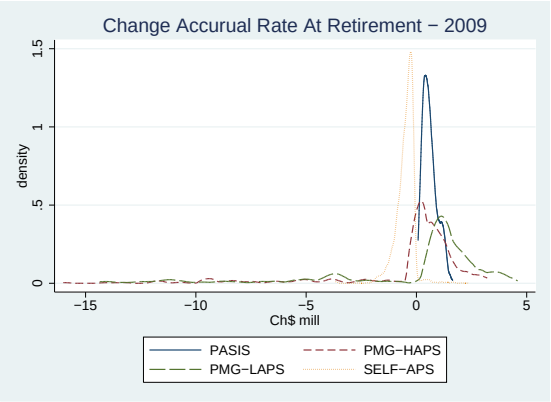


Any variation in either the pension wealth or the accrual rate could explain the changes in the formal labor market participation. Conditional on the accrual rate, a rise in the expected pension wealth at retirement could be understood as a pure income effect reducing the probability to work in the formal sector. On the other hand, a rise in the accrual rate will increase the opportunity cost of not working in the formal labor market sector increasing the probability of being formal. Consequently, the final effect in the formal labor market participation will depend on the direction of the income and substitution effect and their relative size. The next two figures show, considering the pre and post reform scenario, the expected (in 2009) pension wealth change at retirement and the expected accrual rate change at retirement for

PASIS and not complying the contributory requirements for getting a PMG, but once they work an additional year the requirement is satisfied and then the PMG is obtained.

4 different groups: those workers who were receiving before the reform the PASIS, those who were receiving the PMG but will receive a higher pension (HAPS) after the reform, those who were receiving the PMG but will receive a lower pension (LAPS) after the reform and those workers who were completely self-financing their final pension before the reform.





The average final effect of the reform will depend on the relative importance of these groups within the population, the average change in the pension wealth and the accrual rate[38] and finally on the marginal effect of the probability to contribute due to these changes. Next section deals with this last point.

5.2 Estimations.

This section reports the two stages estimation for our main equation 2. As we extensively discussed in section 4.2, we estimated a discrete model for the probability to work in the formal sector using a control function approach for the expected pension wealth variable at retirement. We used as instruments the interaction between time dummies and group dummies, where the groups are cohorts and gender. According the first stage estimation results the change of the pension wealth at the time of the reform varies importantly across both groups, cohorts and gender[39]. We can see

[38]The expected (in 2009) accrual rate has changed in average $Ch -141295 and $Ch -203082 after the reform for women and men, respectively. The expected (in 2009) pension wealth increased in $Ch 15200910 and Ch$ 77495250 after the reform for women and men, respectively.

[39]See the Appendix, section A.3.1, for the first stage results.

clearly a break in the tendency for the cohort and year interacted dummy coefficient after the reform. The coefficients for the interacted gender and year dummies show how the pension wealth has changed largely for women at the time of the reform. Using the forecasted pension wealth we proceeded to estimate the second stage. In the next table we show the results for women[40] using different specifications for a probit discrete model with using either an instrument variable (IV) approach or a control function (CF) approach. The first column includes as covariates the non instrumented (NO IV) pension wealth and the accrual rate. Even though the accrual rate has, as it is expected, a positive sign. The higher the accrual rate the larger the incentives for contributing to the pension system. The pension wealth, contrary to the theory, has a positive effect. However, once we control for possible endogeneity using both the IV and CF approaches, we obtain a negative income and a positive substitution effect. Both effects increase with the age, supporting the idea that the reform has a larger effect on those workers near to retirement.

[40]The results for men are in the Appendix, section A.3.2.

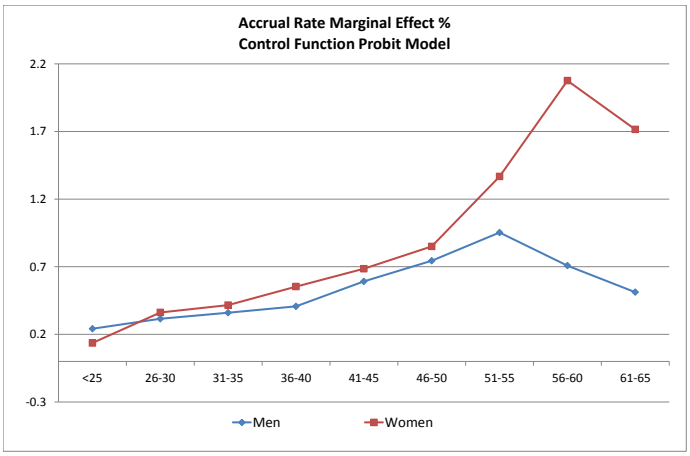
Dicrete Choice Model Estimations - Pr. to Contribute=1

Women Variables	**NO IV -RE**	**IV -RE**	**CF**
Age	-0.1364***	0.0944*	-0.7944***
	[0.0278]	[0.0512]	[0.2260]
Age2	0.0021***	-0.0009	-0.0013
	[0.0003]	[0.0006]	[0.0012]
Primary (1=Yes)	0.4469***	0.9224***	0.5401***
	[0.1125]	[0.1564]	[0.0583]
Secondary(1=Yes)	0.7244***	1.7133***	1.1303***
	[0.1218]	[0.2469]	[0.1125]
Degree(1=Yes)	0.4480***	2.3510***	1.7925***
	[0.1278]	[0.4253]	[0.2184]
Married	-0.5900***	-0.6597***	-0.4928***
	[0.0528]	[0.0550]	[0.0191]
Number Children 0-3	-0.1153***	-0.1705***	-0.2055***
	[0.0350]	[0.0369]	[0.0212]
Number Children 4-5	0.0323	0.0407	0.0339
	[0.0495]	[0.0494]	[0.0329]
Pension Wealth	0.0435***	-0.0167	-0.0253***
	[0.0052]	[0.0114]	[0.0060]
Pension Wealth*Age	-0.0006***	-0.0006***	-0.5362***
	[0.0604]	[0.0002]	[0.0001]
Accrual Rate	-0.6051***	-0.0167	-0.0003***
	[0.0001]	[0.0637]	[0.0001]
Accrual Rate*Age	0.0346***	0.0379***	0.0300***
	[0.0020]	[0.0022]	[0.0012]
Constant	1.1183***	1.1699***	
Observations	27,368	27,368	27,368

Standard errors in brackets *** p<0.01, ** p<0.05, * p<0.1. Pension Wealth variable is intrumented by groups dummies interacted with year dummies. Pension Wealth and Accrual Rate are both measured in Ch$1000000.

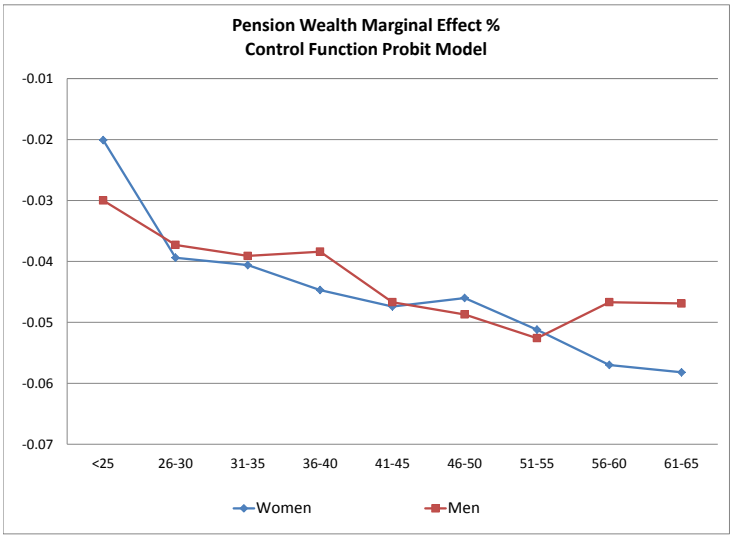
As the worker's age seems to be relevant to explain the effect of the pension wealth and the accrual rate change on the probability to be formal, we estimate

the marginal effects[41] including group age dummies interacted with the pension wealth and the accrual rate, respectively. Using this specification we capture any non-linear effect of the reform by age. The next figure has the marginal effect of a Ch$ mill accrual rate change on the probability of being formal for men and women by different age groups (columns 3 and 4, in section A.3.3 in the Appendix). The graph shows the age increasing and gender dependent positive substitution effect. During the early ages of the life cycle a change of Ch$ mill in the accrual rate rises the probability to contribute to the pension system in less than 0.5%. However, this effect is much larger at the end of the cycle when workers are near to retirement.



The following figure shows the marginal effect of a Ch$ mill expected pension wealth change on the probability of being formal for men and women by different age groups (columns 3 and 4, in section A.3.3 in the Appendix). We observe a negative and age increasing statistically significant income effect throughout the working life. A rise in Ch$ mill in the pension wealth reduces the probability to participate in the formal market, when the employee is near retirement, in more than 0.04%.

[41] The second table in the section A.3 in the Appendix shows the results for these estimations.



Using different values for the future probability to work in the formal labor market we recompute both the expected pension wealth and the accrual rate and estimate the equation 2 again for each scenario. The results considering five different probability to contribute scenarios (Pr=j) are displayed in the table below.

Marginal Effects Probit Dicrete Choice Model Estimations - Women - Probability to Contribute=1

VARIABLES	(1) Pr=0.1	(2) Pr=0.3	(3) Pr=0.5	(4) Pr=0.7	(5) Pr=0.9
Age	0.1044***	0.1786***	0.0740***	0.0396**	0.0288
	[0.0220]	[0.0217]	[0.0185]	[0.0198]	[0.0197]
Age2	-0.0008***	-0.0018***	-0.0010***	-0.0007***	-0.0006***
	[0.0003]	[0.0003]	[0.0002]	[0.0003]	[0.0002]
Married (1=Yes)	-0.4507***	0.2746***	0.5744***	0.4391***	0.3353***
	[0.0183]	[0.0452]	[0.0559]	[0.0580]	[0.0473]
Number Children 0-3	-0.1437***	0.5524***	1.1929***	0.8956***	0.6663***
	[0.0212]	[0.0787]	[0.1078]	[0.1166]	[0.0908]
Number Children 4-5	0.0585*	0.5464***	1.9590***	1.3212***	0.8375***
	[0.0347]	[0.1401]	[0.2086]	[0.2389]	[0.1950]
Number Children 6-13	-0.1028***	-0.4468***	-0.4678***	-0.4365***	-0.4192***
	[0.0171]	[0.0182]	[0.0185]	[0.0181]	[0.0175]
Number Children 14-18	-0.0482**	-0.1421***	-0.1822***	-0.1312***	-0.1537***
	[0.0224]	[0.0209]	[0.0200]	[0.0209]	[0.0202]
Pension Wealth* Group Age <25	-0.0255***	-0.0315***	-0.0516***	-0.0461***	-0.0442***
	[0.0071]	[0.0073]	[0.0084]	[0.0097]	[0.0079]
Pension Wealth* Group Age 26-30	-0.0231***	-0.0243***	-0.0473***	-0.0426***	-0.0359***
	[0.0056]	[0.0058]	[0.0083]	[0.0093]	[0.0075]
Pension Wealth* Group Age 31-35	-0.0219***	-0.0212***	-0.0493***	-0.0391***	-0.0305***
	[0.0059]	[0.0060]	[0.0084]	[0.0093]	[0.0075]
Pension Wealth* Group Age 36-40	-0.0248***	-0.0198***	-0.0557***	-0.0289***	-0.0297***
	[0.0062]	[0.0063]	[0.0085]	[0.0094]	[0.0075]
Pension Wealth* Group Age 41-45	-0.0236***	-0.0216***	-0.0599***	-0.0245**	-0.0181**
	[0.0067]	[0.0067]	[0.0088]	[0.0096]	[0.0077]
Pension Wealth* Group Age 46-50	-0.0189***	-0.0127*	-0.0523***	-0.0184*	-0.0060
	[0.0070]	[0.0069]	[0.0090]	[0.0097]	[0.0078]
Pension Wealth* Group Age 51-55	-0.0200***	-0.0188***	-0.0666***	-0.0198**	-0.0022
	[0.0074]	[0.0073]	[0.0093]	[0.0098]	[0.0079]
Pension Wealth* Group Age 56-60	0.0007	-0.0221***	-0.0719***	-0.0294***	-0.0082
	[0.0076]	[0.0079]	[0.0097]	[0.0101]	[0.0082]
Pension Wealth* Group Age 61-65	-0.0248**	-0.0209**	-0.0760***	-0.0316***	-0.0096
	[0.0097]	[0.0095]	[0.0108]	[0.0112]	[0.0095]
Accrual Rate* Group Age <25	0.6221***	0.6728***	0.2303***	0.3298***	0.4936***
	[0.0318]	[0.0369]	[0.0257]	[0.0287]	[0.0335]
Accrual Rate* Group Age 26-30	0.6770***	0.6341***	0.2194***	0.4200***	0.4811***
	[0.0216]	[0.0225]	[0.0144]	[0.0239]	[0.0254]
Accrual Rate* Group Age 31-35	0.7888***	0.6794***	0.3316***	0.5151***	0.5449***
	[0.0248]	[0.0247]	[0.0206]	[0.0297]	[0.0284]
Accrual Rate* Group Age 36-40	1.0293***	0.7573***	0.5727***	0.3650***	0.7390***
	[0.0360]	[0.0329]	[0.0349]	[0.0330]	[0.0373]
Accrual Rate* Group Age 41-45	1.2359***	0.9842***	0.8268***	0.4214***	0.5467***
	[0.0529]	[0.0503]	[0.0504]	[0.0421]	[0.0442]
Accrual Rate* Group Age 46-50	1.4140***	0.9269***	0.7836***	0.4569***	0.4530***
	[0.0748]	[0.0634]	[0.0618]	[0.0574]	[0.0478]
Accrual Rate* Group Age 51-55	1.7586***	1.5928***	1.6632***	0.7272***	0.6290***
	[0.1024]	[0.1024]	[0.0992]	[0.0737]	[0.0646]
Accrual Rate* Group Age 56-60	0.7183***	2.1904***	2.4676***	1.7264***	1.5431***
	[0.0791]	[0.1628]	[0.1713]	[0.1550]	[0.1481]
Accrual Rate* Group Age 61-65	1.7222***	1.8858***	2.1829***	1.4973***	1.3446***
	[0.3449]	[0.3720]	[0.3600]	[0.3378]	[0.3424]
Residual	0.0702***	0.0710***	0.0844***	0.0820***	0.0786***
	[0.0069]	[0.0069]	[0.0088]	[0.0100]	[0.0087]

Standard errors in brackets *** p<0.01, ** p<0.05, * p<0.1, dummies. Pension Wealth and Accrual Rate are measured both in Ch$1000000. Dummies years and cohorts included.

This exercise shows that both the accrual rate and the pension wealth coefficient are still statistically significant for all the scenarios assumed. Regarding the accrual rate coefficient, its magnitude turns lower as the probability to contribute to the system increases. As the reform reduces in average the accrual rate, section 5.1, we have a final negative effect on the probability to contribute due to the substitution effect. On the other hand, the final effect on the probability of working formally due to the larger pension wealth is negative. Both effects complement each other reducing the probability to contribute in the pension system in 0.7% and 0.4% for women and men, respectively.

5.3 Outcomes of interest.

In this section we go through the eight outcomes listed in the section 4.1. The first three of them are focused on the pension and pension wealth changes before and after the reform, the last five points are mainly focused on the changes in the formal labor market participation due to the reform.

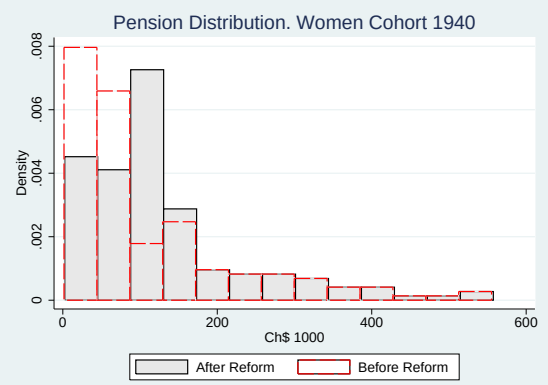
5.3.1 Changes in the distribution of pensions resulting from the reform.

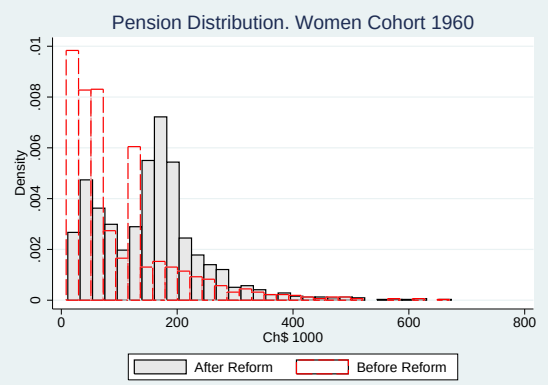
The subsidies introduced by the reform changed the accumulated resources and through it the self-financed pension. Additionally, conditional to a particular pension wealth, the changes introduced to the first tier of the system modified the final pension distribution. These pension and pension wealth changes are different across population groups. For example, as some elements of the reform are just affecting the younger workers, such as the child subsidy, the rise of the final pension will be probably higher for this group. The next two figures show the frequency of the pensions, measured in Ch$1000, before and after the reform for those female[42] workers belonging to the cohorts born in the 40s and the 60s. The first group is composed by workers who are retiring between 2005 and 2015[43] and then it is the first group of employees retiring under the post reform new frame. The 1960 cohort group, composed by employees who will retire around 2025-2035, is the first group

[42] The same graphs for men are in the Appendix, section A.4.1

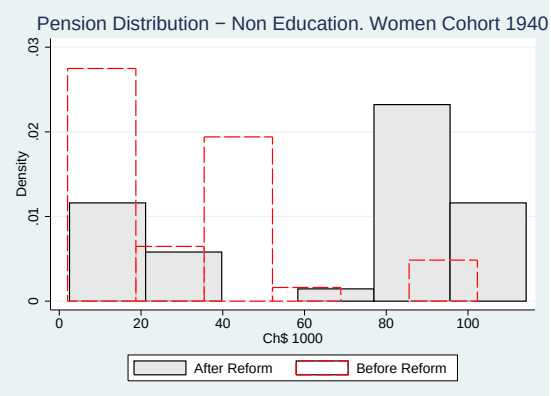
[43] We are just considering those who have not retired in 2009 yet.

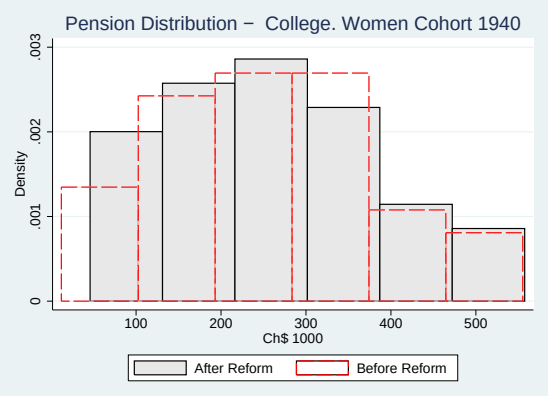
that will retire having contributed all their working life in the DC system. We observe that for both groups the final pension will increase importantly after the reform. The average female pension change is Ch$ 34303 for those workers belonging to 1940 cohort and Ch$ 65824 for those belonging to 1960 cohort, representing an increment of 31% and 57% of the final pension before reform, respectively.





As long as the first tier reform affects particularly to workers with low self-financed pensions, because they will qualify for the new welfare pension subsidies (APS), the change in the final pension should be larger for them. The next two figures show the pension frequency for workers who did not finish the primary school and for those who got a degree, respectively[44]. Even though the differences between both groups are still very important after the reform, we can observe a significant gap reduction as the increment of the pension is clearly more important for the non educated workers.

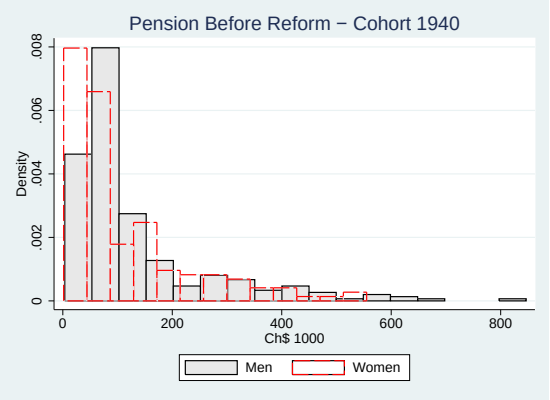


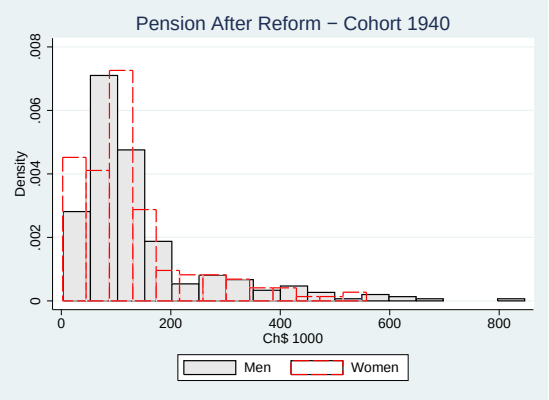


[44]The pension frequency for the workers with primary and secondary level of education are in the Appendix, section A.4.1.

5.3.2 Changes in the distribution of the pension difference between men and women.

As some of the subsidies were specifically target to women, we can expect a higher improvement for the final female pensions than the male pensions. This statement is strongly supported comparing both figures below. Even though the final pensions increase in both cases, the change in the frequency is larger for female pensions, reducing importantly the gap between them [45].

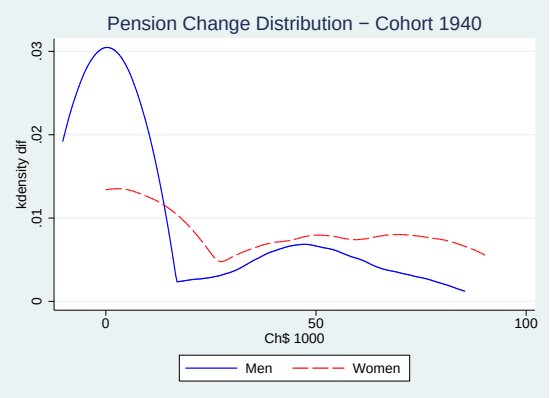


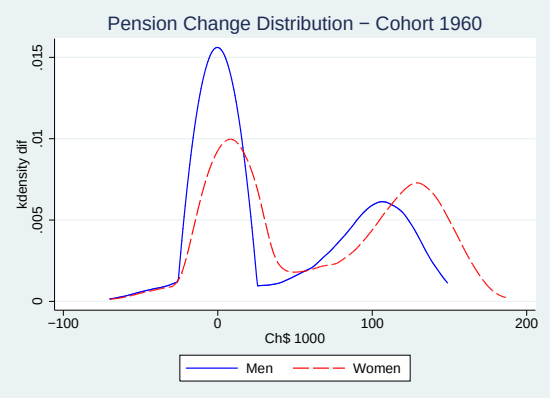


The figures below show the estimated density for the pension change, before and after reform, considering two different cohorts[46]. The final pension increases importantly for both cohorts. However, the rise is clearly higher for those workers belonging to the 1960 cohort. In both cases the change in the female pension is larger than the change in the male pension, closing the gender inequalities. The average change for the female pension is Ch$ 72881, which is 77% higher than the male change.

[45] Graphs for the 1960 cohort are in the Appendix, section A.4.2.

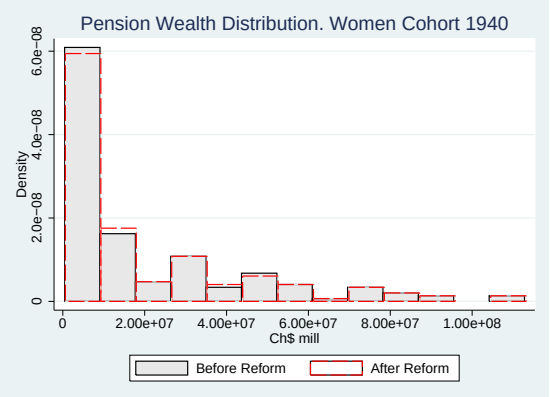
[46] Section A.4.2 in the Appendix has figures with the density for the pension change by educational level

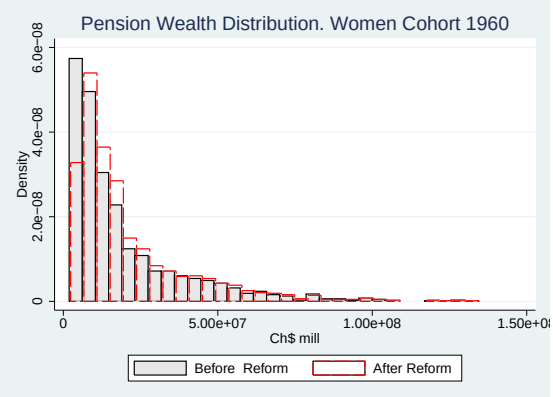




5.3.3 Changes in the accumulated pension wealth before and after the reform.

Here we show some results about the change in the self-financed pension wealth before and after the reform. Any observed change after the reform will be due to the new implemented mechanism or subsidies. The graphs displays the frequency for the self-financed pension wealth for workers belonging to 1940 and 1960 cohorts. Taking into account that the older workers, at the moment of the reform, have not to many years to take advantage of the subsidies, such as the return for every born child or the disability insurance compensation, the change for the this cohort should be smaller than the one for those workers belonging to the 1960 cohort[47].





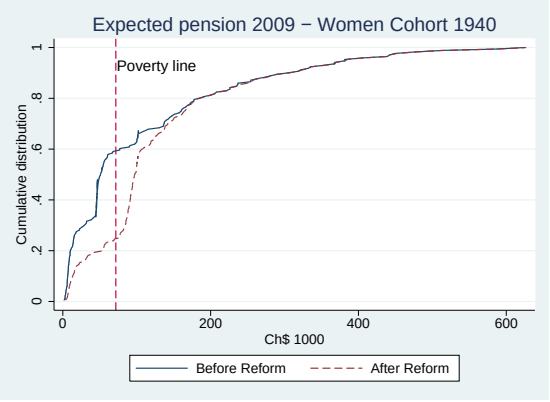
The average predicted self-financed pension wealth change for employees born in the 60s is Ch$ 1136604 which is almost 7 times larger than the change for the ones

[47]Section A.4.3 has figures with the frequency of the self-financed pension wealth by educational levels.

born in the 40s and represents an average increment of 4% of the PW before reform.

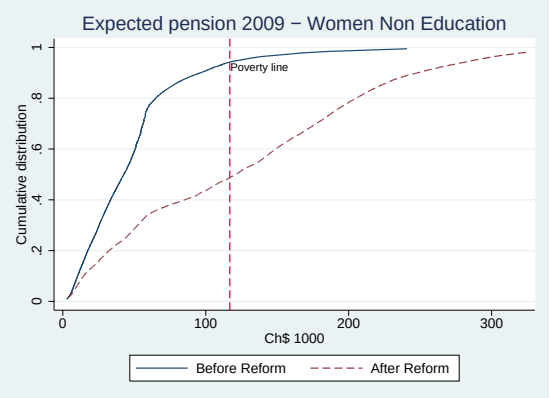
5.3.4 Changes in poverty levels before and after the reform for elderly people, in particular, for elderly women.

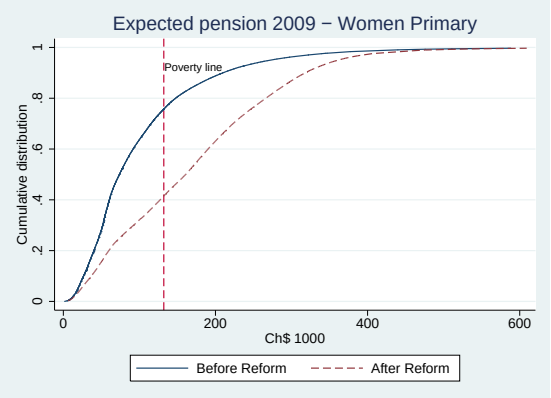
Since 1990 to 2006 the fraction of the Chilean population below the poverty line decreased gradually from 39% to 14%. This reduction has been important as well among the elder population, changing from 21% to 8%, for those older than 60 years old[48]. In this section we give some light about the effect of the reform on the poverty levels at retirement. The following figures show the cumulative expected pension at retirement before and after the reform for different groups. Using the poverty line defined by the government in 2009, equal to Ch$64000[49], we show the fraction of retirees who, assuming that they do not have any other income source, are below the poverty line and then they could be considered as poor people. The poverty levels usually reported by the Chilean Government are computed using the percapita household income, which not only includes all labor incomes but also pensions and all diferent types of governmental subsidies. In this sense, these results here are not comparable with those. However, the point that we want to make here is to show how in the case where the only source of income comes from the pension, the reform will change dramatically the poverty levels.



[48]Serie Analisis de Resultados de la Encuesta de Caracterizacion Socioeconomica Nacional (CASEN 2006). Ministerio de Planificacion, Chile.

[49]CASEN 2009. We assume, in line with the expected inflation, a rate of growth for the poverty line of 3%. Even though the poverty line growth between 2006 and 2009 was 19%, it stayed around the same real value before 2009.





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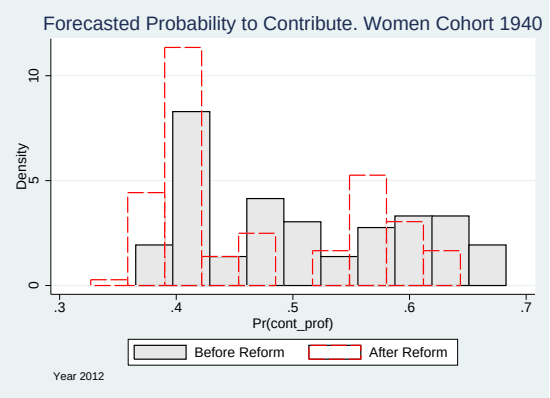
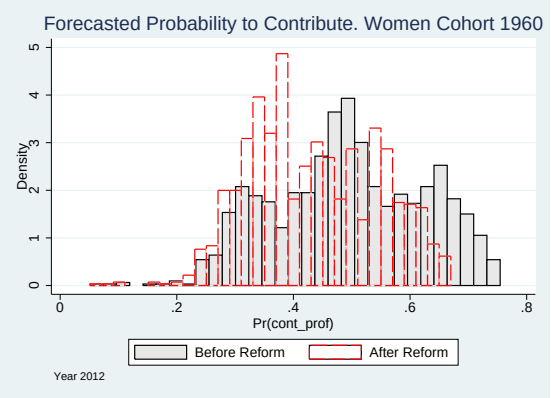
5.3.5 Changes in the probability to contribute and changes in the frequency of contributions.

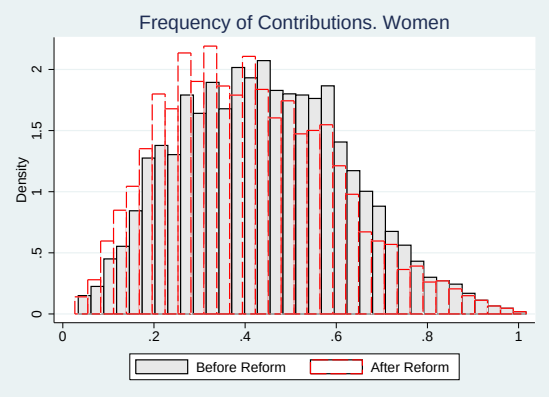
In this section we use our main equation results for forecasting the probability to contribute in any future period under the pre and post reform scenarios, respectively. With these predictions in hand we estimated the fraction of women contributing to pension system before and after the reform. The next two figures show the frequency for the forecasted probability to contribute[50] to the pension system in 2012 under the pre and post reform system's rule. As we discussed in the section 5.2, the final result depends on the relative importance of the income and substitution effect. Considering that in average the accrual rate decreases and the pension wealth increases after the reform, both effect complement themselves reducing the probability of being formal.

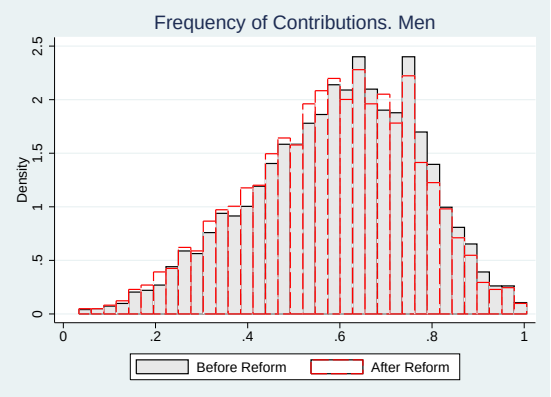
[50]The results for cohorts born in 1950 and 1970 are in the Appendix, section A.4.5.





Using these forecasted probabilities we compute how the frequency of contributions, defined as the total contributed periods over the total potentially working periods, will change with the conditions introduced by the reform. The next two figures show the estimated frequency of contributions for women and men[51]. The reform affects negatively the frequency of contributions for both gender, being the negative effect larger for women than for men.





5.3.6 Changes in the coverage of the system measured as the number of women that contribute to the system over the employees and over the economically active people (EAP).

Using the predicted probabilities to contribute we impute to each future individual-period a contributed period if a randomly generated number falls within the predictions. Then, we compute the fraction of women contributing each period under the

[51]Section A.4.5 has figures with the forecasted probability and the frequency of contributions by educational levels.

pre and post reform conditions. The next figures show the average participation in the formal labor market over the economically active people and employees[52] considering those individuals between 20 and 65 years old. Under both measures the reform reduces the coverage of the pension system being the effects larger for last part of the working life cycle.

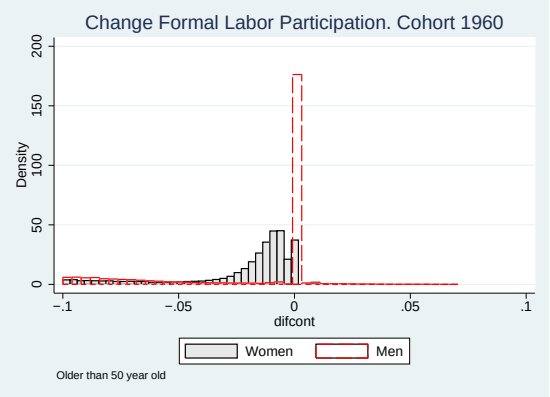
Results by cohort could be find in the Appendix, section A.4.6.

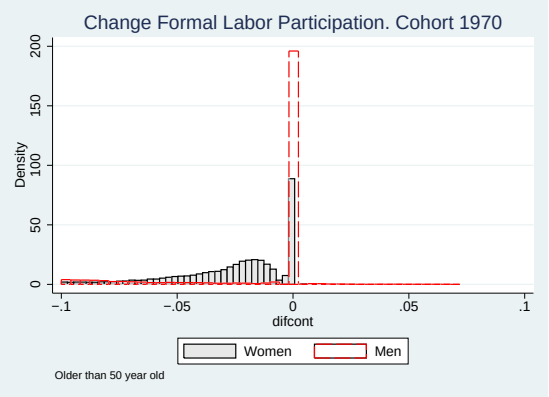
5.3.7 Changes in male and female formal labor market participation.

Many elements of the reform were designed to improve explicitly the final female pensions, reducing in this way the gender pension gap. The child subsidy is an attempt to recognize the non contributed periods due to childbearing, the disability

[52]Regarding the participation over the total employees, as we do not observe future labor market participation we proceed to impute it using the system in the section 4.2.2. This allows us to define those individual-period observations where individuals are working.

insurance compensation recognizes the gender health risk difference and the compensation upon divorce recognizes the share of the household load as a couple. The female accumulated resources have been historically lower than the male ones. This path could be explained not only due to the lower wages profiles but also due to the much lower female labor market participation. In this sense, any decrease in the probability to contribute will compensate, through the associated PW reduction, the initial improvement due to the reform's elements mentioned above. The next figures display the frequency for the change in the formal labor market participation by gender.



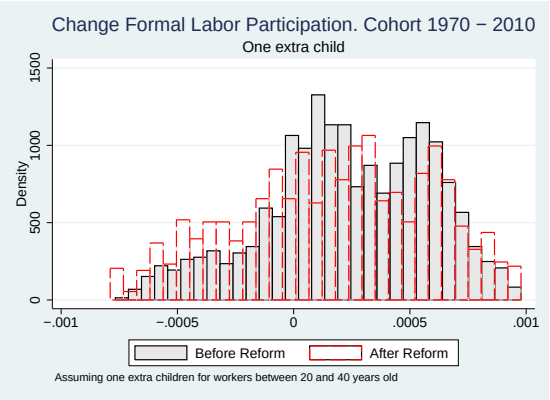


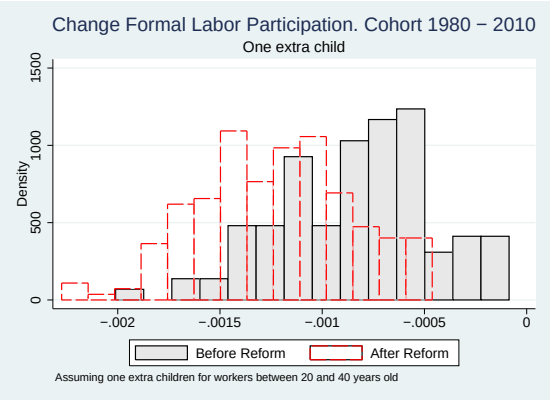
As was discussed in the section 5.2 the probability to work formally decrease due to the reform. However, the effect is much larger for women than for men.

5.3.8 Effects of having a child on the labor market participation before and after the reform.

In this section we simulate the effect of having an extra child on the probability to contribute to the pension system under the pre and post reform conditions. The next figures show the change in the probability to contribute in year 2010. We are assuming that every worker between 20 and 40 years old have an additional child during this year. As the main equation estimations show, an additional child reduces the female probability to work in the formal sector. Both figures below, for cohort 1970 and 1980, confirm this statement and show that after the reform the fall in the probability to contribute is even larger. An additional child after the reform

implies, trough the new child subsidy, an income effect at retirement. Therefore, we can explain the larger post reform reduction of the probability to contribute as a result of this income effect. The average female decrease of the probability to contribute at the year of child birth is around 0.05% for women younger than 40 years old.





6 Conclusions

During 2008 Chile implemented the largest pension system reform since the DC system started in the early 80s. The reform costs annually around 1.1% of GDP, modifying completely the welfare tier of the system and introducing several mechanism to foster contributions, to recognize gender differences and to improve competition within the system. Regarding the system's first tier, both the contributory minimum pension PMG and the means-tested welfare pension PASIS were replaced for a flat unique pension PBS and a pension wealth decreasing subsidy APS impacting the 60% of the 65+ years old poorest retired population. On the other hand, those several subsidies and mechanisms, such as the child subsidy, the divorce compensation mechanism, the new survivor male pensions and the female disability and survivor insurance compensation target different groups. Therefore, we can expect not only important changes in the the expected accumulated pension wealth due to the reform but also differences across groups for those changes.

Using a rich data set, which combines Administrative Records with the EPS, we simulate the direct effects of the reform on the final pension distribution and

estimate the effects of the reform on the formal labor market participation. The reform's eligibility conditions, such as being poor, young or female, will allow us to define groups for whom the change in the currently expected pension wealth at retirement due to the reform differs. We therefore exploit the differential effects of the reform on individuals belonging to several year-of-birth cohorts and different groups to gain identification. In doing so, we need to compute the expected pension wealth at time t for each individual upon retirement. As the final pension wealth depends on the number of contributions, the amount contributed and all subsides obtained during the working life, we estimate the future patterns of contributions to the pension systems, wage profiles and all the socio-economics characteristics which define the eligibility for the different subsidies.

The main results of the paper are two folds. Firstly, the reform has increased not only the self-financed pension wealth, due to the different mechanisms or subsidies received during the accumulation period, but also has importantly improved the final pension due to the first tier reform. For those workers retiring before 2015, the self-financed pension wealth and the final pension will increase in average 0.7% and 15%, respectively. Secondly, the changes in the final pension wealth at retirement and the accrual rate have reduced slightly the formal labor market participation. The probability to contribute to the pension system has been reduced due to the reform around 0.4% for those workers elder than 40 years old. The results are significantly higher for women and elder workers. The reform reduces the probability of being formal in 0.5% and 0.2% for women and men between 56 and 65 years old, respectively. Even though the final pension changes have been positive for both gender, the female pension improvement has been 78% higher than the rise for men reducing importantly the gender inequalities.

The results obtained in this study allows to extent potential labor market effects for either future modifications of the pension system or improvements of the mechanisms and subsidies already implemented. The 2008 reform aimed not only to guarantee a minimum level of consumption upon retirement, prevent old-age poverty, reduce gender inequalities but also to incentivate participation in the formal labor market. As we have seen, the reform has increased importantly the pension wealth,

accomplishing the first set of goals, but at the same time reducing the incentives to participate in the formal labor market. This trade-off rises the point about the optimal subsidies or welfare pensions. The marginal effects computed in this study allows to simulate the optimal subsidies or welfare pensions such as the cost in terms of formal labor market reduction is the lowest possible conditional to reach a consumption increment goal or a gender inequality reduction.

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A Tables

A.1 Children Profiles.

Table A1 - Estimates the probability to have a child. Probit RE

Variables	Delta Child=1
Sex (1=Men)	-0.027
	(3.40)**
Age	0.119
	(42.96)**
Age 2	-0.002
	(59.95)**
Year	-0.004
	(4.00)**
Primary (1=Yes)	-0.048
	(4.74)**
Secondary (1=Yes)	-0.085
	(7.01)**
Degree (1=Yes)	-0.154
	(11.65)**
Married (1=Yes)	0.814
	(92.18)**
Number of Children	-0.103
	(27.15)**
Cohort1940 (1=Yes)	-0.042
	(2.19)*
Cohort1950 (1=Yes)	-0.097
	(3.72)**
Cohort1960 (1=Yes)	-0.151
	(4.44)**
Cohort1970 (1=Yes)	-0.251
	(5.84)**
Cohort1980 (1=Yes)	-0.314
	(5.89)**
Constant	4.618
	(2.50)*
Observations	645413
Number Individuals	19874

z statistics in parentheses
* significant at 5%; ** significant at 1%

A.2 Divorce Profiles.

Table A2 - Hazard ratios from Cox proportional model estimates for the probability of marriage

Variables	Married=1
Age	0.956
	(2.10)*
Age 2	1.001
	(2.28)*
Dummy Cohabiting (Yes=1)	2.76
	(11.44)**
Number of Children	1.115
	(4.07)**
Delta Children 2004-2006	1.231
	(-1.85)
Delta Children 2006-2009	1.695
	(4.79)**
Primary (1=Yes)	1.265
	(2.24)*
Secondary (1=Yes)	1.44
	(3.01)**
Degree (1=Yes)	1.49
	(3.08)**
Observations	6759

z statistics in parentheses
* significant at 5%; ** significant at 1%

Table A3 - Hazard ratios from Cox proportional model estimates for the probability of divorce

Variables	Divorce=1
Age	0.868
	(3.66)**
Age 2	1.001
	(2.45)*
Years as married	1.036
	(2.85)**
Total number of children	1.297
	(2.73)**
Children with other couples	0.708
	(3.39)**
Primary (1=Yes)	1.042
	(-0.28)
Secondary (1=Yes)	1.071
	(-0.41)
Degree (1=Yes)	1.356
	(-1.71)
Observations	10513

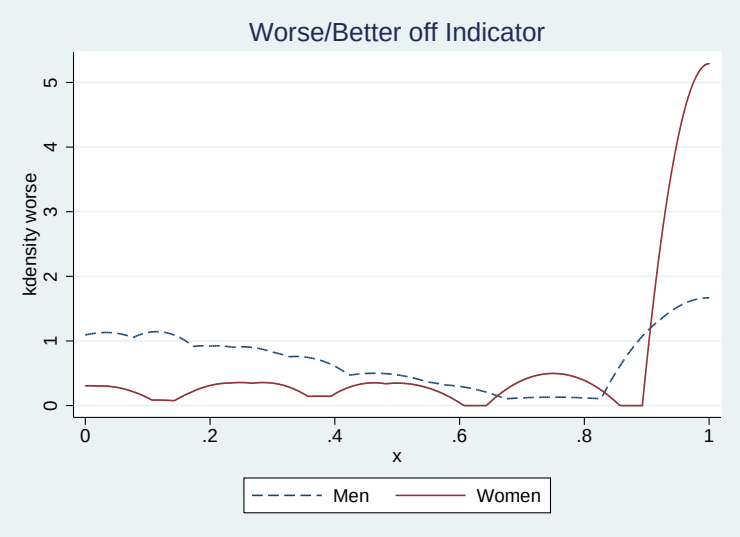
z statistics in parentheses
* significant at 5%; ** significant at 1%

Using the information provided by the two following questions in the EPS we computed an indicator in order to determine who could be considered as the worse off member, in terms of the pension system participation, during the marriage. We basically recorded the answers creating an indicator between 0 and 1 in the following way:

1. Did your partner work frequently during the relationship? a) Most of the time=1; b) Almost half of the time=0.5; c) For a little time=0.25; d) Do not work at all=0.

2. How frequently did your partner make contributions when she/he was working? a) All the time (monthly)=1; b) Over half the time=0.75; c) Half the time=0.5; d) Under half the time=0.25; e) Occasionally contributed=0.

With the product of these two new recorded variables we created, for each at least once married interviewed, the worse/better indicator, which is shown by gender in the figure below. The higher the indicator the higher the partner's frequency of contributions reported by the individual. For all future periods and for all single individuals we imputed the indicator using age, education and gender groups. Finally, combining this indicator with the individual's frequency of contributions we imputed an individual as the worse off member (the best off member) upon divorce in case the worse/better off indicator is above 0.8 (below 0.2) and her frequency of contribution is below 0.8 (above 0.2).


Worse/Better off Indicator
kdensity worse
0
1
2
3
4
5
0
.2
.4
.6
.8
1
x
Men
Women

A.3 Estimations

A.3.1 First Stage.

First Stage Estimations - Linear Panel Data RE

VARIABLES	(1) Pension Wealth	(2) Pension Wealth	(3) Pension Wealth
Age	3.0200***	2.7912***	2.8250***
	[0.1979]	[0.1984]	[0.1958]
Age2	-0.0360***	-0.0341***	-0.0345***
	[0.0022]	[0.0023]	[0.0022]
Sex (1=Men)	9.4748***	9.3279***	9.3369***
	[0.5126]	[0.4937]	[0.4977]
Primary (1=Yes)	7.9989***	7.8871***	7.8529***
	[0.6390]	[0.6043]	[0.6116]
Secondary(1=Yes)	16.8563***	16.6490***	16.6012***
	[0.7062]	[0.6680]	[0.6761]
Degree(1=Yes)	32.6349***	32.2440***	32.1832***
	[0.6999]	[0.6624]	[0.6704]
Married (1=Yes)	-0.9342***	-0.9610***	-0.9668***
	[0.2797]	[0.2780]	[0.2785]
Sex*Married	3.1899***	3.4038***	3.3840***
	[0.3859]	[0.3834]	[0.3841]
Number Children 0-3	-0.9729***	-0.9575***	-0.9751***
	[0.1440]	[0.1447]	[0.1446]
Number Children 4-5	0.0641	0.0658	0.0654
	[0.1975]	[0.1985]	[0.1984]
Number Children 6-13	-0.7492***	-0.7746***	-0.7832***
	[0.1110]	[0.1116]	[0.1115]
Number Children 14-18	-0.5540***	-0.5766***	-0.5780***
	[0.1448]	[0.1455]	[0.1454]
Sex*Number Children 0-3	0.2226	0.2769	0.2719
	[0.1932]	[0.1941]	[0.1940]
Sex*Number Children 4-5	-0.8514***	-0.7343***	-0.7957***
	[0.2685]	[0.2699]	[0.2697]
Sex*Number Children 6-13	0.2014	0.2413	0.2661*
	[0.1474]	[0.1482]	[0.1480]
Sex*Number Children 14-18	0.4995***	0.4407**	0.5023***
	[0.1884]	[0.1894]	[0.1892]
Trend	0.9892***	1.0161***	1.0156***
	[0.1565]	[0.1519]	[0.1530]
Cohort 1950*Year 2003	0.8145	0.9389	0.9263
	[0.6035]	[0.6074]	[0.6065]
Cohort 1960*Year 2003	-0.7060	-0.6632	-0.5846
	[0.5897]	[0.5933]	[0.5925]
Cohort 1970*Year 2003	-2.9585***	-2.9385***	-2.8503***
	[0.6034]	[0.6067]	[0.6061]
Cohort 1980*Year 2003	-1.9195**	-1.5131*	-1.5525*
	[0.7983]	[0.8033]	[0.8021]
Cohort 1950*Year 2004	-0.3318	-0.1674	-0.3195
	[0.6064]	[0.6113]	[0.6093]
Cohort 1960*Year 2004	-1.7788***	-1.7811***	-1.7867***
	[0.6045]	[0.6086]	[0.6071]

First Stage Estimations - Linear Panel Data RE

Cont. VARIABLES	(1) Pension Wealth	(2) Pension Wealth	(3) Pension Wealth
Cohort 1970*Year 2004	-1.8649***	-1.9109***	-1.9144***
	[0.6380]	[0.6411]	[0.6401]
Cohort 1980*Year 2004	-3.3717***	-2.8504***	-3.1293***
	[0.8363]	[0.8419]	[0.8392]
Cohort 1950*Year 2005	-1.1105*	-0.8587	-1.0916*
	[0.6153]	[0.6233]	[0.6181]
Cohort 1960*Year 2005	-3.2268***	-3.2563***	-3.1959***
	[0.6317]	[0.6374]	[0.6339]
Cohort 1970*Year 2005	-3.0480***	-2.9546***	-2.9514***
	[0.6948]	[0.6981]	[0.6961]
Cohort 1980*Year 2005	-5.5895***	-4.3511***	-4.8018***
	[0.9031]	[0.9145]	[0.9058]
Cohort 1950*Year 2006	-0.5483	-0.2079	-0.3700
	[0.6146]	[0.6232]	[0.6172]
Cohort 1960*Year 2006	-3.2218***	-3.1473***	-3.0558***
	[0.6610]	[0.6673]	[0.6626]
Cohort 1970*Year 2006	-2.5746***	-2.4276***	-2.2578***
	[0.7576]	[0.7609]	[0.7580]
Cohort 1980*Year 2006	-5.6513***	-3.9211***	-4.4173***
	[0.9755]	[0.9833]	[0.9780]
Cohort 1950*Year 2007	-0.9176	-0.6101	-0.9018
	[0.6264]	[0.6352]	[0.6289]
Cohort 1960*Year 2007	-3.7129***	-3.6167***	-3.6910***
	[0.7035]	[0.7100]	[0.7046]
Cohort 1970*Year 2007	-2.2658***	-2.3680***	-2.1136**
	[0.8409]	[0.8444]	[0.8403]
Cohort 1980*Year 2007	-4.9504***	-3.2184***	-3.9180***
	[1.0764]	[1.0822]	[1.0769]
Cohort 1950*Year 2008	-2.2864***	-1.9382***	-2.2880***
	[0.6373]	[0.6511]	[0.6396]
Cohort 1960*Year 2008	-3.2886***	-3.1062***	-3.3079***
	[0.7492]	[0.7599]	[0.7496]
Cohort 1970*Year 2008	-0.0992	-0.4534	-0.0540
	[0.9304]	[0.9374]	[0.9287]
Cohort 1980*Year 2008	1.6417	3.4223***	2.5506**
	[1.1870]	[1.1945]	[1.1857]
Cohort 1950*Year 2009	-1.3082**	-0.9559	-1.3884**
	[0.6495]	[0.6668]	[0.6516]
Cohort 1960*Year 2009	-1.5062*	-1.2480	-1.6094**
	[0.7994]	[0.8129]	[0.7992]
Cohort 1970*Year 2009	3.1291***	2.5677**	2.9992***
	[1.0258]	[1.0357]	[1.0232]
Cohort 1980*Year 2009	4.5971***	6.3582***	5.2518***
	[1.3060]	[1.3144]	[1.3031]
Sex*Year 2003	-0.1960	-0.2286	-0.2469
	[0.2492]	[0.2506]	[0.2505]

First Stage Estimations - Linear Panel Data RE

Cont. VARIABLES	(1) Pension Wealth	(2) Pension Wealth	(3) Pension Wealth
Sex*Year 2004	5.6488***	5.5471***	5.5121***
	[2.0932]	[2.1158]	[2.1160]
Sex*Year 2005	8.5784***	8.4380***	8.4016***
	[2.1021]	[2.1248]	[2.1249]
Sex*Year 2006	23.9294***	24.0331***	23.9076***
	[2.3037]	[2.3270]	[2.3273]
Sex*Year 2007	29.7198***	30.0170***	29.8483***
	[2.3125]	[2.3357]	[2.3358]
Sex*Year 2008	-35.2554***	-34.9901***	-35.1068***
	[2.3011]	[2.3241]	[2.3242]
Sex*Year 2009	-23.2240***	-23.0742***	-23.1636***
	[2.2937]	[2.3167]	[2.3169]
Accrual Rate* Group Age <25		0.0053***	
		[0.0005]	
Accrual Rate* Group Age 26-30		0.0017***	
		[0.0004]	
Accrual Rate* Group Age 31-35		0.0009**	
		[0.0004]	
Accrual Rate* Group Age 36-40		0.0032***	
		[0.0004]	
Accrual Rate* Group Age 41-45		0.0036***	
		[0.0006]	
Accrual Rate* Group Age 46-50		0.0059***	
		[0.0007]	
Accrual Rate* Group Age 51-55		0.0095***	
		[0.0008]	
Accrual Rate* Group Age 56-60		0.0119***	
		[0.0010]	
Accrual Rate* Group Age 61-65		0.0200***	
		[0.0027]	
Accrual Rate	0.0034***		-0.0030***
	[0.0002]		[0.0008]
Accrual Rate*age			0.0002***
			[0.0000]
Constant	-358.6417***	-359.4346***	-335.6591***
	[37.3391]	[35.9221]	[35.9190]
Observations	60,310	60,310	60,310
Number of folio	7,988	7,988	7,988

Standard errors in brackets, *** p<0.01, ** p<0.05, * p<0.1
We control for time and cohorts dum

A.3.2 Second Stage.

Dicrete Choice Model Estimations - Pr. to Contribute=1

Men			
Variables	**NO IV**	**IV**	**CF**
Age	-0.2762***	-0.0980**	-0.8282***
	[0.0243]	[0.0432]	[0.1725]
Age2	0.0038***	0.0016***	0.0061***
	[0.0003]	[0.0005]	[0.0010]
Primary (1=Yes)	0.0426	0.4765***	0.3783***
	[0.0846]	[0.1171]	[0.0481]
Secondary(1=Yes)	-0.0671	0.8217***	0.8040***
	[0.0993]	[0.1943]	[0.0962]
Degree(1=Yes)	-1.0456***	0.5612*	1.2168***
	[0.1077]	[0.3367]	[0.1866]
Married	0.1242**	0.2789***	0.6179***
	[0.0513]	[0.0561]	[0.0534]
Number Children 0-3	0.0618*	0.0385	0.0409**
	[0.0331]	[0.0336]	[0.0197]
Number Children 4-5	0.0136	-0.0121	-0.0285
	[0.0465]	[0.0468]	[0.0315]
Pension Wealth	0.0480***	-0.0005	-0.0287***
	[0.0048]	[0.0110]	[0.0056]
Pension Wealth*Age	-0.0008***	-0.0009***	-0.1783***
	[0.0557]	[0.0002]	[0.0001]
Accrual Rate	-0.2646***	-0.0005	-0.0003***
	[0.0001]	[0.0591]	[0.0001]
Accrual Rate*Age	0.0255***	0.0298***	0.0173***
	[0.0017]	[0.0019]	[0.0011]
Constant	1.0181***	1.0129***	
Observations	32,942	32,942	32,942

Pension Wealth variable is intrumented by groups dummies interacted with year dummies. Pension Wealth and Accrual Rate are both measured in Ch$1000000.

A.3.3 Marginal Effects.

Marginal Effects - Probit Model, Instrumental Variables and Control Fucntion Approach

VARIABLES	(1) IV-RE-PwWomen	(2) IV-RE-PwMen	(3) CF-PwWomen
Age	0.0991*	-0.1363***	0.2056***
	[0.0557]	[0.0494]	[0.0240]
Age2	-0.0009	0.0023***	-0.0023***
	[0.0007]	[0.0006]	[0.0003]
Married (1=Yes)	-0.6672***	0.2744***	-0.5014***
	[0.0556]	[0.0572]	[0.0192]
Number Children 0-3	-0.1640***	0.0517	-0.2046***
	[0.0371]	[0.0337]	[0.0213]
Number Children 4-5	0.0338	-0.0039	0.0431
	[0.0495]	[0.0467]	[0.0328]
Number Children 6-13	-0.2314***	0.0060	-0.1909***
	[0.0298]	[0.0261]	[0.0181]
Number Children 14-18	-0.1353***	-0.0166	-0.0949***
	[0.0368]	[0.0337]	[0.0224]
Pension Wealth* Group Age <25	-0.0169	-0.0079	-0.0201***
	[0.0133]	[0.0112]	[0.0067]
Pension Wealth* Group Age 26-30	-0.0242**	-0.0093	-0.0394***
	[0.0122]	[0.0103]	[0.0062]
Pension Wealth* Group Age 31-35	-0.0350***	-0.0166	-0.0406***
	[0.0125]	[0.0104]	[0.0063]
Pension Wealth* Group Age 36-40	-0.0359***	-0.0216**	-0.0447***
	[0.0127]	[0.0104]	[0.0064]
Pension Wealth* Group Age 41-45	-0.0358***	-0.0315***	-0.0474***
	[0.0136]	[0.0110]	[0.0067]
Pension Wealth* Group Age 46-50	-0.0403***	-0.0450***	-0.0460***
	[0.0140]	[0.0111]	[0.0068]
Pension Wealth* Group Age 51-55	-0.0440***	-0.0590***	-0.0512***
	[0.0148]	[0.0116]	[0.0070]
Pension Wealth* Group Age 56-60	-0.0858***	-0.0670***	-0.0570***
	[0.0165]	[0.0121]	[0.0075]
Pension Wealth* Group Age 61-65	-0.1038***	-0.0783***	-0.0582***
	[0.0232]	[0.0139]	[0.0089]
Accrual Rate* Group Age <25	0.2038***	0.4031***	0.1362***
	[0.0222]	[0.0273]	[0.0173]
Accrual Rate* Group Age 26-30	0.3868***	0.4387***	0.3619***
	[0.0239]	[0.0225]	[0.0162]
Accrual Rate* Group Age 31-35	0.5703***	0.5209***	0.4160***
	[0.0308]	[0.0280]	[0.0174]
Accrual Rate* Group Age 36-40	0.6933***	0.6351***	0.5532***
	[0.0424]	[0.0359]	[0.0225]
Accrual Rate* Group Age 41-45	0.7993***	0.9076***	0.6851***
	[0.0576]	[0.0485]	[0.0288]

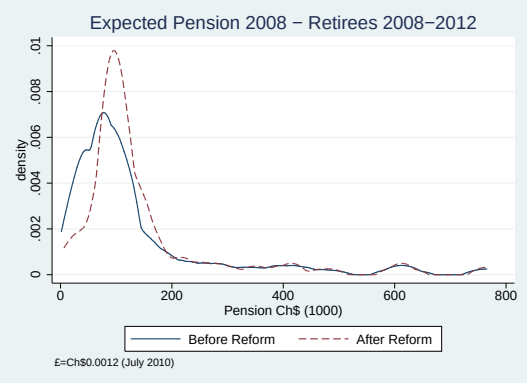
A.3.4 Scenarios.

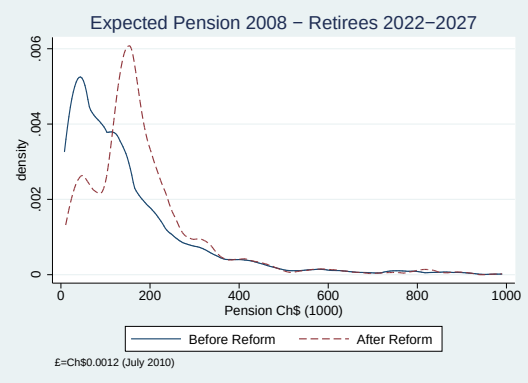
Marginal Effects Probit Dicrete Choice Model Estimations - Men - Probability to Contribute=1

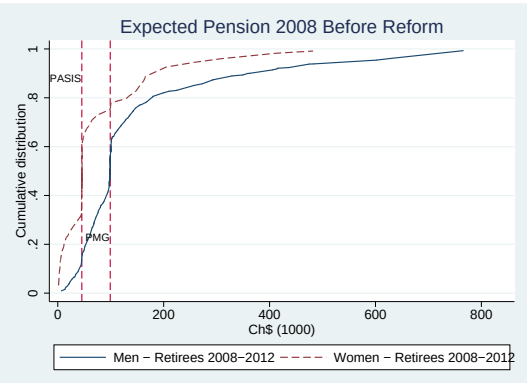
VARIABLES	(1) Pr=0.1	(2) Pr=0.3	(3) Pr=0.5	(4) Pr=0.7	(5) Pr=0.9
Age	0.0129	0.0392**	-0.0889***	-0.0579***	-0.0084
	[0.0191]	[0.0187]	[0.0163]	[0.0168]	[0.0166]
Age2	0.0002	-0.0002	0.0008***	0.0005**	0.0002
	[0.0002]	[0.0002]	[0.0002]	[0.0002]	[0.0002]
Married (1=Yes)	0.4730***	0.1819***	0.3700***	0.2074***	-0.0274
	[0.0420]	[0.0355]	[0.0465]	[0.0509]	[0.0410]
Number Children 0-3	0.0362*	0.3587***	0.7549***	0.3885***	-0.0791
	[0.0199]	[0.0647]	[0.0932]	[0.1062]	[0.0827]
Number Children 4-5	-0.0279	0.2926**	1.1052***	0.4574**	-0.5073***
	[0.0319]	[0.1143]	[0.1801]	[0.2177]	[0.1778]
Number Children 6-13	0.0811***	0.4278***	0.6377***	0.4432***	0.1705***
	[0.0176]	[0.0426]	[0.0602]	[0.0689]	[0.0511]
Number Children 14-18	0.0448**	0.0416**	0.0487**	0.0378*	0.0327*
	[0.0218]	[0.0199]	[0.0194]	[0.0195]	[0.0197]
Pension Wealth* Group Age <25	-0.0188***	-0.0268***	-0.0525***	-0.0444***	-0.0082
	[0.0065]	[0.0064]	[0.0077]	[0.0090]	[0.0072]
Pension Wealth* Group Age 26-30	-0.0286***	-0.0247***	-0.0475***	-0.0358***	-0.0020
	[0.0049]	[0.0051]	[0.0074]	[0.0086]	[0.0069]
Pension Wealth* Group Age 31-35	-0.0318***	-0.0253***	-0.0473***	-0.0320***	0.0007
	[0.0049]	[0.0051]	[0.0074]	[0.0086]	[0.0069]
Pension Wealth* Group Age 36-40	-0.0325***	-0.0242***	-0.0486***	-0.0277***	0.0010
	[0.0051]	[0.0052]	[0.0074]	[0.0086]	[0.0068]
Pension Wealth* Group Age 41-45	-0.0400***	-0.0319***	-0.0559***	-0.0294***	-0.0021
	[0.0053]	[0.0053]	[0.0076]	[0.0087]	[0.0070]
Pension Wealth* Group Age 46-50	-0.0415***	-0.0339***	-0.0567***	-0.0313***	0.0028
	[0.0054]	[0.0055]	[0.0076]	[0.0088]	[0.0071]
Pension Wealth* Group Age 51-55	-0.0470***	-0.0354***	-0.0624***	-0.0280***	0.0005
	[0.0057]	[0.0057]	[0.0078]	[0.0089]	[0.0072]
Pension Wealth* Group Age 56-60	-0.0342***	-0.0318***	-0.0563***	-0.0212**	0.0114
	[0.0059]	[0.0060]	[0.0080]	[0.0090]	[0.0073]
Pension Wealth* Group Age 61-65	-0.0420***	-0.0316***	-0.0599***	-0.0274***	0.0098
	[0.0069]	[0.0068]	[0.0086]	[0.0096]	[0.0080]
Accrual Rate* Group Age <25	0.3882***	0.4548***	0.2697***	0.4066***	0.4239***
	[0.0235]	[0.0280]	[0.0215]	[0.0264]	[0.0291]
Accrual Rate* Group Age 26-30	0.4592***	0.4478***	0.2627***	0.3737***	0.3658***
	[0.0173]	[0.0187]	[0.0155]	[0.0217]	[0.0229]
Accrual Rate* Group Age 31-35	0.5599***	0.5040***	0.3532***	0.4270***	0.3861***
	[0.0201]	[0.0204]	[0.0202]	[0.0263]	[0.0251]
Accrual Rate* Group Age 36-40	0.7249***	0.5959***	0.5416***	0.4703***	0.4822***
	[0.0277]	[0.0269]	[0.0309]	[0.0328]	[0.0328]
Accrual Rate* Group Age 41-45	1.0240***	0.8632***	0.8291***	0.5883***	0.6640***
	[0.0403]	[0.0391]	[0.0437]	[0.0410]	[0.0439]
Accrual Rate* Group Age 46-50	1.2624***	1.0744***	1.0141***	0.8449***	0.6026***
	[0.0563]	[0.0529]	[0.0577]	[0.0594]	[0.0488]
Accrual Rate* Group Age 51-55	1.5500***	1.2183***	1.3221***	0.7566***	0.8531***
	[0.0779]	[0.0709]	[0.0788]	[0.0679]	[0.0713]
Accrual Rate* Group Age 56-60	0.7733***	1.0208***	1.1375***	0.4795***	0.4027***
	[0.0630]	[0.0944]	[0.1020]	[0.0704]	[0.0723]
Accrual Rate* Group Age 61-65	0.9387***	0.9287***	1.0033***	0.7599***	0.5673***
	[0.1722]	[0.1789]	[0.1718]	[0.1774]	[0.1799]
Residual	0.0461***	0.0482***	0.0722***	0.0566***	0.0296***
	[0.0062]	[0.0063]	[0.0082]	[0.0092]	[0.0078]

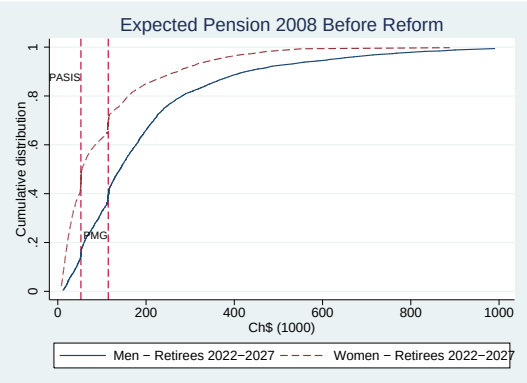
Standard errors in brackets *** p<0.01, ** p<0.05, * p<0.1, dummies. Pension Wealth and Accrual Rate are measured both in Ch$1000000. Dummies years and cohorts included.

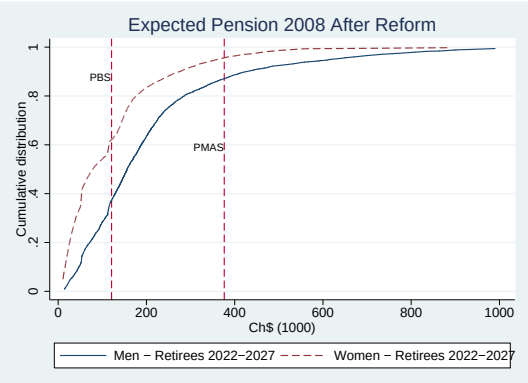
A.4 Outcomes of interest



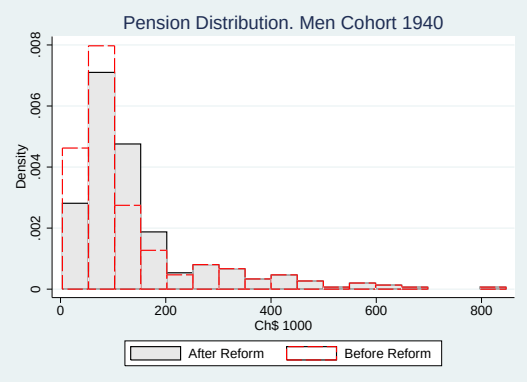


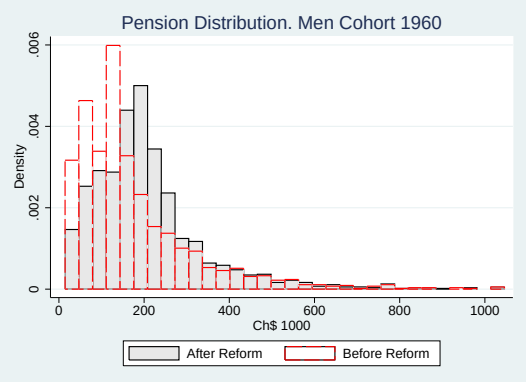


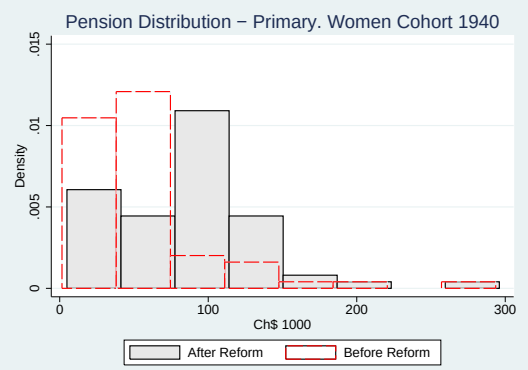


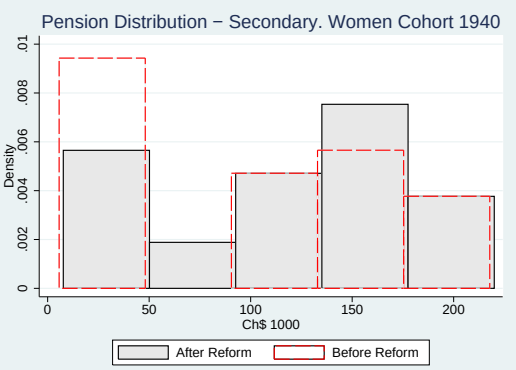


A.4.1 Changes in the distribution of pensions resulting from the reform.

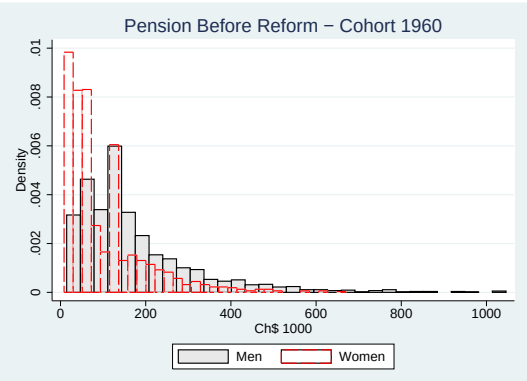


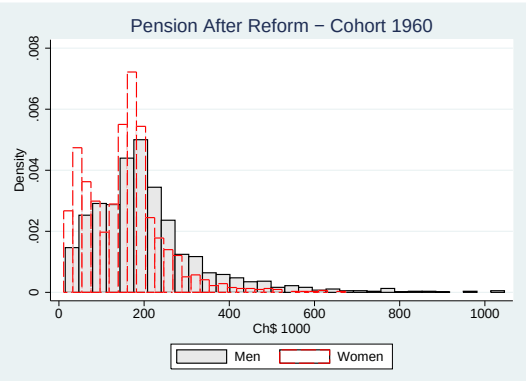


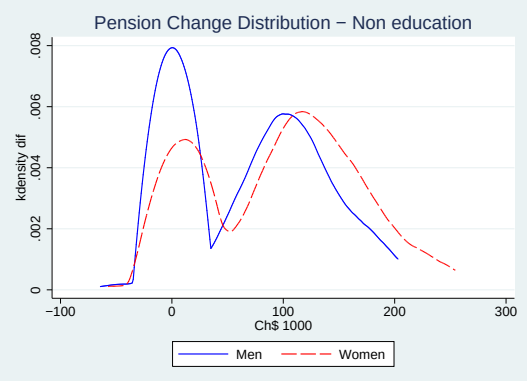


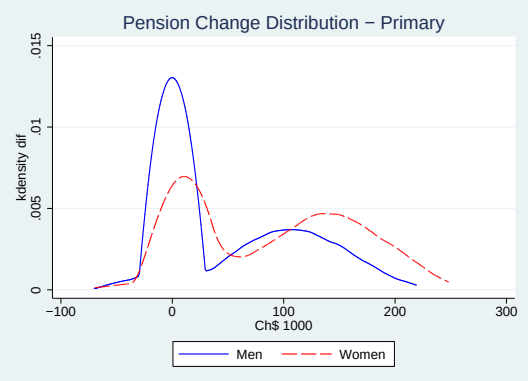


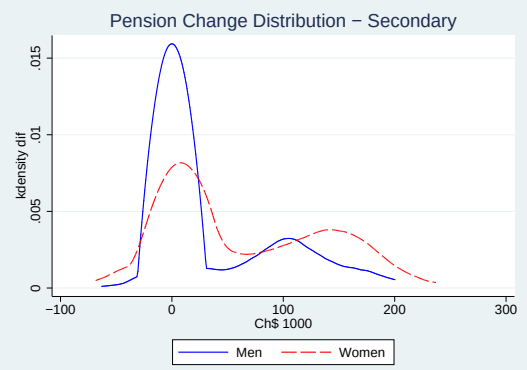
A.4.2 Changes in the distribution of the pension differences between men and women.

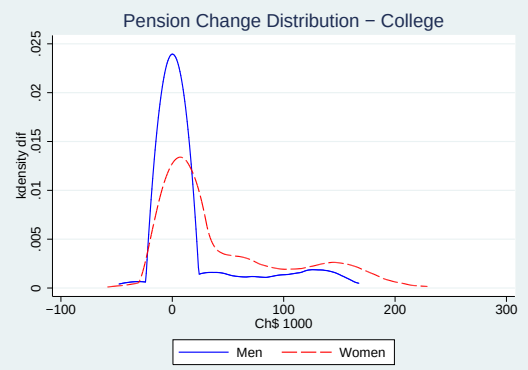




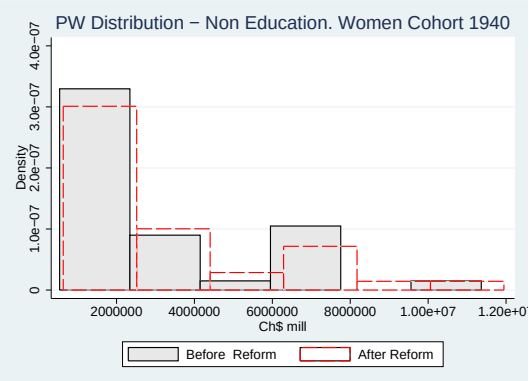


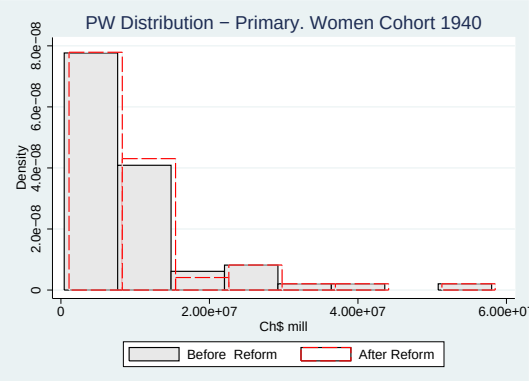


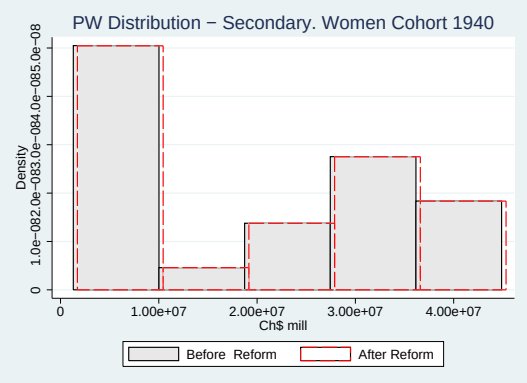


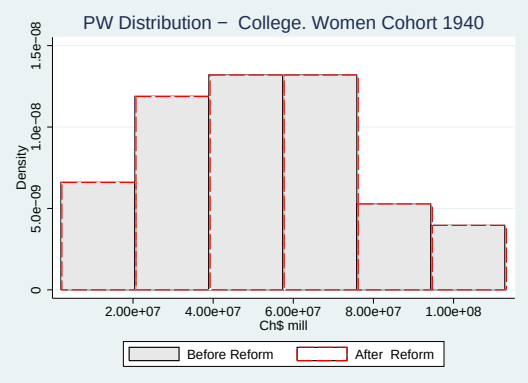


A.4.3 Changes in accumulated pension wealth before and after the reform.

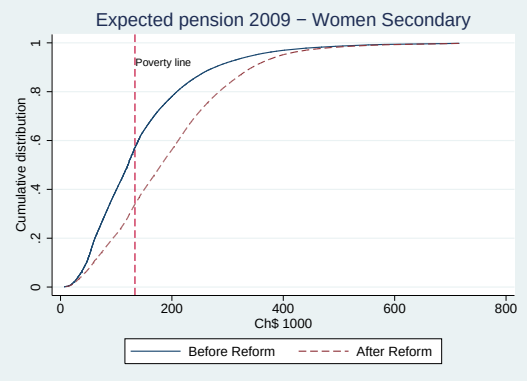


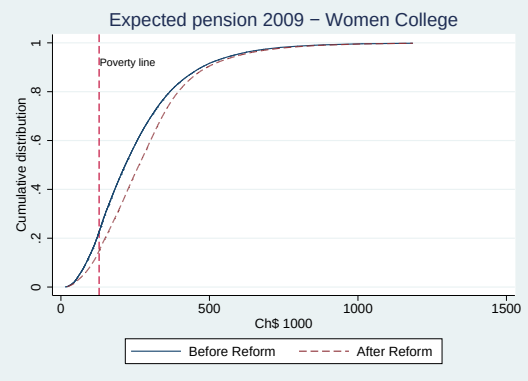




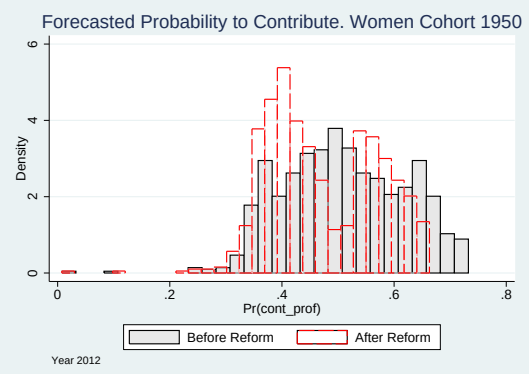


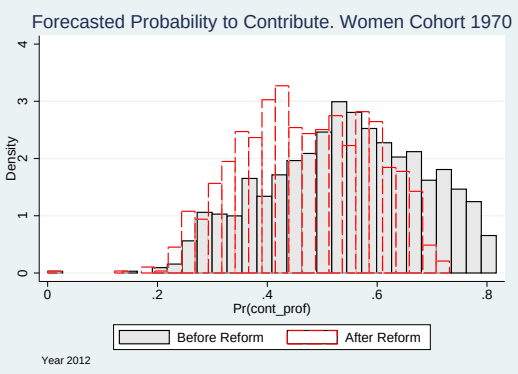
A.4.4 Changes in poverty levels before and after the reform for elderly people, in particular, for elderly women.

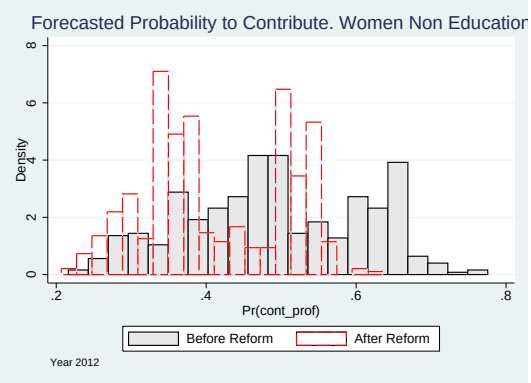


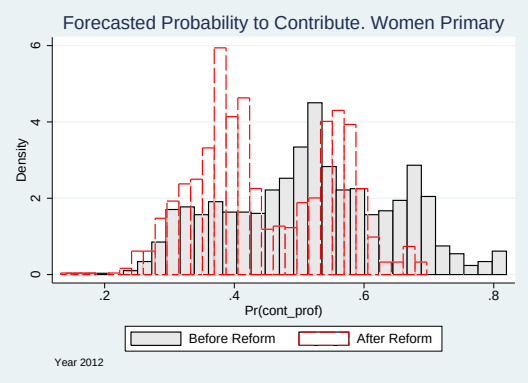


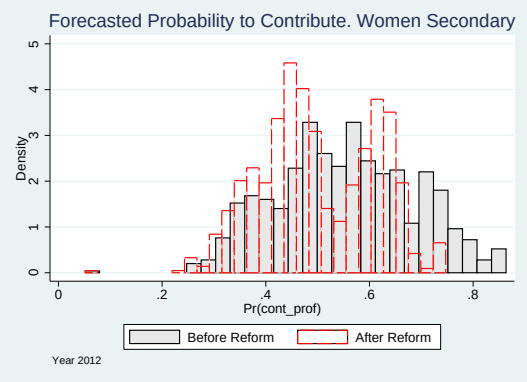
A.4.5 Changes in the probability to contribute and changes in the frequency of contributions.

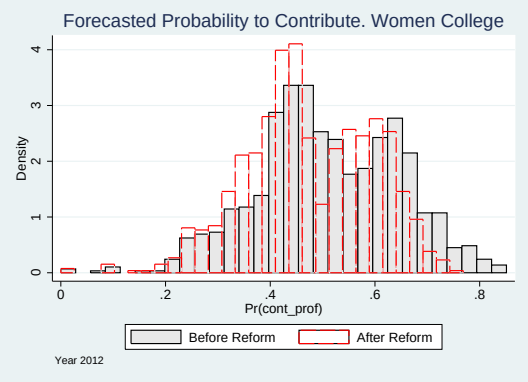


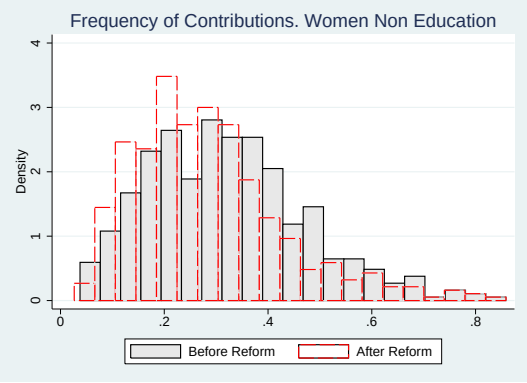


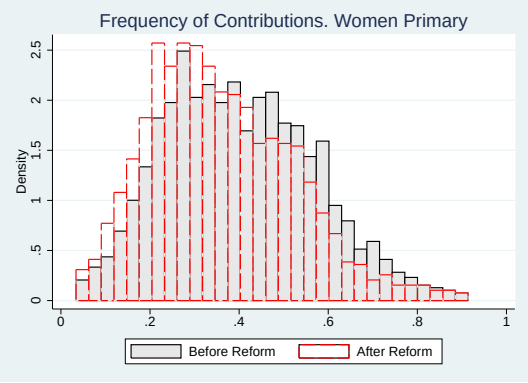

Forecasted Probability to Contribute. Women Non Educatior
Density
Pr(cont_prof)
Before Reform
After Reform
Year 2012

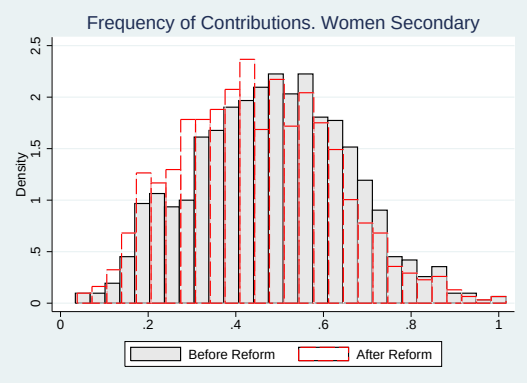

Forecasted Probability to Contribute. Women Primary
Density
Pr(cont_prof)
Before Reform
After Reform
Year 2012

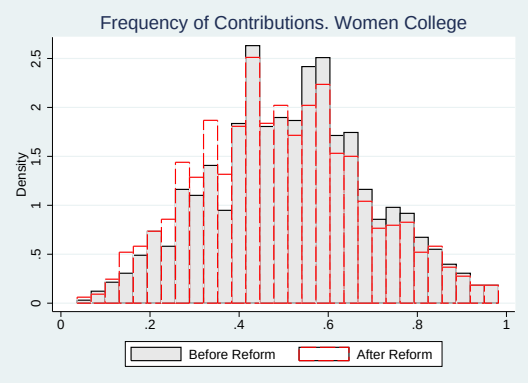

Forecasted Probability to Contribute. Women Secondary
Density
Pr(cont_prof)
Before Reform
After Reform
Year 2012


Forecasted Probability to Contribute. Women College
Density
Pr(cont_prof)
Before Reform
After Reform
Year 2012

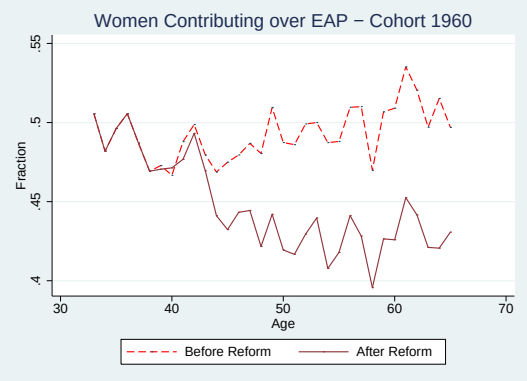

Frequency of Contributions. Women Non Education
Density
Before Reform
After Reform

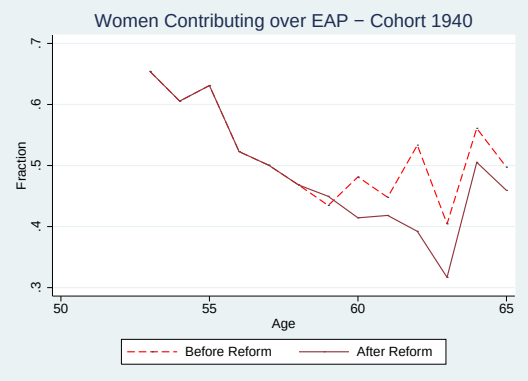

Frequency of Contributions. Women Primary
Density
Before Reform
After Reform

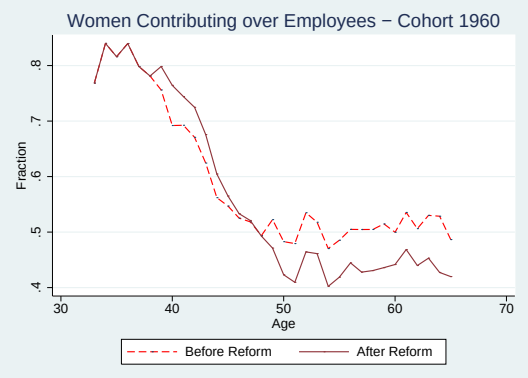




A.4.6 Changes in the coverage of the system measured as the number of women that contribute to the system over the employees and over the economically active people (EAP).







B Assumptions

1. Sample. Not retired AFP (No INP) workers between 20 and 65 years old.

2. Retirement age: We are assuming that all individuals will retire at 65 years old. No early retirement.

3. Interest rate=8%.

4. Recognition bond return=5% Individuals that contributed in the old PAYG system (pre-80s) will receive at retirement a bond (RB) recognizing those contributions. We are assuming a return of 5% for that bond. For individuals that have not claimed the RB, and then its value is not observed in the Administrative Record, we are assuming average values by age, education and gender groups.

5. Discount factor=0.97.

6. PMG/PASIS/PBS and PMAS values. For the welfare pensions before (PMG and PASIS) and after (PBS) the reform we are using the following Ch$ values: PASIS=44186; PMG=96391; PBS=7500; PMAS=70000 at 2008, 120000 at 2009, 150000 at 2010, 200000 at 2011 and 255000 at 2012 onwards.

7. PBS and PMAs growth=3% and PMG and PASIS growths at 1% annually.

8. Disability premium rate difference between men and women=0.2%

9. Partner's pension wealth fraction as compensation upon divorce= 30%

10. Minimum wage: Value of Ch$ 1650000 at 2009 and assuming a rate of growth of 3%.

11. Total contribution rate=12%

12. Cap contributions: 64 UF (Ch$20319). UF is indexed on inflation.

13. Pensions: All retirees are buying an annuity at retirement.

C Computing pension entitlements

The present value[53] of the expected accumulated pension upon retirement in periods $t = \{2002, .., 2009\}$ is computed as

$$E_t(PW_{iR}) = \sum_{j=0}^{t}(cont_{ij}) \prod_{j}^{t}(1+r_j) + E_t[\sum_{j=0}^{t}(cont_{ij}) \prod_{k=t+1}^{R}(1+r_k) + \sum_{j=t+1}^{R}(cont_{ij}) \prod_{j}^{R}(1+r_j)] +$$

$$+NE_{ij} + RB_{iR} \tag{9}$$

The first sum is the total observed[54] accumulated pension until period t. The elements following the expectation incorporate the unobserved future returns earn for the contributions done before t and all the future contributions and their own returns until retirement R. NE_{ij} captures the new elements introduced by the reform, such as the child subsidy and compensation upon divorce forecasted, $cont_{ij}$ is the annual contribution described below, r is the interest rate earned by the accumulated resources[55] and RB_{iR} is the recognition bond created for capturing any old contributions to the PAYG system[56].

$$cont_{ij} = \phi w_{ij} \times (\imath[W^F]\imath[W^E]) + \phi 0.8 w_{ij} \times (\imath[W^F]\imath[W^{SE}])$$

Where $\imath$ is an indicator function taking the value of 1 if the expression in the brackets is true and W^F, W^E, W^{SE} take the value of 1 if individual i is a formal worker, employee and self-employed[57], respectively.

[53] To make the things simpler we are not writing the discount factor, which is assumed to be equal to 0.97, in the following formulas.

[54] Observed by the employees, but not necessarily by the econometrician. We observed the real accumulated resources just for periods previous to 2005.

[55] Historical returns of the system has been higher than 10% since its beginning, see Superintendencia de Pensiones. We will assume future returns equal to 7%.

[56] We observe the RB value for those affiliates who have claimed it. However, for affiliates who have not claimed the recognition bond, we assume their values according groups defined by education, age and cohorts groups.

[57] Self-employed workers will be incorporated gradually to the system since 2012. Thus, we are not incorporating these workers in the analysis.

$$NE_{ij} = \lambda_i \times CA_{td} \prod_{j=td}^{R}(1+r_j)\imath[Woff] - \lambda_i \times \sum_{j=0}^{td}(cont_{ij}) \prod_{j}^{R}(1+r_j)\imath[Boff] + \quad (10)$$

$$+ \sum_{nc=1}^{Tc}[1.8MW_{tb(nc)}] \prod_{j=tb(nc)}^{R}(1+r_j)\imath[WO] \quad ; \quad 0 < \lambda_i < 0.5$$

The first two terms in equation (10) are the compensations upon divorce introduced by the reform. Family courts will determine if one of the member must be compensated receiving a fraction λ_i of the partner's accumulated resources, CA_{td}, when divorce happens at period $j = td$[58]. Woff (Boff) takes the value of 1 if individual i is considered by the court as the worst (better) off member. The final summation includes all the subsidies received for each child. Where MW is the minimum wage at period tb[59], Tc is the total number of children, tb(nc) [60] is the period in which child number nc was born and WO takes the value of 1 if individual i is a woman. Finally using the total expected accumulated pension wealth we compute pensions according the following formulas in the post-reform scenario.

$$P_{iR} = \begin{cases} PBS & \text{if} \quad \frac{E_t PW_{iR}}{12 \times CNU_{iR}} = PBS \\ & and \quad i \in 60\% \quad poorest \\ \frac{E_t PW_{iR}}{12 \times CNU_{iR}} + (PBS - \frac{PBS}{PMaS} \times PB_{iR}) & if \quad 0 < \frac{E_t PW_{iR}}{12 \times CNU_{iR}} \leq PMaS \\ & and \quad i \in 60\% \quad poorest \\ \frac{E_t PW_{iR}}{12 \times CNU_{iR}} & if \quad PMas < \frac{E_t PW_{iR}}{(12 \times CNU_{iR})} \\ & or \quad i \in 40\% \quad richest \end{cases} \quad (11)$$

Where PBS is the new non contributory welfare pension, PMaS is an upper limit pension[61] such as affiliates receive a pension complement defined as $APS = (PBS - \frac{PBS}{PMaS} \times PB_{iR})$, PB_{iR} is the sum of the self-financed pension plus any received

[58] Compensation upon divorce is for divorces after 2008 only.

[59] We are assuming a rate of growth of 3% for the minimum wage in all future periods.

[60] For children born before the reform the bond receives return since 2008.

[61] The PBS pension are readjusted annually according inflation. We are assuming a annual rate of growth of 3%.

survivor pension and any pension received from the past PAYG system and CNU_{iR} is a factor that incorporate the individual's life expectancy[62].

Prue-reform pensions are computed similarly but considering the cases when retirees receive either a PMG or the PASIS at retirement. Thus, retirees self-finance annuities according the accumulated wealth under the non reform scenario, receive a PMG if the annuity is below the value of the minimum pension at retirement and the 240 months of contributions requirement is satisfied and receive a PASIS if the the self-financed pension is lower than this value and the means tested requirement is satisfied[63].

[62] As the pension formulas show, we are computing pensions as annuities. All the computations were done using stata codes provided by the Chilean pension regulator, "Superintendencia de Pensiones". See Pino (2005). $\frac{1}{CNU_{iR}} = \frac{l_x \frac{1}{(1+r)^x}}{\sum_x^{110} l_x \frac{1}{(1+x)^x}} - \frac{11}{24}$ Where $l_x = l_{x-1}(1 - q_{i,x-1,R-1})$ is the number of people alive at the age x in period R,$(1 - q_{i,x-1,R-1})$ is the probability to die at age x-1 in period R-1 and $r = 0.8 \times rv + 0.2\bar{r}$ is an interest rate computed as a weighted average between the implicit interest rate in that past year annuity market (rv), which is assumed 3%, and the average last 10 years interest rate $\bar{r}$. If retiree has potential survivors the final retiree's CNU is the sum of survivors' CNU and his own CNU. We use mortality tables defined in RV-2004. As the insurance companies must finance retiree's funerals, they discount a mortuary fee from the original accumulated resources. Even though we are considering a mortuary fee in our computations we are not explicitly writing it in the formulas just for simplicity.

[63] PASIS is allocated according a poverty indicator and it has been usually given to retirees belonging to the first quantile.

2008 CHILEAN PENSION REFORM

NEW ELEMENTS	AIM	BENEFITS	REQUIREMENTS
I. Subsidiary Pillar			
Welfare basic pension (PBS). 1st July 2008.	To alleviate old age poverty	Flat pension of $60000. It will increases to $75000 from 07/2009	1. Belong to 40% poorest population at 2008 (increasing 5% each year until reach 60% in 2012). 2. Older than 65 years old. 3. Not eligible for contributory pension.
Welfare pension complement (APS). 1st July 2008.	Incentivate participation in the system	Pension complement which decreases with self-financed pension PB. APS=PBS- c*PB	1. Belong to 40% poorest population (increasing gradually until 60% in 2012). 2. Older than 65 years old. 3. Eligible for a contributory pension >0 and <PMaS

Note: US$1=Ch$0.0016, PMaS is the maximum pension such as one receives government pension complement. Its value is $70000 in 2008; $120000 in 2009; $150000 in 2010; $200000 in 2011; $255000 in 2012.

SUMMARY OF THE CHILEAN PENSION REFORM 2008

NEW ELEMENTS	AIM	BENEFITS	REQUIREMENTS
II. Compulsory Contributing Pillar			
Subsidy to the mother for every child. 1st July 2009.	To reduce gender inequality at old-age. Recognizing the childbearing periods	Subsidy equal to (1.8*MW)*R. For the period 07/2009-06/2010 the subsidy was $286,200	1. Women must be affiliated, receiving a survivor pension or be eligible for PBS. 2. Older than 65 years old.
Gender dependent rate for survivor and disability insurance. 1st July 2009.	Recognize different survival and disability risks for men and women	Women receive in their individual accounts the difference between the male and women rate offered by AFPs	1. Women must be affiliated.
Compensation upon divorce and Male survivor pension. 1st October 2008.	To reduce gender inequality at old-age and to equal gender rights	Worst off member will receive a fraction of couple's accumulated funds. Husbands will receive a survivor pension	1. Just for divorces after October 2008. 2. Final amount is decided by trial, will not be more than half of the couple's funds.

Note: MW is the minimum wage at the time of the birth of the child (t) and R is the rentability since (t) until retirement. For children born before 01/07/2009 the rentability is just from this date onwards.